DEVELOPMENT OF TALENT IDENTIFICATION MODEL FOR HOCKEY

A

Thesis

Submitted to

For the award of

DOCTOR OF PHILOSOPHY (Ph.D)

in

(Physical Education)

By

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PUNJAB
2018

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DECLARATION

I declare that the thesis entitled **"Development of Talent Identification Model for Hockey"** has been prepared by me under the guidance of Dr. Harmanpreet Kaur, Associate Professor, Department of Physical Education, Lovely Professional University, Professor J. P. Verma, H.O.D Psychology LNIPE Gwalior and Dr. Yuvraj Singh, Assistant Professor AMITY University Noida. No part of this thesis has formed the basis for the award of any degree or fellowship previously.

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ABSTRACT

Sports, an institutionalized competitive activity, the most exciting modern phenomenon involves rigorous physical exertion or the use of relatively complex physical skills by the participants, who are motivated by personal enjoyment and external rewards. Sports participation eternally benefits everyone irrespective of age, gender, caste, creed, race, ethnicity, socioeconomic status in multidimensional aspects for an individual and the Nation as well. Although professional sport is a modern phenomenon, but evidences showed that, it was there in ancient times too. Identification of most talented individual irrespective of discipline is as old as its existence and sports was not exception to this. But, the approach and methods towards talent identification have been revolutionized throughout the years' especially due to ever increasing professionalism, competitiveness to top the medal tally in various national and international level competitions, to economically use scarce but valuable resources, and broad scale commercialization of sports. Nations, professional organizations, physical educationists and coaches are always in search for identifying most talented and suggesting most objective, scientific criteria to address the issue in early childhood in different sports. Present research endeavors to focus on developing objective, scientific, parsimonious and multidimensional talent identification criteria in field hockey.

Field hockey, an Olympic sport since 1908 (London) for men and 1980 Moscow Olympics for women is the second most popular sport after football. Field hockey has undergone quite rapid and radical changes within the past few decades and has had a vast history, especially the memorable one for India. The physical, morphological, technical, tactical and physiological requirements of the game have drastically changed at all levels especially at elite level. To cope with these evolutions within the game, hockey players have to develop physiologically to meet the physical standard requirements of the elite level. The research in this area has gained popularity in recent decades, where numerous attempts to develop talent identification criteria have been made. But until, there is no theoretical framework which could be universally accepted. Indian sports scientists, researchers, physical educationists also stressed upon urgent need to develop Indian sports-specific talent identification model. The purpose of the present study was the "Development of talent identification Model for Hockey", which would be more comprehensive and scientific in approach. The objectives of the study were, to find out relevant anthropometrical, bio-motor, physiological and game skill variables for the development of talent identification model in field hockey and to develop the percentile scale norms. The study was conducted on 207 Indian youth male field hockey players of mean age 15.87±1.31 years and 4.61±1.56 years of playing experience, selected from different renowned sports academies in north India. Investigation was delimited to Anthropometric factors (Body weight, Standing height, Body mass index, Arm length, Leg length, Upper arm Girth, Forearm Girth, Thigh Girth, Calf Girth, Chest Girth, Wrist diameter, Humerus Bi Condyle diameter, Femur epicondyle diameter, Ankle diameter) Bio-motor factor (Left and Right hand Grip strength, Arm & Shoulder Strength, Core Strength, Leg Strength, Standing Broad Jump, Speed, Flexibility, Agility), Physiological factor (Resting heart rate, Percent body fat, Basal metabolic rate, Skeletal muscle mass, Aerobic power), Game skill factor (Shooting ability, Balancing ability, Ball Controlling ability). The data on selected variables was collected using valid and reliable tests/tools. The parametric data collected on interval and ratio scale for anthropometric, bio-motor, physiological and game skill factors, was described using mean as measure of central tendency, standard deviation as the measure of dispersion. However, median as a measure of central tendency and quartile deviation as dispersion was reported for asymmetrical data. Symmetricity was measured using skewness statistics, whereas kurtosis was used to understand distribution of the data. To accomplish the main objective of the study i.e. to develop a model to identify the talent in field hockey, factor analysis was applied. Assumptions for applying parametric statistics, factor analysis on the metric data to yield reliable results were satisfactorily fulfilled. Principal component analysis an extraction technique to extract and retain the variables into the factors was used. The developed model was tested for reliability using Cronbach's alpha, Spearman Brown coefficient, Guttmann split half reliability coefficient. Before accomplishing major objective of developing a multidimensional talent identification model, investigator had thoroughly analyzed five sub-objectives separately i.e. to find out the anthropometrical, bio-motor, physiological and game skill factors for the development of talent identification model in field hockey and further suggested percentile scale norms for easy interpretations of raw data.

Finally a talent identification model based on key multidimensional factors was suggested. Thus the talent identification model constructed to identify talent in field hockey explained quite high i.e. 75.414% of the total variance in explaining the latent construct, intended to explain talent identification in field hockey. This meant that out of 100 times, there is probability that the

developed model will accurately define talent 75 times. In other words one can also say that 75% of the times the individual will rightly be selected or rejected as being talented.

The developed model for identifying talent in field hockey, suggested three factors viz. physical, anthropometrics and skill factor. These were distinguishing factors to identify talent in field hockey. Factor one, "physical factor" is the most important and included four variables-left hand grip strength, right hand grip strength, standing height and vo2max. These variables jointly explained 33.645% of the total variance. Body mass index and upper arm girth were retained in factor two, named as "anthropometrics" and explained 26.094% of the total variance. Least important in the model was "skill factor" which explained 15.675% of the total variance in defining talent in field hockey. The findings of the present study are in line with the way many major sporting nations such as Germany, China, Cuba, USSR, Australia and Soviet Union attempt to identify talent at different stages.

Lastly, it is always of concern for evaluator that whom to select or reject as being talented. So, in order to assess performance, ascertain status quo of an individual in comparison to others and to further select or reject an individual as being talented or not talented, percentile scale norms were developed. To develop percentile norms raw data was first converted into standard Z-score, so that all the variables measured on different units of measurement could be converted into a single unit. The Z-score was then converted into transformed standard score (T-score). Percentile scale norms p3, p10, p25, p50, p75, p90, p97 percentile was calculated based on these transformed standard scores. Anyone can easily compare the obtained score on the variable of interest and get to know about their status in the population using percentile scale norms. Norms were developed for each variable separately, so that an individual or coach could assess weakness and strength by focusing on individual variables, but for comprehensive assessment of an individual composite norms should be followed. The percentile composite score was ranged from as low as p^{3} = 265.90 to as high as p^{97} =417.49. Investigator had suggested p^{50}= 353.78 as the point to make the decision about selection or rejection. So, anyone scored below 50^{th} percentile could be rejected as talented and subsequently an individual having higher centile point or percentile score than p^{50}= 353.78 could be selected as talented. The p^{50} was suggested because it is neither appropriate nor wise to exclude too many children's at the initial stage. The children's scoring p^{50} and above might be selected and then must put into talent development pools for continuous deliberate practice, then only the children's can further be reduced considering several factors such as, consequent testing on several dimensions, receptivity to training, rate of development etc. To conclude, talent may be defined as an individual with healthy body mass index, higher upper arm girth, longer stature, firm hand grip strength, exceptional aerobic power and higher shooting accuracy. India has made steady progress in sports in recent years and there is need to showcase this tremendous potential at global stage. Developed objective criteria for talent identification in field hockey will assist sports bodies, coaches, and physical education teachers in selecting physically, physiologically, morphologically, anthropometrically and skilfully more suited children's. This will reduce frustration induced dropouts and increase the sense of fun in identified sports. The application of the findings will filter the best out of the rest and will effectively tackle false negative and false positive in talent identification. Different sports organizations can use the findings of the present study to use scarce/valuable sources available economically, thus saving energy time and money and substantially reducing the time to reach at the highest level of performance.

An investigator's four years' deliberate efforts lead to the development of philosophical approach about the development of sports as a whole and talent identification in sports. Talent in sports is the sum total of everything an individual possesses whether it is stable or ever changing characteristics range from concrete objectively measurable anthropometrical, physical, biomechanical, at organic level physiological fitness, skilful, pace of learning new skills, receptivity to training, rate of development, genetics and to a huge number of unobservable characteristics cognitive, meta-cognitive, motivation etc. A talented individual possesses high abilities in productive thinking, decision making, planning, forecasting, communication and sound academics. Talent identification should always focus on stable factors; least affected by developmental process and are hard to change. The whole process of talent identification and nurturing of most talented should be based on ever evolving modern scientific principles. In India, we do not have right ecosystem for sports due to lack of institutional education program, weakened school sports system. In fact, school education program should focus on development of motor behaviour of children's, age appropriate training, and create equal opportunity for early and late bloomers. For realization of talent fully it has to be coupled with rigorous training spread over several years effected by parents/ teachers and coach's education, facilities provided, infrastructure available and support factor. Whereas specialized training in sports should only be started after strong foundation has been set by complete multilateral development up to 15 years of age. There should be talent developmental pools, NGO'S should be set in or schools should be used as developmental pools to provide age appropriate diverse physical education program from 6-14 years of age. The competition must be encouraged in the activities which are adventurous, enjoyable, recreational like tracking, mountaineering, climbing etc. together with athletic, gymnastics and swimming at junior level. Sports Academies should then select the players from such talent developmental pools for specialized training only after complete multilateral development. It requires a visionary, thoughtful administration which truly espouses the cause of sports.

Keywords: Talent, Talent selection, Talent Identification, Talent Development, Talent Emergence, Variance, Factor Analysis, Physical factor, Anthropometric factor and skill factor.

ACKNOWLEDGMENT

The work, as it stands, is the result of monumental motivation and prized help extended to me by eminent sporting scholars, senior colleagues and acquaintances. At this momentous moment of the completion of my thesis, I register a profound sense of gratitude to all of them. To begin with, I thank God, the almighty for showering endured blessings unto me throughout my life providing self-confidence, strength, will power and self belief to undertake the present study and accomplish it satisfactorily.

To be specific in acknowledging the persons whose consistent help has phenomenal, I deem it an honor to mention my worthy supervisor, Dr. Harmanpreet kaur, Associate Professor, Department of Physical Education, Lovely Professional University, working under her enlightened guidance has been a rewarding experience to me. I wish to express profound regard and gratefulness to my co-supervisor Prof. J. P. Verma, Head Department of Psychology, LNIPE Gwalior, whose incessant support and expert mentoring went a long way in enriching the content and accuracy of data incorporated in relevant chapters and Dr. Yuvraj Singh Assistant professor, Amity School of physical education and sports sciences, Amity University, Noaida. It was he who painstakingly chalked out the plan and guided me through all stages of my research work. My indebtedness to him is as immense as is my gratitude.

I express my profound gratitude to Sh. Ashok Mittal, The Chancellor and Smt. Rashmi Mittal, The Pro Chancellor, Lovely Professional University for providing research infrastructure and encouraging scholars for quality research work. Special thankfulness is done to Prof. Sanjay Modi, Dean Lovely faculty of business and arts. Dr. Neelam K Sharma, HOD School of physical education, Lovely professional university. Dr. Priya Bhagel Assistant professor, School of physical education, Lovely professional university, for their valued guidance during the course of my doctoral studies.

I register my sincerest reverence to my grandparents, parents for their unqualified motivation and trust in my abilities, Brother Mukesh Kumar college Director Physical Education and Sports, Government Degree College, Ramnagar (J&K), Ashish Sharma, Arjun Singh college Director Physical Education and Sports, Government Degree College Chatru, (J&K), and Vimal Kishore college Director Physical Education and Sports, Government Degree College Kishtwarh (J&K) for being a huge source of strength and positive energy for me, throughout my studies, I am equally thankful to all the others members of our Madhotra family for their eternal love, affection and encouragement. Their unstinted support would rejuvenate my spirits during the arduous moments of this project.

I also place on record a deep sense of gratitude to all the subject experts, sports scientists, and hockey players of different sports academies for their expertise support and cooperation during my field work.

I am grateful to have the true companionship, emotional support, motivation and consistent encouragement of my friends and colleagues Dr. S.S Aswal, Senior PGT English KV NO.2 Ambala cantt, Sanjeev Kumar, Sunjay Verma, Jagtar Singh in the completion of my study.

I too extend my heartfelt gratitude to Dr. Rekha Head CRDP and Dr. Naveen Assistant Professor CRDP, Lovely Professional University.

Date:

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CHAPTER-I

INTRODUCTION

Sports is as old, as the existence of human species on earth and can be defined as an institutionalized competitive activity which involves rigorous physical exertion or the use of relatively complex physical skills by the participants, who are motivated by personal enjoyment and external rewards. Any activity to be classified as sports, it must have to accomplish three major criteria’s first activity must involve physical exertion, skill prowess, second activity must be institutionalized and competitive and third the activity must be motivated by a combination of extrinsic and intrinsic motivation. In other words, sports is a physical activity that involves competition conducted under formal and organized condition i.e. the activity which is governed by standardized pattern or set of behavior, where standardized rules are enforced. Sports participation can eternally benefits everyone irrespective of age, gender, caste, creed, race, ethnicity, socioeconomic status in multidimensional aspects for an individual and the Nation as well. Although professional sports is a modern phenomenon, but evidences showed that gymnastics have been popular in China as early as in 2000 BC, Iranian martial art, polo, jousting and swimming, fishing was played in ancient Egypt, however for different reasons such as pastime, recreation and preparation for war etc. Sports being a physical activity, thus individual are sports performance is a byproduct of multidimensional human characteristics ranging from inherited characteristics such as genetics, anthropometrical characteristics, bio-motor fitness, physiological capacities, tactical abilities, psychological characteristics and game intelligence etc. Sports’ training is a scientific and systematic phenomenon of helping an athlete to achieve optimal performance or preparing an athlete for higher level of performance in adulthood. It is a long term process based on set scientific principles, there is no short cut in achieving excellence in sports. Sports training should involves making use of knowledge in all sports science disciplines such as anatomy, physiology, biomechanics, statistics, test & measurement, sports medicine, psychology, motor learning, nutrition, history and sociology for harmonious development of an athlete. A coach should prepare training plan on the basis of knowledge in these sports science disciplines. But today as the sports becomes a multibillion dollar business, always quest for dominating the sporting arena, with the ever increasing in competitiveness, professionalism there is continuous searching on the part of coaches and all the stakeholders responsible for making an athlete, the way to succeed in sports which includes various legal and illegal procedure of improving performance. Unknowingly that there is no supplement for hard practice put for years and years. In the quest to dominate the sporting world today most of the sports clubs, academies selecting the individuals for hard and specialized practice in early childhood (with the fear of being too late in training) and thus are playing with the natural developmental process. A child comes across through different stages of development after birth till adulthood which are marked by various hormonal changes, growth spurt, early/late development etc. It is always been important that training should be age appropriate without any infringement in the natural development process of the child. Due to the lack of planned school physical education program and awareness about the role of multilateral development in determining the future of an athlete, early specialization in sports easily can be seen in different sports activities and can have many negative consequences for an individual's health and for the destiny of sports. Mental readiness of the children is important to make him learn any motor skill, the child should be mentally ready to perceive. So in most of the sports especially the team sports the specialized training i.e. technical, tactical training should only be given after the age 13-14 years. Specialized training in sports should be started only after the strong foundation has been set by complete multilateral development between 13-17 years of age. Hugo (2004) suggested highly competitive sports should always be considered after 14-15 years of age, but there is still disagreement exists as to what is the suitable age to commence the specific sports training and talent identification and detection, Arnot & Gaines (1986) children's should be detected and identified only after 10 years of age, final talent identification should be taken place at the age of 14 years Riordan (1998) and further suggested that the age for talent identification at early age is different from sports to sports, whereas Australia focused on secondary school children's of 12-15 years of age. Gulbin (2001) and Pletola (1992) considered talent detection should be attempted at 12-14 years of age. There should be talent development pools, organization should be developed which can provide age appropriate diverse physical activity program from the age of 6-7 to 12 years. Limited competitions at sub junior and junior level, focus on winning should be only after multilateral development and sports specific mastery has been occurred reduced focus on winning at junior level. Encourage competition in diverse activities which can be adventurous, enjoyable such as varied recreational activities, tracking, mountaineering, climbing etc. which leads to the development in different domains. Competition can be encouraged in athletics, gymnastics and swimming at junior level. Sports academies should select the players from development pools for specialized training only after complete multilateral development occurred. Strengthening of school sports is of very much importance, if India has to regain the glory and do well in sports. In school education physical education should focus on gross motor movement in fact from kindergarten which should be operated by physical education personnel. Children's should be left free to participate in any kind of sports activity until 13-14 years of age, through a planned physical education program and providing required quality infrastructure and motivational strategies to involve all children's to be actively participate in sports. But providing uniform multilateral development is a major concern.

Field hockey played between two teams, generally a stick and ball game. The credit for the development of modern hockey, in which India had proudest moments and remained champion for nearly six decades, goes to England. It grew in English public schools around 1840's. The first club was established at Black-heath in South East London 1849 and the modern rule grew from a version played by Middlesex cricket club in winter. Earlier rubber cube was used as a ball and there was no striking circle, but with the establishment of Teddington Hockey club, it revolutionized the game by introducing the striking circle and a sphere ball in place of rubber cube. Hockey association founded firstly in 1886, Ireland played versus Wales in First international hockey match in 1895. Hockey was first introduced in 1908 London Olympics where Great Britain won gold for men and introduced in 1980, Moscow Olympics for women. In 1924 Hockey was not the part of Olympics due to some conflicts. But as it returned in the very next 1928 Amsterdam Olympics, where first time Indian hockey team had participated, from where Indian dominance started. Indian hockey had glorious past, it is very hard to accept the present status that the country, which had 6 Olympics gold in a row and dominated the world for around 6 decades has to struggle hard even to qualify for Olympics. This had laid the focus on what had gone wrong over the years that we lost hockey potential and curiosity for the game in youth, which is alarming. India won 6 Olympics gold medal in a row from 1928 (Amsterdam) to 1956 (Melbourne), whereas Olympic Games were not held due to world war 2nd in 1940 and 1944. First time India lost an Olympics gold to Pakistan in 1960 (Rome), India came back strongly in the next Olympics to won 7th gold at Tokyo (1964) fallowed by a bronze in 1968 (Mexico), 1972 (Munich) and it is from where Indian Hockey start declining. First time India came from the Olympic Games without a medal was in 1976 (Montreal) Olympics. In 1980 Moscow Olympics India won last ever gold after that drastic declining in the Indian hockey takes place at the Olympics and since then India is waiting for its first Olympic medal. But the greatest humiliation was when India could not even qualify for 2008 Beijing Olympics. The credit of starting hockey world cup in 1971 (men) and championship trophy in 1978 goes to the effort of Air chief Marshal Nr Khan of Pakistan. Women world cup was first played in 1974. India have a soul world cup gold in 1975. The physical, morphological, technical, tactical and physiological requirement of the game has drastically changed at all levels, especially at elite level due to the advent of synthetic playing surfaces, to cope with these evolution within the game, hockey players has to develop physiologically to meet physical requirement of elite level and to prevent the injury risk as playing on synthetic surface has more injury risk as compared to playing on grass Reilly & Borrie (1992). The artificial turf was introduced in early 1970's citing the reason, that it was cost effective in term of management in comparison to natural turf, reduces the chances of injuries as the surface is much flatter. Astroturf was co invented by Donald, James and Robert in 1965. First international field hockey game played at Astroturf was in 1975 (Molson Stadium) Montreal. Astroturf was first used in 1976 Montreal Olympics since then in every Olympic Games hockey has been played on turf, which was undigested for most of the Asian countries. Due to these quite rapid and radical changes within past few decades, the field hockey has now became fast and more attractive with the implementation of quarter rule on 1st September 2014 which reduces the time to 60 minutes of four quarters i.e. 15-2-15-10-15-2-15 unlike earlier where it includes two halves of 35 minutes each with 10 minutes half time interval, 40 seconds timeout was included which a team can take during awarding of penalty corner and after scoring a goal, these changing rules has put a huge physical demands on the part of the player and to cope with this a player has to be fitter Bishop, Brazin, Cree, & Turner, (2016). A lot have been rumored and talked about the cause of declining in Indian hockey performance, many assume that with the introduction of Astroturf, it shifts power base from Asian continent to European continent and also European supremacy over the world body which had made rules to suit the players of European continent. There is always been lot of excuses given and proud on the past, instead of thinking and improving the real cause and leave which had happened and could not be changed. Astroturf was introduced in place of natural turf, citing the reason it was cost effective and easy to manage, if it is cost effective than India and many developing countries should have sufficient Astroturf, but the truth is different even after 40 years of its implementation India have only few limited number of Astroturf and Indian hockey player first get a chance to play at Artificial turf at 19-20 years of age (Sardara Singh), another cause cited by world body that it reduces the injury risks while playing on the artificial surface in contrary to this, there are numerous evidences showed that there is not much difference in the occurrence of injury in both the surfaces and even some studies showed, increase in certain injuries on artificial surface, so why hockey had turned to Astroturf Indian administrator should objected but they did not. With the introduction of Astroturf the game became fast, ball travels more faster than natural surface, it demands more physical fitness with skills and techniques but the Indians are still highly dependent on skills which they too could not execute on artificial surface due to the lack of desired fitness although India had more than 50% of ball possession in its more than 80% of matches India had played in recent decades which includes unnecessary dribbling, too many fouls inside oppositions shooting circle to earn penalty corner, ineffective play in shooting circle and inability to convert field goals. India was the champion when very few countries played hockey globally (1928-1936 period where India won all the matches of Olympics one sided) as the number of countries started playing hockey regularly, Indian hockey started declining during 1960's from 1956 Olympics India fought hard for a single win, which means others had improved their game with time but we did not. In reality India failed to adapt to modernization in sports citing lack of funds and mammoth corruption at every step, No talent identification and game promotional scheme with declining interest in youth could also be a cause. Today rarely a young boy is interested in playing hockey because the stakeholders are not paying much attention to youth who can be the Indian future, thus we are losing future talent. Popularity is also drastically decreased. Lack of infrastructure and insecure future, lack of academies at youth level. Times of India reveals unscientific preparation or training at each level, Lack of physical fitness, Lack of focus, over reliance on few aspects rather on all areas of the game, Game plan conflicts in team management, federation system, and biasness in player selection effects talent identification and its development. In India we do not have right ecosystem for sports, no emphases is laid on strengthening the school sports which is the determinant of future in every field of life and the major issue is the lack of competent leadership who truly work for the cause of the game and sports either it is corrupted conflicting administration. No doubt hockey India league has retained some lasting interest. Tennis like system can be followed by allowing internationally some tournaments on natural turf and some on artificial turf. India should organize lucrative leagues on natural surface to attract foreigner to switch back to the natural surface.

The concept talent is like a conundrum for the sports scientists and coaches till today, as there is no consensus regarding the definition of talent and it is of greatest discussion among the scholars (Abbott & Collins 2004; Howe, Davidson & Sloboda 1998). The purpose of talent identification is the earliest possible selection of auspicious athlete in order to systematically maximizing their potential (Breitbach, Yug, & Simon, 2014). Moon (2003) defined talent as an exceptional natural ability to attain goal. The talented players learn personal characteristics such as technical skills faster than most of their peers and gain more from training (Toering et al., 2009). In games and sports, talent identification means identifying the promising individual who have perceived potential, talent and inherited natural ability to excel at highest level and have maximum probability of getting medals in a particular sport at highest level. Now question arises, weather talent exists or as more interestingly being demonstrated by the researchers that talent can be created, While verifying its reality Howe et al., (1998) gave example of many autistic savants and child prodigies which prove veracity of innate talent and numerous researchers also indicated that autistic savant exists and they can play art and music without any instruction (Miller, 1989). Although in our day to day life coaches, physical educationists see a child with exceptional nature ability in any field around us, but the questions which surrounds is, how it will be defined or identified. Ommundsen, (2009) defined talent is something one has, something one is, something one can be and something one can develop, here it cover both the static as in first three which are more genetically determined and dynamic aspects in the latter case which depends on the environment. It means talent is something which lives under the forearm of heredity and environment. It is not necessary that every child possess inherited pre-requisite required to excel, but the critical factors such as coaching, training facilities and willingness to train may develop excellence in sports. If parents are active, than there is 5.8 times more chances of child being active than the children's of non-active parents (Hugo, 2004). The literature on talent identification and development is very limited; moreover there is no research on athletic talent identification (Pearson, 2002). Talent identification and development had given interest only in 2007, when two editions of International journal on sports psychology and high ability studies revealed talent identification should takes place at all ages and levels of play, but typically must target young and adolescents for identification as they have much time to develop. Identifying talent accurately at different ages and levels of play is difficult and greatest challenge for whole sports fraternity. Generally talent is identified by examining physical ability Simonton (2001) cautioned on the use of uni-dimensional aspect, considering sports and talent both or multidimensional in nature, further suggested motivation, cognitive abilities, and Meta cognitive abilities plays important role in realizing athletic talent. Athletic talent is the sum of physiological and supports factors, further suggested potential to develop depends on psychomotor factors, and thus every child should be given utmost opportunity to develop psychomotor fitness. But one should not forget the fact that each sport has unique characteristics and needs, therefore each sport should have specific talent identification Model (Vaeyens et al., 2008). Talent identification demands consistent focus on productive thinking (talent to generate unusual ideas and finding interesting solution), decision making (talent to take most appropriate decision after comprehensively analyzing situation), planning (talent to prepare strategy for the execution of an idea), forecasting (talent to understand cause and effect and make possible predictions), communication (talent to express emotions, ideas in different verbal and non-verbal ways) and academic talent (talent to gain multidisciplinary knowledge) (Callahan, 1997). There are numerous factors which can affect the performance of an individual, it is very difficult to determine the sequence of these variables on the basis of they affects the performance of an athlete, but it also could not be ignored that performance may depends on some specific variables and if we can find those variable carefully, we can easily classify the players to their respective game and sports. However, it is very complex task to find out (determine those variables which can directly affects the performance of the sports person however it is not impossible to detect those variable) the specific variables for the game but not impossible. It may take long time to specify (those specific variables) the specific variables for the game. But, if we want good performance at the higher level, so we need to accept these challenges and work on it. The variables that can affect the performance of an athlete can broadly be classified as physical, physiological, anthropometrical, morphological, biomechanical body compositional and sports skill (Burr, 2008; Roczniok, 2016; Kutáč, & Sigmund, 2015). Physical, physiological, skill, sociological and psychological factors were placed in hierarchical order of their importance in recruiting and identifying the players to field hockey. Physical, physiological and skill factors are most important factors as they are most stable and hard to change, therefore in order to get progress in these one has to work intensively hard for longer period of time, although physiological factors cannot be changed like type of muscle fibers one possess such as to perform high intensity contractions like sprinting etc. required fast twitch type of muscle fibers, whereas to perform repeated contractions for longer period such as marathon, cross country running required higher proportion of slow twitch muscle fibers, which both are genetically determined and cannot be changed, in result they can change the fate of sportsperson. There is no doubt that numerous factors can affect the performance of an athlete i.e. Human performance can be affected by the physiological, physical and anthropometric components of an individual (Rico-Sanz, 1998). It is well generalized and published in various journals recently, that the sports events are mostly dependent on the Physique of an individual (Rico-Sanz, 1998). Some studies have suggested that anthropometrical variables were highly related to the performance of an individual (Bond, et al., 2015; Chaouachi, 2009; Sertić, et al., 2007). Higher level of competition can be classified on the basis of anthropometric profiles and specific physical characteristics of an individual (Claessens, et al., 1999). On the basis of existing literature, the researcher had selected all those possible anthropometric variables which could affect the performance of an individual at the higher level. Authors from time to time had suggested sports skills played key role in determining the performance, without appropriate sport skills, it is impossible to develop performance at elite level (Hermiston, 1979). LTAD model developed by Balyi (2001), on small group of Canadian cross country skiers was used worldwide, especially in UK for talent identification. This model focused on identifying a promising player at young age and then by following certain phases i.e. learn to train (understand how to train), training to compete (get training to enhance competitive performance), training to win (training to perform at highest level) and retirement (learn to cope without sports) to achieve top performance. But, the appropriateness of using this model as a talent identification tool for all sports was questioned by many sports scientists from time to time. Talent identification system currently used in Britain is single system pathway (SSP) focused on creating equal opportunity to every field hockey player and provide suitable coaching and competition at the appropriate stage to maximize everyone's potential. As the competitiveness among the countries, clubs, and professionalism in sports is growing day by day it becomes increasingly necessary to identify the promising individual at youngest possible age and then providing suitable learning and training environment to nurture the acquired talent. Talent identification and development programs are relentlessly been used in sports but both these terms have gained popularity in recent decade, where numerous investigations have been done in this area. Elferink- Gemser, (2005) stressed need for knowledge and understanding of how talent can be identified best. Several sports science disciplines are actively engaged in tackling this problem, how do we know who is talented and who not, but though, till now there is no uniformly accepted clear cut procedure and theoretical framework is available to guide current practice of talent identification and development programs. Sports performance as well as talent is a multidimensional and dynamic concept this problems cannot be solved unidemsionally, so it becomes crucial to give due importance to the multidimensional and dynamic aspects of sports and talent while developing a talent identification model for any particular sports (Russell, 1989; Williams & Reilly, 2000; Vaeyens et al., 2008). The concept of talent identification n sports is important and thrust area in sports investigation to estimate the future potential of an athlete at an early age, as talent indicators/predictors are indicative of the seeds of outstanding performance (Verma, 2009, 2011; Kamlesh, 2012). Singh, (1991) further stressed a need for talent identification when stated that talent development and its identification has became significant research area in games and sports; an individual having talent only have a chance to win a medal in different international competitions, an individual identified as talented must have gone through rigorous training for several years to ensure win at higher level. But, there is no doubt in it that ultimately talent determines the boundary to the level to which performance in sports can be improved through rigorous and hard training. There is no doubt in it that talent in games and sports is a byproduct of heredity (genetically inherited traits) and environment (in which the individual is brought up), but an individual should be gifted with basic minimum of inherited biological potential only then the acquired talent can be developed through training.

Previous studies had suggested that physical fitness components played an important role in determining the performance of an individual, without desired level of physical components for the concerned game we cannot expect the higher performance in the competition at higher level. These studies on physical components indicated that importance of physical components is not negligible (Burr, et al., 2008). It is not mandatory that each and every game need similar physical fitness or components, because every game has its own degree of difficulty thus specificity of physical components also changed according to the game. The level of physical fitness required for a footballer is not required for chess player likewise the physical components required for a volleyball player may not be same for a hockey player (Pandey, & Sardar 2015; Nara 2017). There are six different physical components which are most important for assessing the physical performance or for improving the performance of an individual i.e. strength, endurance, speed, coordination, flexibility and agility. Almost all sports require some amount of these abilities or combination of these because these six factors are major to classify the performance and these factors can significantly affect the performance of sports person. After introduction of turf and quarter system of playing, field hockey becomes much faster in nature and required greater amount of physical fitness and sound technique. Studies have shown that there is significant relationship between many of the physical fitness variables with the hockey performance (Hoppe, et al., 2015). So, for identifying the talent for field hockey it is important to emphasis on bio-motor variables, along with this regular assessment can also help to prepare the training program for the athlete (Gursoy, et al., 2012), on the basis of physical abilities an individual can be identified or rejected as being talented (Edwards, 1994; Dudink, 1994; Helsen et al., 2000). Deliberate theory proponents (Ericsson, Krampe & Tesch-Romer 1993; Singer & Janelle 1999) suggested volume hour spent on deliberate practice considering intensity and content may be not inherently enjoyable, determination, concentration, a well defined challenging task, feedback, repetition and error correction are directly related to expertise in sports. The commitment to sports can be ascertained by the level of enjoyment, personal investment & involvement opportunity, realization of positive initial experience, family influence, facilities, equipments, coaching, injuries and situational factors (Bloom 1985). Agility, flexibility, hand grip strength, speed (35 meter sprint) arm span, aerobic power are important parameters to identify players and recruit them to represent their country (UK) in the hockey world cup at the Hague the Netherlands (Hit 2 Hague a talent recruit scheme). Field hockey is an intermittent endurance sport which involved short repeated sprints with and without ball (Manna et al., 2009). Superior performance in field hockey is influenced by bio-motor factors (aerobic, anaerobic capacity, strength, speed, agility (Nikitushkin & Guba, 1998) & anthropometric characteristics such as body size, height, weight, diameters, composition (Scott, 1991; Singh et al., 2010). Field hockey players tend to bend forward to the ground to handle the ball effectively with maximum range of motion Sodhi, (1991) which lead to the back and abdomen muscles come under huge stress, stressed a need for stronger back, also back strength was found positively correlated with hip circumference, height, weight, BMI, abdominal muscle endurance and % lean body mass (Koley et al., 2012). Physiological, anthropometric, and skill- related tests can be considered for talent identification (Keogh et al., 2003).

Anthropometry deals with the measurement of an individual in terms of circumference, mass, skeletal diameter and length etc. Anthropometry is broadly used to classify an individual and to identify the talent for a particular sport. Because of its convenience, anthropometry can be used to understand the physical characteristics of an individual in the field of sports science and also helps to predict the target improvement in performance of an athlete. Anthropometric measurements had shown significant relationship with physical characteristics and the sports capabilities revealed by numerous previous studies. Different sports required different anthropometric composition, it might be seen in elite athletes that, an athlete required different anthropometric composition then that of a field hockey player and a football player, field hockey and football player required different anthropometric composition in comparison to that of volleyball or basketball player. Anthropometric characteristics may assist coaches trainers as well to fix the desired and most suitable position of an individual, where an individual can give his best in team Sports, such as in Basketball, coaches appoint longer player in the pivot position (Kagawa, M. 2008). In recent years, numerous anthropometrical studies had suggested that anthropometric variables are very important in distinguishing the players among themselves. Anthropometric variables can play a key role in defining the players as per the requirement of different games. The result of these studies had shown that each sport has their own anthropometric requirements (leone, 2002).

Higher performance in sports is significantly determined by physiological capacities and body composition variables. Every sports activity has unique physiological requirements, further there is huge difference in predicting performance based on physiological capacities for open and closed loop sports. The performance in closed loop sports (100 meter, marathon running, swimming etc.) can easily be predicted quantitatively, but the performance in open looped sports (hockey, football, cricket, kabaddi, kho-kho etc.) is affected by numerous factors, which affect the predictive power**.** Cardio respiratory endurance (Vo2max) can be predicted with accuracy using lower heart rate, heart rate reserve, and relative work power capacity of the field hockey players (Hanjabam, & Jyotsna 2017). Further resting pulse rate could predict hockey playing ability and should be considered while attempting to identify talent in field hockey (Suthamathi, & Suganthi 2014; Emmanuel, 2012). (Reilly 2009; Keane et al., 2010; Gabbett 2000; Reilly, & Borrie 1992) suggested a range of physiological variables and the variables having strong genetic influence played a huge role in talent identification such as vo2max, aerobic fitness. Elite and senior field hockey players are significantly better in body mass index, anaerobic power, higher triglycerides, total cholesterol, high density lipoprotein, low density lipoproteins and lesser percentage body fat (Manna et al., 2010). International field hockey players were too having lesser body fat percentage and it significantly predicts hockey performance Singh, et al., (2009). Given the desire to realize optimal potential, the timing and pace of growth spurt such as physical characteristics and maturity rate should not play a crucial role in the selection of talented athletes (Malina & Rogol, 2011). Varied amount of anthropometrical characteristics, physical ability, physiological capacities are fundamentals to higher sporting excellence, they set and determine the extent to which the most specific and complex sporting skills can be learned and trained at the sports specific and higher performance training stage. Therefore, suggesting talent identification criteria without giving due consideration to general and relevant sporting skills would not fulfill the purpose. Investigator had selected general, fundamental playing skills such as shooting in the target, balancing the ball on the stick and moving with ball, which could be detrimental to sporting prowess at later stage. These variables were used to check the playing ability of hockey players.

Genetical testing can be used to identifying talent in children's but the knowledge till date is not more beneficial as compared to the existing method of physiological testing (Boutina, 2007). Genetical testing in Japan done to identify intelligence, athletic ability and artistically sensible child, more specifically identifying gold medalist gene. Application of genetical testing could impact the career of tested individual negatively, as test results may be discourages or identified individual may be pressurized. 70% of an individual's maximum force, Power or capacity is a matter of genetical factors and having a major role in performance capacity (Astrand & Rodhal, 1986). However UNESCO has warned on using genetic testing and asked for respecting uniqueness and diversity, parents have primary responsibility of upbringing and nurturing child, study raises serious questions on genetical testing of a child (Inoue, & Muto, 2016). There is lot of burden on identified young children as a talented i.e. to carry a beacon of excellence to fulfill their potential, children's loss interest in sports as they progress to secondary school. Early talent identification make them averse of participation in single sports, pressure of expectations, winning rather the process should be enjoyable (Clark, 2012). Only 1% students continue playing sports in college level from among school students, Dropout is also a challenge in talents identification and developmental process. This all to a greater extent is a function of cognitive aspects of children's as it is stated by Jonkes et al., (2012), that cognitive skills plays a crucial role in development of sports carrier and to become an elite athlete. It needs a comprehensive research on the measurement of cognitive characteristics related to sports. There is need to make the approach to talent identification more scientific, as in general the children's were selected in the sports to which they were psychologically, physically, physiologically unsuited led to frustration, early dropouts (Bompa 1985; Pletola 1992; Ghita 1994), which leads to lose the sense of fun in sports Molinero et al., (2006), Because if the children's are not playing the sports to which they physically, physiologically, anthropometrically, technically or tactically suited, then they may not be intrinsically motivated, can be less goal oriented and dropout sooner ((Elferink, 2005).

Performance in any sports can be characterized by several multidimensional factors ranging from anthropometrical (standing height ,body weight, leg length, knee diameter, thigh girth, calf girth and skin fold (biceps, triceps, sub scapula, suprailiac, Arm length, Shoulder width, Arm span, arm length palm length, forearm, waist, Fat percentage, hip width, chest width), bio-motor (grip strength, explosive leg strength, strength endurance, agility, flexibility, shoulder flexibility, leg strength, back strength, speed, endurance, upper body strength, lower body power, counter movement jump, sit-ups, Arm & shoulder strength, explosive strength, endurance of legs, sprinting speed, Abdominal strength, Arm & shoulder flexibility, Trunk flexibility, vo2max), physiological (Breath holding capacity, Resting pulse rate, Resting respiratory rate, Vital capacity, resting heart rate, resting, Aerobic power and Anaerobic power, oxygen consumption, peak expiratory flow rate, aerobic capacity), psychological (self-efficiency, anxiety, self-confidence, state and trait anxiety, motivation, personality inventory, intelligence in group, sports achievement motivation, team cohesion, Task Orientation, Ego Orientation, Rebound Ability, Ability to Handle Pressure, Concentration Ability, Attraction to Group Task, Group Integration Task, Attraction to Group Social, Group Integration Social, Mental toughness, concentration ability, pressure tolerance, motivation level, confidence level, rebound ability), technical (dribble performance in a peak and repeated shuttle run), tactical (general tactics; tactics for possession and non-possession of the ball), game skill (passing for accuracy, kicking for distance, shooting in the goal, receiving dribbling feinting heading, tackling and ball sense), playing ability, maturation, cognition, sociological, cultural, morphological, and train-abilility. Providing an individual with appropriate training opportunity and learning environment, so that the child gets optimal to realize his potential and natural ability. In the process of talent development it becomes decisive on the part of coaches and trainers to give challenge & chance to the talented athletes, to be responsible for their own development rather than to make all the decisions by the coaches themselves, which meant a player, should be given equal opportunity in the decision making process (Van Ark et al., 2009, 2010), as proved by Malina et al., (2000) and Starkes (2000) that the players who have clear goals and are responsible are more successful in their carrier. The players with clear and realistic goals, monitor one's own personal development, perceived competence, knowing what to do and how much efforts require to put and realize one's goal, making right decisions at right time, creating environment with opportunity to develop as effectively as possible (Zimmerman, 2002 & 2006). Australia established Australian institute of sports in 1981 to focus on systematic approach to elite sports which consequently improved the medal tally for Australia in Olympics. Australian government initiated a centrally funded talent identification scheme "Talent search program” (keeping 2000 Sydney Olympics in mind) by screening school going children’s from 2000 high schools to test their physiological abilities to identify potential elite performers not involved in sports and put them into the sports based on their physiological potential. Further Australia reduced funding to these initiatives after 2000 Sydney Olympics, led Australians to slip in medal tally same has happened with other countries as well.

Effective management of talent by means identification, development, appraisal, deployment & retention of highly potential individual, is still in infancy state. Researchers need to use different methodology for solution; much improvement is required in the process of identifying, developing, managing, positioning and retention of right individual at right role, so that organizations can spend disproportionate investment on those who are the future prospects (Mcdonnel, 2016). Everyone has talent and special ability irrespective of minority, economically disadvantaged, culturally different (Fulkerson, & Horvich, 1998) and not limited to certain advantaged classes having rich sporting infrastructure, financial assistance. The talent identification process in sports should cross the boundaries of urban limitation and should stretch to every nooks and corner of the country. Talent should not be wasted, there should be a centrally controlled proper talent identification process, scientific nurturing of talent, more importantly stakeholders should invest more at junior level and sustain interest only than Indian sports can become at par with international sports. Visionary, thoughtful leadership and administration who truly work for the cause of sports is required.

1.1 Statement of the Problem

Ever increasing competitiveness, Professionalism and urge to top the medal tally in various National and International Competitions, to use the scarce but valuable source in economical way and to increase the profile of sports in the country, it becomes increasingly important on the part of physical education teachers, coaches, clubs, association and Nations, to identify the most promising athlete in early childhood, to remain at top or to gain top position in sports. Till date there is no Indian model to identify talent (Chengappa, 2013). Most scientific approach towards identifying the talent is used in China, followed by Russia, USA, Australia and Cuba which too evident from their supremacy in International competitions like Olympics (USA is the champion followed by Russia and China), Asian games (China) and Commonwealth games (Australia followed by England). Indian sports scientists, researchers; physical educationists also stressed on urgent need to develop Indian sports specific talent identification model. Further there should be a talented identification scheme owned by government similar to Australia, keeping in view, researcher has stated the topic as "Development of talent identification Model for Hockey", which might be comprehensive, holistic and scientific in approach.

1.2 Objectives

Major Objective

1) To develop talent identification model in field hockey.

Sub objectives

1) To find out anthropometrical variables for the development of talent identification model in field hockey.
2) To find out bio-motor variables for the development of talent identification model in field hockey.
3) To find out physiological variables for the development of talent identification model in field hockey.
4) To find out game skill variables for the development of talent identification model in field hockey.
5) To provide percentile norms.

1.3 Hypothesis

The developed talent identification model might significantly define the latent construct "talent identification" and significantly helps in identifying talent in field hockey.

1.4 Significance

Ever evolving nature of sports (amateurism to professionalism and large scale commercialization) tremendously increased the competition among nations, clubs, associations and its impact on sports has significantly increased the demand for talent identification at appropriate stage. The major aim of talent identification is to find the individuals who are promising and have required prerequisite's to succeed in future. Pienaar et al., (1998), highlights the importance of talent identification saying talent identification is a priority for modern sports, sporting bodies, association and elite programs.

It is an evolutionary process, which contributes for identification and selection of those, who have or showing potential to develop, the most prominent advantage of talent identification is to assist sports bodies, organizations to scarcely use their limited and valuable resources in most beneficial and productive way. If one could shed light on the most objective and scientific criteria of talent identification and selection through one's study, he will be rendering yeoman's service to physical education teachers, coaches and sports administrations, (Kamlesh 2012). The research will take sight into talent identification and development programs in sports, as this is important to increase performance and secure future, present study is significant in the following aspects.

The study will provide an objective Indian criterion for identifying talent in field hockey and to suggest definite parameters for talent identification. The study will significantly help to make the approach to talent identification more scientific and increase the horizon of knowledge in the field of hockey, as in general the children's were selected to the sports to which they are psychologically, physically, physiologically unsuited leads to lose the sense of fun in sports and leading cause of dropouts in sports Molinero et al., (2006). Thus the study will helps to reduce frustration which arises due to participation in unsuited sports, (Bompa 1985; Pletola 1992; and Ghita 1994).

The study will help to ensure economical use of available infrastructure, money and personnel i.e. coaches, so that one can use the vital and most important resources in developing promising children's, thus save energy, time and money. Present study will acts as a filter to remove children's, having less/few perceived important characteristics when applied to a large population it increase the profile of sports in the country attracts children and secure future of young athletes. Further the study will help the sports associations, talent development pools, and sports clubs, to deal with the problems of false negative (erroneously overlooked the talented) or false positive (erroneously identified as talented) effectively.

Present model will help to accurately discriminate between best and rest. The model not only help to identify which predictors are most important, but will also allow to put forth the most parsimonious and predictive selection model possible, which in turn also reinforce the idea of assessment of each player holistically.

The study will provide much needed help to the coaches in knowing the athlete holistically and to focus more on those aspects that makes athlete successful on the players who have many years to develop. The result of this research endeavor has significant implication in coaching science and overall talent identification process. The study will foster the government, sports associations to have the talent identification scheme; As in China, Australia, Cuba, where systematic governmental system is fallowed for spotting talent, (Chengappa, 2013) it will improve the likelihood of medals at the international competitions. To sum up this process of using scientific criteria in talent detection and identification, helps the talented individual to substantially reduce the time to reach at high performance thus training also becomes more effective and increase competitiveness, self-confidence, also eliminate the high volume of energy, work and talent on the part of the coach (Bompa, 1999). The result of the study will provide criteria to identify the talent in early age and will serve as a breeding ground for future research in the area. The study will further improve the reputation of Lovely Professional University by contributing in the area of talent identification in sports.

1.5 Delimitations

1. Present study was delimited to 207 Indian youth male field hockey players (14-17 years), who were training in field hockey from at least one year in different hockey academies, training centers and developmental pools.
2. The study was delimited to the district level North Indian field hockey players.
3. Study was delimited to the following factors:
   I. Anthropometric factors
   II. Bio motor factor
   III. Physiological factor
   IV. Game skill factor
4. The present study was delimited to following Anthropometric Variables:
   - Body weight
   - Standing height
   - Arm length
   - Leg length

- Body mass index
- Upper arm Girth
- Forearm Girth
- Thigh Girth
- Calf Girth
- Chest Girth
- Wrist diameter
- Humerus Bi Condyle diameter
- Femur epicondyle diameter
- Ankle diameter

5. Present study was delimited to the following Bio-Motor Variables:
    - Hand grip strength (LHGS &RHGS)
    - Strength Endurance
        (i) Arm & Shoulder Strength (PU)
        (ii) Core Strength (FAP)
        (iii)Leg Strength (LLWST & RLWST)
    - Leg explosive power (SBJ)
    - Speed (SP)
    - Flexibility (FL)
    - Agility (AG)
6. Present study was delimited to the following Physiological variables:
    - Resting heart rate
    - Percent body fat
    - Basal metabolic rate
    - Skeletal muscle mass
    - Aerobic power
7. Present study was delimited to the following Game skills:
    - Shooting in the target.
    - Balancing the ball on the stick.
    - Moving with the ball.
8. The study was delimited to the selected sports academies and training centers/institutions from north India:

1.6 Operational Definition of the Term

Talent: In the present study talent is defined as the individual's ability or potential to perform at highest level.

Talent Selection: Is the scientific process of selecting the players for immediate competition.

Talent Identification: In games and sports, talent identification means identifying the promising individual/child who have perceived potential, talent and inherited natural ability to excel at highest level and who is currently involved in sports with maximum probability of getting medals at highest level.

Talent Development: Talent development is the process of nurturing an individual through different stages of development from fundamental to higher performance training stage through deliberate practice put on for several years.

Talent Emergence: Is defined as an individual who is talented will emerge itself without giving special consideration.

Variance: Is defined as the extent or proportion to which the spread out different variables explained the latent construct talent in filed hockey.

KMO Test: Is the statistical technique to measure adequacy of sample size taken in the study.

VO2 Max: Also known as maximal oxygen consumption is the indicator of the aerobic power. It is the amount of oxygen consumption during incremental exercise; it is a point above which an individual can't consume more oxygen irrespective of increase in exercise intensity. Although it is genetically determined, but to somewhat extent it can alter through training, it limits the performance in aerobic sports to a greater extent.

Factor Analysis: Is a statistical technique used to reduce large number of variables considered to be associated with performance into few significant variables which explained much of the variations of the group characteristics and to a structure which can be easily understood.

Principal Component Analysis: PCA is a factor extraction technique used to extract the factors explaining maximum variance.

Physical Factor: In the present study physical factor explained grip strength, aerobic endurance and physical stature of an individual.

Anthropometric Factor: In the present study is defined as individual's weight to height ratio and upper limb musculature.

Skill Factor: In the present study is defined as an individual's ability to hit the ball accurately between the target placed at 10 meter distance.

Chronbach's Alpha: Calculates consistency in the findings.

Skeletal Muscle Mass: Is the proportion of voluntary muscles and individual posses.

Percent body fat: Is the proportion of fat in terms of percentage an individual possess in the body.

Shooting in the target: Is defined as the ability of the player to hit hockey ball with the stick accurately between the target.

Moving with the ball: Is defined as the ability of the players to run and move while keeping the ball in constant touch with the blade of the stick.

Balancing the ball on the stick: Is the ability to hold or balance the ball on the blade of the stick without tossing the ball.

1.7 Limitations

Certain factors like daily routine, lifestyle, deliberate practice done, family history and dietary habits of the subjects could not be controlled and might have affected data.

Insincere responses from the players might leads to the existence of biasness in data and are also considered as limitations of the study.

During data collection no special motivational technique was used to influence subjects, although the players were encouraged to do their best & cooperate in testing process; however lack of motivation might have affected data and is also considered as the limitation of the study.

CHAPTER- II

REVIEW OF RELATED LITERATURE

Talent identification is a big business, whether it is in sports, arts through education. Researchers in all domains, relentlessly trying to find a way to identify the best in their respective field. Talent is of supreme importance for the rise of any nation at international stage. In sports domain too, identifying talented individual at suitable age, following scientific principles is of utmost importance and is detrimental for success. The construct talent identification in sports, is truly a multidimensional aspect and the numerous previous studies have been tried to explore the concept from various different perspectives and collectively suggested that talent identification is most critical issue the sports is facing today. In order to understand it holistically, a comprehensive literature review was undertaken. The investigator has carefully examined contemporary research studies, clarifying various dimensions, myths, wrong practices surrounds talent identification. A review of relevant and extant research studies on talent identification in sports had been categorized as below:

1. Conceptual, Reviewable and theoretical approach to talent identification.
2. Worldwide Current practices in talent identification.
    - Anthropometric correlates of success.
    - Physiological determinants of success.
    - Talent identification based on bio-motor variables.
    - Game skill variables as the base for talent identification.
    - Genetics and talent identification.
    - Multidimensional approach to talent identification.
3. Country wise approach to talent identification.
4. Principles & Criticism of Talent identification.
5. Research gap.

The process of talent identification, development, appraisal, deployment & retention of highly potential individual, is still in infancy state, researchers need to use different methodology for solution, much improvement is required in the process of identifying, managing, positioning and retention of right individual at right role, so that organizations can spend disproportionate investment on those who are the future prospects (Mcdonnel, 2016). Talent identification is a pertinent component of sports science, helping practitioners, the opportunity to target developmental opportunity to the selected few optimizing economical use of resources (Carls, et al., 2016)**.** Baloni, (2014) studied management issues that might influence development of sports (football) in India and revealed 71.5% of the respondents believed that lack of scientific knowledge in talent identification process and unscientific selection influence the development of the sports in the country. Not giving serious consideration to talent management can have many serious consequences as Anthony, (2011) identified crucial issues the practitioners facing in effective talent management. Emphasized that talent management will be the most important challenge the organization will face in the coming decades due to workforce demographics and skill shortage can leads to the "war for talent", suggesting best criteria for talent management is a competitive necessity. We are yet to define an exact science in discovering or developing athletic talent and suggested multidimensional factors should be considered while attempting to identify talent (Gray, 2010). Pearson, Naughton, & Torode, (2006) emphasized the importance of identifying talent at youngest possible age in streamlining the resources and getting maximum output from individuals. Therefore, if a talent identification model has to succeed a multidimensional and reliable testing procedure must be adopted. This section critically analyzed and reviewed past research procedures employed for talent identification in sports. As the performance is naturally multidimensional, but most researches in the domain till date has displayed a uni-dimensional focus i.e. concentrating solely on the anthropometric measurements with no attentions being paid to any other factor of crucial interaction. Remember Bailey (2007) reported that only 0.001% of current school people, who are involved in sports probably, reach at highest level in sports. In this chapter investigator, had holistically reviewed all the past approaches followed to address talent identification ranging from conceptual, theoretical to unidimensional models and finally the need for multidimensional model.

2.1 Conceptual, Reviewable and theoretical approach to talent identification

Saether (2014) conducted a reviewable study which aims at knowing the coaches perspectives to identify the talent in soccer. A reviewable study included 9 studies among 100 National, states, regional level coaches of Norway. The data was collected using questionnaire and interview technique. The result indicated that the coaches focus on player's skills, mental skills (Personality, perceptual cognitive skills, game intelligence, daring to try, taking a chance, inner drive, willingness to train, self-resilient, courageous, hardworking, dedicated) technical, physiological, sociological, tactical psychological, their own position in talent identification process, motivation was considered as most detrimental and the players who are responsible, self-reliant were considered as talented. Whereas some of the coaches were of the opinion that technical, physiological, anthropometrical, sociological factors are less important. Coaches could have problem in identifying the talented due to lack of definite factors to separate the players, Further the study had recommended that the study was limited to one country which included the studies on youth and senior top level coaches of Norway the finding can be different from state to state and country to country.

Lidor, Cote, & Hackfort (2009) reviewed 13 previous studies conducted on those who were talented and those who were less-talented athletes distinguished groups in order to predict the athlete's future success. Review analyzed and highlighted number of limitations. Studies recommended that, coaches lessen the batteries of motor skill and physical tests used in the early phases of talent development. Physical and skill tests should be administered under resting and exertion conditions, to meet more real world task, through a unison efforts of coaches, researcher, measurement and evaluation experts, much sensitive physical and skill tests should be developed to apply during early phase of talent identification and development.

Christensen (2009) interviewed eight national youth team soccer coaches to explore how talent identified in soccer. Analysis of findings indicated that talent was identified by coaches in three ways. In the first way coaches use their visual experience and their practical sense to distinguish patterns of movement among the players. In the second phase the coaches classify the promising athlete by their preference so-called "autotelic" i.e. the player who showed highest potential to learn and practice, third the coaches has the final authority and act as arbiters.

Vrljic (2008) interviewed five district level football coaches experienced in coaching and identifying most talented young football players in Queensland. The inductive analysis by the coaches opined that physical skills, cognitive skills, cognitive perceptual skills, personal characteristics, speed, ball control and desire to succeed are most distinguished factors in differentiating the talented and less talented players.

Helsen, Hodges, Winckel, & Starkes (2000) identified the potential contributors in identifying the talent i.e. physical precocity (early talent related with relative age effect) and practice in developing an elite soccer player. The study was depending on the coach's perspectives and past literature that assess the progress of provincial, National and International players. The finding suggested the practice volume per week, everyday activity and demands of various practice, found a positive relationship in individual's team practice and skill.

Morris (2000) psychological variables has a role to play in identification and development of talent in soccer, the investigation reviewed numerous cross-sectional studies didn't revealed any clear pattern, studied relationship between psychological characteristics and performance in football conducted more than the last 30 year. This investigation has shown a relationship between psychological characteristics but suggested further research on talent identification and creativity is obligatory to imitate the results found through the present study. The study did come up with several interesting findings among them the sum of the suggestions were of the opinion that the findings of the present reviewable and cross-sectional study conducted on adult individuals cannot be applied to identifying talent in adolescents (young individuals between 13-16 years of age). The investigation stressed on quasi-longitudinal or longitudinal research to decide whether the analogous psychological uniqueness is important for stupendous performance all through the process of development or whether psychological variables measured during adolescence could predict exceptional performance in adulthood. Callahan (1997) revealed talent identification demands consistent focus on productive thinking (talent to generate unusual ideas and finding interesting solution), decision making (talent to take most appropriate decision after comprehensively analyzing situation), planning (talent to prepare strategy for the execution of an idea), forecasting (talent to understand cause and effect and make possible predictions), communication (talent to express emotions, ideas in different verbal and non-verbal ways) and academic talent (talent to gain multidisciplinary knowledge).

Limoochi (2013) studied (40 international level tennis) coaches opinion about talent identification using questionnaire and 36.1% of the coaches revealed anthropometric (standing height, pelvis width, weight, sitting height, forearm length, trunk leg ratio, trunk standing height ratio and arm length), 11.1% physiological (ATP-PC, fast tissue percentage in bat arm, percentage of slow tissues in legs, lactate threshold, vo2max, percentage of fast tissues in legs, and percentage of slow tissues in bat arm), 12.9% physical/bio motor (agility, explosive power, coordination, general endurance, general speed, general strength, flexibility and dynamic balance), 33.3% psychological (intelligence, decision making, reaction time, anticipation, recognition), 25% psychomotor (motivation, self-confidence, concentration, handling mental pressure, hard-working, arousal, attention and boldness), and 8.3% somato-type variables should be considered while identifying talent in sports.

Summary

Review of different conceptual/ reviewable and theoretical studies on talent identification suggested that coaches emphasized on their experience, their own position in talent identification process and considered players personal skills (Personality, perceptual cognitive skills, game intelligence, daring to try, taking a chance, inner drive, willingness to train, self-resilient, courageous, hardworking and dedicated) should be assessed along with due importance should be given to sociological, tactical and psychological factors (Saether, 2014). Moreover it was observed that coaches give preferences to their visual and practical experiences, select autotelic players and acts as arbiters (Christensen, 2009). Vrljic, (2008) suggested cognitive, cognitive perceptual, physical, personal characteristics and game skills are distinguishing factors among talented and less talented athletes. Talent identification demands consistent focus on productive thinking (talent to generate unusual ideas and finding interesting solution), decision making (talent to take most appropriate decision after comprehensively analyzing situation), planning (talent to prepare strategy for the execution of an idea), forecasting (talent to understand cause and effect and make possible predictions), communication (talent to express emotions, ideas in different verbal and non-verbal ways) and academic talent (talent to gain multidisciplinary knowledge) (Callahan, 1997). In the opinion of the international level tennis coaches anthropometrical (standing height, pelvis width, weight, sitting height, forearm length, trunk leg ratio, trunk standing height ratio and arm length), physiological (ATP-PC, fast tissue percentage in bat arm, percentage of slow tissues in legs, lactate threshold, vo2max, percentage of fast tissues in legs, and percentage of slow tissues in bat arm), bio-motor (agility, explosive power, coordination, general endurance, general speed, general strength, flexibility and dynamic balance), psychomotor (motivation, self-confidence, concentration, handling mental pressure, hard-working, arousal, attention and boldness), psychological(intelligence, decision making, reaction time, anticipation, recognition) and somatotyping should be considered while attempting to address talent in sports (Limoochi, 2013). Physical and skill tests sensitive to use in early phase of talent identification should be developed through unison efforts of different stakeholders and apply these tests during both resting and exertion condition Lidor, et al., (2009), further Helsen, et al., (2000) laid emphasis on deliberate practice volume per week, everyday activity and demands of various practices are crucial for talent identification and development.

2.2 Worldwide Current practices in talent identification.

2.2.1 Anthropometric correlates of success

Hanjabam, & Jyotsna (2017) found anthropometric variables has a role to play in determining optimal strength & flexibility of a field hockey player which can leads to performance improvement and prevent injury risk. The findings revealed the taller players with broader chest, hip, hand length, limb length, body weight, fat free mass & body mass index was found associated with upper limb strength, back strength, endurance, flexibility, lower limb strength and also ascertained positive correlation between %body fat, body mass index and fat free mass. The study concluded that anthropometrical variables especially breadths, heights and body composition may serve as a monitoring tool for talent identification as they predict bio-motor abilities.

Lemos, Paz, Maia, Da Silva, Lima, De Castro, & Miranda (2017) maintaining optimal body fat percentage is of prime importance and may contribute in improved field hockey performance. As % body fat may decrease aerobic power, Hanjabam, B. S. & Jyotsna, K. (2017) revealed vo2max was negatively correlated to body weight, %body fat and body mass index.

Rana (2016) findings showed that national level players were taller, heavier and healthier ascertained by BMI (20.31)

Bakhtiyari, Ebrahim, Aghaee, & Yousefi (2015) studied anthropometric (weight, BMI, sitting height and arm length) and found favorable anthropometric characteristics for Iranian Hockey players.

Sahu (2015) compared 20 male collegiate hockey and cricket players of 18-22 years of age selected from Kolkata, Jalpaiguri on body segments and BMI . Findings showed hockey players were significantly taller in stature, having higher leg and arm length and cricket players were having higher BMI, further no significant difference was found in body weight.

Suthamathi, & Suganthi (2014) constructed a specific test battery in hockey and suggested biepicondylar femur width and sitting height could be considered while selecting talent.

Sidhu (2012) predicted hockey performance from selected anthropometrical variables (skin-fold fat, circumference and diameter measurements) on 200 interuniversity level players. Coefficient of correlation showed that standing height and arm length has significant relationship with performance.

Dillern et al., (2012) studied anthropometric characteristics and aerobic capacity on 32 Norwegian elite recruit female soccer players in relation to playing position. Findings suggest that different playing position have different needs therefore there should be different physiological training plans for different playing positions to ensure maximum benefits.

Van den Berg, Coetzee, & Pienaar (2012) determined whether biological maturation has any effect on anthropometrical determinants for talent identification, by studying U/14 top provincial female players. Data was collected using Biological Maturation Identification Questionnaire on Biological maturation and on 28 anthropometrical variables. On the basis of assessment subjects were grouped into 4 early mature, 11 averages and 11 late developers. No statistical difference was observed between different biologically maturation group on anthropometrical variables. However on the basis of rankings the findings suggests average and late developer players may outshine the early developer in overall tennis performance.

Manna (2011) studied morphological variables, among 120 (n=30 in each age groups U16, U19, U23, Senior) subjects. Result revealed that U23 and senior players were significantly better in body mass, height on comparing to U16 and U19 players.

Natarajan (2010) predicted handball playing ability from selected anthropometrical (Height, Arm Girth, Arm Length, Hand Span) variables. Handball playing ability was rated subjectively by three experts during match situation. 100 university men handball players of age 17-25 had participated voluntarily. Multiple regression method revealed anthropometrical variable could predict handball playing ability.

Mohamed (2009) studied morphological variables between elite and sub-elite youth handball player. MANCOVA revealed elite players were heavier, further discriminant analysis suggested height was important parameter for identifying talent.

Reilly (2009) established role of anthropometric characteristics in talent identification and development, revealed top class soccer players are required to adapt to the multi factorial demands of the game. The players should have high standards in all domains of physical performance. There is no hard and tough for extraordinary capacity. The study suggested that a range of relevant anthropometric characteristics having strong genetical influence (such as stature) can be considered for talent identification.

Singh, Kanwar, & Kanwaljeet (2009) compared Indian, Pakistani and Srilankan field hockey players on anthropometric variables. Findings revealed that Pakistan team had significantly higher upper arm length & bi-hummers diameter whereas Srilanakan players had significantly less hand width, wrist circumference and lean body mass further Indian team had significantly lesser percent body fat.

Lauren (2007) studied role of biological maturity, relative age and physical size in the selection to age-banded ice hockey team. The findings analyzed using ANOVA and other statistical techniques applied in the data analysis revealed the selected players were taller, heavier and more mature (i.e. biologically mature predicted using age at peak height velocity) and too coaches appeared to selecting the players who are early maturing players and who born in early quarter of the year.

Pramanick (2002) predicted badminton playing ability by studying 25 international national and state level players from selected anthropometric (Ht. Wt. arm length, leg length, trunk length, hand girth, thigh girth, calf girth, shoulder width, age) Dependent variable playing ability was rated subjectively by the experts. PPMC, Multiple correlations, ANOVA and multiple regressions showed that arm length, trunk length and height were found significant and should be used to predict badminton playing ability.

Nieuwenhuis, Spamer, & Rossum (2002) identified kin- anthropometric variables to predict field hockey performance on female youth field hockey players 27 players were from top two winning teams and 25 players were selected from the teams which have finished at the bottom. Result revealed anthropometrical variables (Humerus and femur diameter) significantly differentiate between successful and less successful youth female field hockey players.

Sharma, Tripathi, & Koley (2012) established strength of relationship of anthropometric variables with hand grip strength, aerobic power, lower limb power and skill tests among Indian male field hockey players. Result of the study indicated that height was positively correlated to weight, hand grip strength and lower limb power, whereas negatively correlated to percent body fat and dribbling ability. Further body weight was positively correlated to percent body fat, hand grip strength and lower limb power however negatively correlated to slalom sprint.

Scott (1991) eight morphological parameters were directly measured to ascertain important characteristics of elite male field hockey players. Findings revealed hockey players were ecto-mesomorphic and found that elite male field hockey players were characterized by tall stature, low percentage body fat.

Summary

Every sports is unique in itself and require varied anthropometrical characteristics in order to excel at highest level. The anthropometrical characteristics required for a basketball player may not be similar for weightlifter, similarly anthropometric characteristics required for field hockey players different from that of a table tennis players (Leone 2002). It was evident from different research studies in field hockey and other sports that elite field hockey players used to be taller, heavier and healthier (Rana 2016). Further anthropometrical variables (broader chest, hip, hand length, limb length, body weight, fat free mass & body mass index) determine bio-motor abilities (upper limb strength, back strength, endurance, flexibility, lower limb strength), prevent injury risk and ultimately leads to performance improvement in field hockey (Hanjabam, & Jyotsna 2017). Sharma, Tripathi, & Koley (2012) revealed that anthropometrical measurement such as standing height predicts weight, hand grip strength, leg power and playing ability Natarajan (2010), whereas negatively predicts percentage body fat, dribbling ability and body weight was positively correlated to percentage body fat, hand grip strength and leg power, further %body fat and body mass index predicts vo2 max (Lemos et al., 2017). Bakhtiyari et al., (2015) suggested maintaining anthropometrical variables at optimal is necessary in any performance domain, as anthropometrical variables having strong genetical influence (stature, leg length, arm length, bi-epicondylar femur width and trunk length) and having a larger role to play in whole talent identification process (Reilly 2009; Mohamed 2009; Suthamathi & Suganthi 2014; Lauren 2007; Pramanick 2002), whereas percentage low body fat and BMI should also be considered while addressing to identify talent in field hockey (Scott 1991; Sahu 2015; Sidhu 2012). Anthropometrical variables has a detrimental effect on individuals performance in field hockey evident from senior national team of Pakistan and India, on comparing both the teams it has been found that Pakistani field hockey players were having significantly higher upper arm length, bi-hummers diameter and Indians had lesser body fat percentage Singh et al., (2009), further anthropometrical variables (humerus, femurs diameter, height, weight and BMI) significantly differentiate between successful and less successful field hockey players and revealed that successful and senior players were significantly taller, heavier, better BMI, higher humerus and femurs diameter (Nieuwenhuis, Spamer, & Rossum 2002; Manna, Khanna, & Dhara 2011).

2.2.2 Talent identification based on bio-motor variables

Alias, N. et al., (2018) study showed that physical fitness components should be considered to identify talent in field hockey at young age.

Hanjabam, & Jyotsna (2017) found bio-motor abilities (optimal strength & flexibility) may be predicted from anthropometric variables can leads to performance improvement and prevent injury risk in field hockey. The findings revealed the taller players with broader chest, hip, hand length, limb length, body weight, fat free mass & body mass index was found associated with upper limb strength, back strength, endurance, flexibility, lower limb strength, body composition may serve as a monitoring tool for talent identification.

Lemos et al., (2017) established relationship between Sargent jump test, agility and core muscle endurance with skill performance with & without ball among Brazilian female field hockey. Results indicated agility, core muscle endurance showed contribution in hockey performance.

Kusnanik et al., (2017) studied distance covered by a field hockey player during a game and revealed that a female field hockey players cover lesser distance and time spent in walking and running than other players based on literature.

Rana (2016) on comparing field hockey players of different levels revealed national players were significantly better in muscular strength speed and agility.

Bakhtiyari et al., (2015) studied physical fitness (36 meter shuttle run, Illinois test, standing broad jump, bending forward, 1600 meter, sit and reach and zig-zag jump test) found players were weak in most of the physical fitness variables and suggest more thorough study of the variables.

Boyer et al., (2013) & Tong et al., (2014) and Jernstedt et al., fore arm plank test is a valid and reliable test to measure core muscle strength and endurance in athletes.

Nallella (2014) studied psychomotor skills (Reaction time, movement time ,eye hand coordination) and psychological factors (Anxiety ,Aggression, Motivation) among randomly selected 200 hockey and football players of 18-22 years of age selected from Osmania and Telangana University. Data was collected on ground during intercollegiate competition, mean, SD, t-test, correlation and ANOVA revealed insignificant difference between hockey and football players in relation to simple visual reaction time and audio reaction time of Osmania University, However significant difference was found in Kakatiya University. Meant hockey and football are almost same nature of sports.

Sultana, & Pandi (2013) predicted Athletic Ability by applying Talent Identification Model (world beater talent test) on 156 randomly selected boys of 12-14 years from Tirunelveli Tamilnadu who were identified as talented. Multiple regression revealed inherited factors strength, speed, power and coordination were best predictors of athletic ability.

Burr et al., (2008) predicted hockey playing potential from fitness variables at elite level. The findings of the study revealed the body index (composite score of lean mass, height and muscular development) and standing broad jump were important to predict overall hockey playing potential.

Durandt et al., (2009) studied physical demands of field hockey and soccer players and revealed no difference in speed and repeated sprint test, whereas field hockey players had stronger upper body further concluded that same sports specific tests can be used to measure sprinting power and sprinting fatigue resistance, however questioned the use of same upper body tests.

Abbott, Button, Pepping, & Collins (2005) early talent identification is important in any performance domain, Germany and Soviet Union select talented performers on the basis of physical and performance measures.

Wassmer, & Mookerjee (2002) developed a profile and examine relationship between hand grip strength, power and sports specific performance among female field hockey players and indicated similarities in players playing at different playing positions with international players, further power was found correlated to specific performance in field hockey especially pushing accuracy.

Scott. (1991) revealed field hockey players were having ecto-mesomorphic personality and found that elite male field hockey players were characterized by higher right hand and left hand grip strength, superior leg strength (SBJ) and poor flexibility.

Elferink-Gemser, et al., (2006) keenly studied the mechanism behind the development of interval endurance capacity in 377 talented field hockey players of 12-19 years.3 years longitudinal model was developed using multilevel modeling program for interval endurance capacity. Model revealed during adolescent both female and male have more promising development then sub-elite players.

Suthamathi, & Suganthi (2014) suggested a talent identification criteria and constructed a specific test battery in hockey from selected motor. 30 Females (18-23 years of age) intercollegiate hockey players were randomly selected from around Trichy city Tamilnadu. Factor analysis found that speed, agility were important among others sitting height, 30 meter run, three consecutive jump and 2.4 km run could be considered while selecting the talent.

Sidhu (2012) predicted hockey performance from selected physical fitness by studying 200 interuniversity level players. Findings revealed none of the physical fitness variable was found significantly correlated to field hockey performance.

Emmanuel (2012) predicted the hockey playing ability (rated subjectively by three experts through rating scale) by studying 100 university players of age 18-25 on the basis of selected physical fitness (speed and agility measured using Speed – 50 Mts. Dash Agility – 4 x 10Mts.Shuttle Run). Multiple regressions revealed that speed, agility were related to the playing ability and these variables can be used to predict performance in hockey.

Sardar (2011) compared 40 male (20-25 years) hockey players of district, state and national level on psychomotor and coordinative abilities. Results revealed that Kinesthetic perception, Orientation ability, movement speed, time to response, ability to Balance, Differentiation ability, Reaction ability and Rhythmic ability differs significantly according to the level of playing. National and State level hockey players were better in comparison to the hockey players who had participation at District level in Kinesthetic perception, Balance ability, Response time, Speed of movement, Differentiation ability, and Orientation ability. Whereas, insignificant difference was found in rhythmic ability and reaction ability.

Palani (2010) compared physical (speed, agility, power) among the Southern Region men hockey teams at different playfields. For the purpose of the study 120 southern region men hockey players of 22-28 years of age were selected as subjects. ANOVA revealed players showed superior performance in the artificial turf field followed by gravel and grass fields.

Natarajan (2010) predicted handball playing ability (rated subjectively by three experts during match situation) from the selected physical (Hand Grip Strength, Leg Strength, Endurance, Speed, Agility), by studying 100 university men handball players of age 17-25 had participated voluntarily. Multiple regression method revealed that handball playing ability could be best predicted by speed.

Chander (2010) studied purposively selected 72 volleyball players to predict volleyball playing ability from the selected motor fitness variables Speed (20m, 30yards, 50 yards), Explosive strength of the shoulder (Basketball throw, Softball throw, Overhead medicine ball throw), Legs strength (Running spike jump, Sergeant jump, Standing broad jump), Agility (Semo Agility test), Coordinative ability (reaction only), Endurance.

Mohamed (2009) studied bio motor and performance measure between elite and sub-elite youth handball players in 14-16 years. MANCOVA revealed elite players were having greater muscular endurance, cardiovascular endurance, speed, agility and strength but not differ on balance, upper limb speed, upper body muscular endurance and flexibility. Discriminant analysis suggested speed, height and agility were important parameter for identifying talent.

Singh (2006) developed test battery to identify talent in soccer in early age 120 school students were randomly chosen. physical fitness (muscular strength, muscular endurance, speed, flexibility, agility), Pearsons product moment correlation coefficient, factor analysis, hull scale (norms) and 6-sigma scale method revealed that all the factors included in the study were highly correlated with the playing ability.

Pramanick (2002) predicted playing ability (rated subjectively by the experts) of the badminton players by studying 25 international national and state level player as a sample from selected physical (speed, explosive strength, agility, flexibility and reaction time). PPMC, Multiple correlations, ANOVA and multiple regressions showed that reaction time, endurance speed were found significant and should be used to predict badminton playing ability.

Gabbett (2000) identified physiological characteristics of senior rugby and sub-elite junior league players. The players underwent body mass, muscular power measured with vertical jump, agility with Illinois agility run, maximal aerobic power measurement. The result of the study revealed that physiological capacities improves with playing level and the use of physical, physiological, sociological and personal talent predictors are important.

Nieuwenhuis et al., (2002) identified kin- anthropometric, motor-physical, psychological and game skill variables which predict field hockey performance on 14-15 year old 52 female field hockey players 27 players were from top two winning teams and 25 players were selected from the teams which have finished at the bottom. Variables were found to predict and distinguish between successful and less successful field female hockey players.

Sharma (2012) established strength of relationship of anthropometric variables with hand grip strength, aerobic power, lower limb power and skill tests among Indian male field hockey players. Result of the study indicated that height was positively correlated to weight, hand grip strength and lower limb power, whereas negatively correlated to percent body fat and dribbling ability. Further body weight was positively correlated to percent body fat, hand grip strength and lower limb power however negatively correlated to slalom sprint.

Summary

Germany, Soviet Union select talent on the basis of physical fitness variables (Abbott et al., 2005). Alias (2018) and Gabbett (2000) considered physical fitness variables should always be used while identifying talent in field hockey. (Lemos et al., 2017; Singh 2006) observed agility, speed, core muscle endurance, muscular strength endurance determine performance in field hockey. (Rana 2016; Scott 1991) revealed elite players were significantly better on right and left hand grip strength, whereas (Suthamathi & Suganthi 2014; Emmanuel 2012; Nieuwenhuis et al., 2002; Natarajan 2010; Mohamed 2009; Pramanick 2002) observed standing broad jump, speed, agility and 30 meter run predicts playing potential and significantly discriminate between successful and less-successful athletes. (Bakhtiyari et al., 2015; Sidhu 2012) observed none of the physical fitness variables (36 meter shuttle run, Illinois test, standing broad jump, bending forward, 1600 meter, sit and reach and zig-zag jump test) was significant whereas (Burr et al., 2008; Wassmer, & Mookerjee 2002) revealed standing broad jump and power can predict overall hockey playing potential. Durandt et al., (2009) field hockey players had stronger upper body and suggested athletic ability can be best predicted by strength, speed, power and coordination Sultana & Pandi (2013), further National field hockey players were significantly better on Kinesthetic perception, Balance ability, Response time, Speed of movement, Differentiation ability, and Orientation ability Sardar et al., (2011). On the basis of physical ability an individual can be identified as talented and can be ruled out as well Heslen et al., (2000).

2.2.3 Physiological determinants of success

Kusnanik, Rahayu, & Rattray (2017) studied distance covered and physiological demands of a field hockey players during a game and revealed that a female field hockey players run an average distance of 4372.5±263.9 meters, further concluded that female players were having lower heart rate, blood lactate concentration, distance covered and time spent in walking and running than other players based on literature.

Hanjabam, & Jyotsna (2017) predicted (vo2max) from physiological parameters and revealed that vo2 max was positively correlated to HR max., Basal metabolic rate, heart rate recovery, relative work power capacity and hemoglobin whereas vo2max was negatively correlated to %body fat, body mass index, resting heart rate and resting blood pressure. The study too ascertained that % body fat had the maximum negative effect on vo2max, further heart rate recovery, resting heart rate and relative work power capacity explaineded 95.2% of total variance in predicting vo2 max.

Suthamathi, & Suganthi (2014) suggested a talent identification criteria and constructed a specific test battery to identify talent in field hockey Factor analysis found pulse rate could be considered while selecting the talent.

Emmanuel (2012) predicted hockey playing ability by studying 100 university players of age 18-25 on the basis biochemical (high density lipoprotein, Low density lipoprotein by biochemistry analyzer model RA-50 in mg/dl), physiological (resting pulse rate, vital capacity) Dependent variable playing ability was measured through subjective judgement by three experts by preparing a rating scale. Multiple regressions revealed that resting pulse rate, vital capacity, high density lipoprotein, Low density lipoprotein were related to the playing ability and these variables can be used to predict performance in hockey.

Dillern et al., (2012) studied anthropometric characteristics and aerobic capacity on 32 Norwegian elite recruit female soccer players in relation to playing position. Findings suggest that different playing position have different needs therefore there should be different physiological training plans for different playing positions to ensure maximum benefits.

Manna et al., (2010) studied physiological and biochemical variables among 120 (n=30 in each age groups U16, U19, U23, Senior) subjects. Laboratory testing and result revealed that U23 and senior players were significantly better in body mass in comparison to U16 and U19 players, however, were having significantly lower percent body fat. Further U19 players possess significantly higher VO 2max than the other age group players. Further U23 and senior players were significantly higher in anaerobic power, strength, serum urea, uric acid, and hemoglobin (Hb), when compared to U16 and U19 players. Further the U23 and senior players were having significantly higher triglyceride (TG), total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), and low density lipoprotein cholesterol (LDL-C). Concluded that the changes related to age on physiological and biochemical variables should be given consideration while selecting the player.

Keane et al., (2010) studied fitness items among 83 top performer women 18-29 years using Eurofit test battery consisting 8 items, Logistic regression revealed that elite Gaelic football players were characterized by high aerobic fitness and suggested holistic training program is needed to accomplish multiple requirement of the game.

Natarajan (2010) predicted handball playing ability rated subjectively by three experts during match situation from physiological (Vital Capacity, Resting Pulse Rate, Mean Arterial Blood Pressure, Breath Holding Time) on 100 university men handball players of age 17-25 had participated voluntarily. Multiple regression method revealed that handball playing ability could be best predicted by vital capacity.

Reilly (2009) established role of physiological characteristics in talent identification and development, revealed top class soccer players are required to adapt to the multi factorial demands of the game. The players should have high standards in all domains of physical performance. There is no hard and tough for extraordinary capacity. The study suggested that a range of relevant physiological characteristics having strong genetical influence (such as vo2max) can be considered for talent identification revealed physiological variables have a huge role to play in talent identification.

Singh (2009) optimal amount of percentage body fat may leads to improved hockey performance revealed when compared Indian, Pakistani and Srilankan field hockey players on body composition parameters. Result showed Indian Hockey players were having significantly lesser body fat compared to Pakistan and Srilanka and also India is higher in International ranking then both these teams.

Pramanick (2002) predicted playing ability (rated subjectively by the experts) of the badminton players by studying 25 international national and state level player from selected physiological (RHR, CVE, BP, BC, Hb, quantum sweat excretion). None of the physiological variable significantly predicted badminton playing ability revealed by multiple regression.

Gabbett (2000) identified physiological characteristics of senior rugby and sub-elite junior league players. The players underwent body mass, muscular power measured with vertical jump, agility with Illinois agility run, maximal aerobic power measurement. The result of the study revealed that physiological capacities improves with playing level and the use of physical, physiological, sociological and personal talent predictors are important.

Boyle, Mahoney, & Wallace (1994) established energy cost of competitive field hockey during competition (measured through modified sport tester PE3000 telemetric HR monitor) revealed competitive matches plays heavy demand on aerobic system and energy expenditure ranges from 61.1kj/min for left corner and 83kj/min for center midfield players.

Reilly, & Borrie (1992) studied physiological basis of field hockey and revealed aerobic power in excess of 60ml/kg/min is required for playing hockey at elite level.

Scott (1991) hockey players were ecto-mesomorphic and found that elite male field hockey players were characterized by low percentage body fat.

Bhanot, & Sidhu (1981) compared anaerobic power (measured through maximal vertical velocity and body weight method of Margaria) between field game (hockey, football) and court game (volley ball and basketball) among senior and junior national players. The findings of the study revealed that football players had maximal vertical velocity followed by hockey, volleyball & basketball players whereas volleyball players were having maximal anaerobic power followed by football, hockey and basketball players.

Summary

Kusnanik et al., (2017) revealed field hockey players were characterized by lower heart rate, heart rate reserve, relative work power capacity which explained 95.2% of total variance in predicting vo2max (Hanjabam, & Jyotsna 2017). (Suthamathi, & Suganthi 2014; Emmanuel, 2012) suggested resting pulse rate could predict hockey playing ability and should be considered while attempting to identify talent in field hockey. A range of physiological variables played a huge role in talent identification such as vo2max, aerobic fitness and the variables having strong genetic influence such as vo2 max etc. should necessarily be considered while talent identification (Reilly 2009; Keane et al., 2010; Gabbett 2000; Reilly, & Borrie 1992). Manna et al., (2010) revealed U/23 and senior field hockey players were significantly better in body mass index, anaerobic power, higher triglycerides, total cholesterol, high density lipoprotein, low density lipoproteins and lesser percentage body fat, whereas the players in U/19 age group were having higher vo2 max. Reilly, & Borrie (1992) observed a vo2 max of above 60ml/kg/min. is required for playing field hockey at elite level. Elite Scott (1991) international field hockey players were too having lesser percentage body fat and it significantly predicts hockey performance Singh, et al., (2009). Whereas Pramanick (2002) observed none of the physiological variables (RHR, CVE, BP, BC, Hb, quantum sweat excretion) predicts playing ability in badminton. Whereas percentage low body fat and BMI should also be considered while addressing to identify talent in field hockey (Scott 1991; Sahu 2015; Sidhu 2012).

2.2.4 Game skill variables as the base for talent identification

Singh (2006) developed test battery to identify talent in soccer in early age based on soccer skills (passing for accuracy, kicking for distance, shooting in the goal, receiving dribbling feinting heading, tackling and ball sense). Pearsons product moment correlation coefficient, factor analysis, hull scale (norms) and 6-sigma scale method revealed that all the factors included in the study were highly correlated with the playing ability. Early talent identification is important in any performance domain, Germany and Soviet Union select talented performers on the basis of physical and performance measures (Abbott et al., 2005).

2.2.5 Genetical Basis of talent identification

Inoue, & Muto (2016) genetical testing in Japan done to identify intelligence, athletic ability and artistically sensible child more specifically identifying gold medalist gene. But revealed application of genetical testing can have many negative or potential impacts on the career of tested individual, as test results may be discourages or identified individual may be pressurized. UNESCO has warned on using genetic testing and asked for respecting uniqueness and diversity, parents have primary responsibility of upbringing and nurturing child, study raises serious questions on genetical testing of a child. Genetic tests for athletic performance might violate the child's right to an open future, suggests that genetic tests need not to be as a tool of talent identification Miah, & Rich (2006). Further Williams, & Reilly (2000) indicated the strong genetic influence in identifying the talent identification but concluded that training and programs for development cannot be underestimated and said they play an important role in realizing, identifying and nurturing potential. Gimbel, (1976) points out that genetic factors are crucial in predicting the talent but this require suitable environmental conditions otherwise genetic potential will be stifled (du Randt & headley 1992b; Regnier et al., 1993; Durand bush & Salmela

2001). (Loland 2015) Concluded genetic tests for talent identification lacks validity, predictive power and restricts children's right to an open future.

2.2.6 Multidimensional approach to talent identification

Asteya (2015) developed a talent identification model in squash for immediate selection to the competition. 86 National male squash players aged 18-25 selected from different sports academies of the country. The independent variables physical fitness (grip strength, explosive leg strength, strength endurance, agility, flexibility, shoulder flexibility, leg strength, back strength), physiological variables (resting heart rate, resting respiratory rate, oxygen consumption, peak expiratory flow rate, aerobic capacity), anthropometrical variables (weight, Height., leg length, arm length palm length, forearm, waist, calf circumference, Fat percentage, shoulder width, hip width, chest width) and psychological variables were (Mental toughness, concentration ability, pressure tolerance, motivation level, confidence level, rebound ability) were selected. Data was analyzed using factor analysis Cronbach's alpha, percentile and Z-scale revealed only 7 factors (Motivation, calf circumference, back strength, arm length, hip width flexibility, fat percentage) were sufficient to explained characteristics of the squash players.

Ahamad, Naqvi, Beg, & Ahmed (2015) talent a enhanceable natural superior quality of a person important for achieving prescribed goals easily and is a differentiating factor between winners and loosers. A web based system was prepared for talent identification with the help of result from various anthropometric, physical, and cognitive tests, such as speed, agility, endurance, upper body strength, lower body power, flexibility, vo2max, BMI.

Dachen (2012) developed talent identification model for archery by studying a total of 157 National archery players selected from the different sports academies of the country. The independent variables Physical Fitness (Right hand grip strength, Left hand grip strength, Back strength, Leg strength, Arm & shoulder strength, Abdominal strength, Arm & shoulder flexibility, Trunk flexibility), Physiological variables (Breath holding capacity, Resting pulse rate, Resting respiratory rate, Vital capacity), Anthropometric variables, (Height, Weight, Arm length , Leg length, Shoulder width, Arm span). Dependent variable archery shooting ability measured in terms of score hit during 36 shoots. Factor analysis, t-ratio and discriminant analysis showed that the arm and shoulder strength, resting pulse rate, rate of respiration and vital capacity discriminate the high performance and low performance archers.

Yadava (2012) prepared a Psychological profile on Indian field hockey players on purposively selected 180 subjects (90 State, 60 National and 30 International of 18-26 years of age). The result of the study revealed the different level of players were significantly differ in state and trait anxiety, motivation, self-confidence, Task Orientation, Ego Orientation, Rebound Ability, Ability to Handle Pressure, Concentration Ability, Attraction to Group Task, Group Integration Task, Attraction to Group Social, Group Integration Social.

Matthys et al., (2011) examined difference between elite and non-elite handball players in the three different age groups U14 (n=186), U16 (n=150), and U18 (n=92). Data was collected using multidimensional test battery. Result revealed significant effect of maturation on anthropometrical and most of the performance variables. When the comparison is made between elite and non-elite, elite players demonstrated significantly better aerobic capacity, strength and power. In U14 group elite players were better (counter movement jump, sit-ups and handgrip strength) whereas in U16 category elite players were better in (counter movement jump, five jump test) speed, flexibility and agility respectively. Suggested maturation has an effect on most of the physical variables and this should be considered during talent identification and development programs.

Amir, & Navid (2011) compared elite and sub elite youth soccer players to find out that they differs significantly on anthropometric, physiological, technical & psychological factors.

Singh (2011) studied anthropometrical (standing height ,body weight, leg length, knee diameter ,thigh girth , calf girth and skin fold (biceps, triceps, sub scapula, suprailiac) Physical fitness (explosive strength, endurance of legs, sprinting speed, agility, endurance, flexibility) psychological (self-efficiency, anxiety, self-confidence) and football skills (soccer skill test, ball control with the body and head, dribbling with a pass, dribbling, passing, shooting) accordingly the playing position of 200 intervarsity soccer players on the basis of playing position the subjected were studied in four different groups such as goal keeper, defense, midfield and sticker players**.** Mean, sd. and ANOVA revealed that the Defenders, Goalkeepers, were tallest and heaviest among all the subjects. Strikers were best in shooting skills whereas the Goalkeepers were the worst in Shooting, Mid-fielders were best in ball control. Players playing in different playing positions did not differ in psychological abilities.

While addressing key road-locks to identifying talent in early age Gray, H. J. (2010) suggested anthropometrical (humerous, femur measurement), motor (speed, agility, endurance, ball handling) and psychological variables should be considered while attempting to identify talent.

Hadavi & Zarifi (2009) developed a multifactorial model on Iranian Athlete to address the coaches' problem in identifying the best children for track and field. 38 randomly selected coaches were tested using research made questionnaire. The model had explained contemporary condition of the process followed to identify talent and provided suggestions to pick up performance in international competitions. The research data was collected on six factors i.e. motor ability, physiological, anthropometrical, psychological, sociological and cultural. The model involves three important phases (initial selection, general tests and special tests) with specific aims such as determining not fitting children for athletic fields and in determining the abilities of the youth individual for track and field.

Vaeyens, Lenoir, Willians, & Philippaerts (2008) threw light on the TID and development Programs which have been adopted continuously and gaining popularity in recent decades, revealed that due to lack of consensus required in how talent should be defined in sports, as there was no homogeneously accepted theoretical frame to guide this current practice talent identification. The rate of success of these talent identification and development program had rarely been assessed and validated. The problem associated with the identification of gifted adolescents is late maturing, 'Promising' due to dynamic and multi-dimensional natural of games and sports and advocated that talent identification and development Program in sports should be dynamic and inter connected taking into account maturity status and potential to develop rather than exclude at an early age. Finally it was suggested to develop real world task and then employed in a multidimensional design to raise the efficacy of talent identification and development program.

Pearson et al., (2006) emphasized the importance of identifying talent at youngest possible age in streamlining the resources and getting maximum output from individuals. Therefore, if a talent identification model has to succeed a multidimensional and reliable testing procedure must be adopted.

Singh (2006) developed test battery by studying randomly chosen 120 school students to identify talent in soccer in early age. Four parameters taken for the study were fundamental soccer skills (passing for accuracy, kicking for distance, shooting in the goal, receiving dribbling feinting heading, tackling and ball sense), physical fitness (muscular strength, muscular endurance, speed, flexibility, agility), physiological (resting heart rate, vital capacity, Aerobic power and Anaerobic power) and psychological (personality inventory, group test of intelligence, sports achievement motivation, test of group cohesion). Pearsons product moment correlation coefficient, factor analysis, hull scale (norms) and 6-sigma scale method revealed that all the factors included in the study were highly correlated with the playing ability except personality.

To realize the potential fully talent has to be coupled with appropriate training. (Abbott, & Collins 2004) explored prerequisites which are required to succeed in sport, and to ensure how much efficacious they are when employed to talent identification schemes. It is suggested that talent needs to be re-conceptualized for giving special consideration to multidimensional aspects of talent so that talent identification and talent development processes are perceived to be dynamic and interrelated. Additionally, there is need to give greater emphasis on the capacity of a child to develop and the psychological factor which are important and that underpin this process is to be highlighted. It was advocated that talent identification and development schemes should be prepared while keeping the multidimensional nature of sports in mind.

Elferink-Gemser (2004) determined the relationship between anthropometric, physiological, technical, tactical and psychological characteristics with level of performance. The samples for the study were 126 talented field hockey players of which 63 males (13.9 years sd. 1.4 and range 11-16) and 63 females (13.9 years sd. 1.3 and range 12-16), further 38 samples were elite (13.2 years, sd. 1.3) and 88 non-elite players of mean age 14.2 years, sd. 1.3. MANCOVA with age as covariate and performance level, gender as factor revealed elite players showed better on technical (dribble performance in a peak and repeated shuttle run), tactical (general tactics; tactics for possession and non-possession of the ball) and psychological variables (motivation) than non-elite. Motivation, performance in slalom dribble and tactics for the possession of the ball were most discriminating variables with age also discriminate found elite players were younger than sub-elite players. Tactical qualities, motivation and specific technical skills should be more focused.

A model to select talent in early age in swimming was developed by Gogia (2002) by studying 200 male swimmers aged 9,10,11,12 years and 50 in every age group who were training at least from one year were selected. Performance in 50 meter front crowe swimming was taken as dependent variable while anthropometrical (height, weight, hand length, hand breadth, leg length foot length, shoulder width, hip width), physical (grip strength, arm & shoulder strength, abdomen strength, shoulder flexibility, trunk hip flexibility, average ankle flexibility), physiological (body fat percentage, vital capacity, resting pulse rate, respiratory rate) were the predictor variables. Multiple correlation and regression revealed different variables were important to predict the performance in different years of age.

Reilly et al., (2000) proposed a multidisciplinary TID Scheme for Soccer. Test battery piloted on 31 adolescent boys. 15 anthropometric, 8 Physiological, 3 Psychological variables were studied using (task and ego orientation in sports questionnaire Duda 1989) Anticipation test by (Williams & Davids, 1998). Statistical analysis of data indicated that agility, 30m sprint, ego orientation and anticipation discriminated between elite and sub-elite players. The 30m sprint speed was negatively associated with elite player making slower sprinter more likely to be elite player than faster sprinters.

Talent Identification and development in football Williams, & Reilly (2000) declared that no unique characteristics from among anthropometry, physiology, psychology and sociology can be isolated with confidence but can play a role in talent identification process. Both behavioral and biological scientists indicated the strong genetic influence in identifying the talent, but concluded that training and programs for development cannot be underestimated and said they play an important role in realizing, identifying and nurturing potential.

Review of the key components of perceptual skill and its implications for talent identification in soccer. Williams (2000) showed difference in skilled as well as less skilled players in recalling and recognizing the pattern of play. Similarly, experts

Predicts future events based on their own understanding of the situational probabilities. Experts have a fair idea of what could likely be happen given a particular set of conditions. Study observed that skillful players use superior understanding to organize the eye movement patterns essential for seeking significant information. Search strategies were based on the nature of the task. There is a difference in use of the search strategies by skillful and less skillful players in viewing the field in 11 vs 11 situations as compared to 1 vs 1, 3 vs 3 situations. There is a difference in Visual search behavior between offensive and defensive players.

Hoare, & Warr (2000) developed quasi applied model of research for identification and development of players in soccer (women's of 15-19 years as samples) having experience in athletics and ball sports. Interested samples were tested in two days testing program, the test include anthropometrics, skill and physiological variables. Finally 17 athletes were selected two take part in 12 months talent development programs. Prior to season two pre-season programme of 2 months having 5 training season per week was conducted. This programme was given with an aim to enable them to acquaint them with require ball and game skill to play competitively. After the training of 25 season was over it was found that 10 players from among the samples of 17 were get selected to zone team while 2 players were selected for team representing state within 6 months, this study clearly said that the talent can be better identified by using anthropometrical, physiological and skill variables.

Elferink-Gemser (2007) revealed physiological, anthropometrical, tactical, technical, and psychological characteristics measured on three different occasions, which was separated interval of one year with an aim to predict future elite field hockey performance. Studied elite (30 players) and sub elite (35 players) of mean age 14.2±1.1 years. ANCOVA with age as a covariate revealed elite players were better on endurance capacity, confidence and motivation and further predict elite players seems to be better in tactical skills and they better develop endurance and technical capacity then sub elite youth.

Williams & Frank, (1998) talent identification model considered one of the best models for talent prediction followed till today. According to which the role of Sociological factors (socioeconomic background, education, parental support, coach child interaction and hours in training) Psychological predictors (attention, anticipation, self-confidence, decision making game intelligence, perceptual cognitive skills, personality, anxiety control, concentration and motivation) anthropometrical factors (weight, height, fat percentage, muscle mass) and physiological factors (anaerobic endurance, muscle strength and Aerobic capacity) has to be considered to predict talent in soccer.

Bompa, (1985) recommended that talent can be identified with three important factors, i.e. Morphological attributes, physiological capacities and motor capacities that are composed of perceptual and motor skills, endurance strength, power and further said talent should be directly selected by comparing profile of young to that of elite. This model believed that while identifying the talent three phases should be given importance these were primary phase during pre-puberty (3-8 years of age) in this phase general information like general physical development and health is collected by examination by the physician. Secondary the most important phase the participants are selected during puberty but those who are continuously in practice aiming at evaluating functional and biometric parameters, in this phase first time the psychologist introduced to prepare the psychological profile.

Gimbel, (1976) suggested three major criteria's important for talent detection these three measures are physiological and morphological characteristics, Trainability (Reaction and receptivity to training) and Motivation. He further points out that genetic factors are crucial in predicting the talent but this require suitable environmental conditions otherwise genetic potential will be stifled (du Randt and headley 1992b; Regnier et al., 1993; Durand bush and Salmela 2001). This model consists of four steps, suggested that a sports person achieve peak performance in sports at the age of about 18-20 after decade of strenuous training therefore promising athlete need to be identified at 8-9 years of age, In the first step psychological, physical and morphological factors are identified, second step application of these variables on children's and data was collected for suggesting further development, In the third step, children was regularly analyzed for up to 12-24 months, After monitoring prediction is made about the chance of success in the future, The major advantage of this model is late developer are properly accommodated. He further suggested three reasons that why athlete who previously were identified as talented didn't succeed because the psychological variables were neglected in predictive process, difference in biological age in relation to chronological age and the tests which are being used in the studies are not valid, reliable or objective.

Toohey, Beaton, & Auld (n.d.) Biophysical markers are important for talent identification, moreover Australian primarily relied on these markers, but other researchers urge to consider multidimensional factor, considering talent as complex concept, hard to define and lacks a clear theoretical framework, suggesting talent is important at macro, meso and micro level. Micro level: drive to win, personal enjoyment, Values/character, work ethics, family influence, role models, peers/friendship, push from family etc. Meso- Coaches influence, social aspects, quality competition, impact of schools, multisport involvement. Macro level- facilities & resources influence of sports academies, quality of talent identification, technical development opportunities.

Elferink-Gemser (2005) ascertained relationship between psychological skills and performance level on 458 talented youth athlete of 14.8±1.5 years using questionnaire. MANCOVA reveals psychological skill differs in more and less successful talented athlete suggests there is different psychological profile for male and female, team and individual sports athlete. But in case of elite and sub-elite youth athlete motivation and mental preparation was useful indicator and are independent of gender and type of sports.

Summary

Performance in sports can be characterized by several multidimensional factors ranging from anthropometrical (standing height ,body weight, leg length, knee diameter, thigh girth, calf girth and skin fold (biceps, triceps, sub scapula, suprailiac, Arm length, Shoulder width, Arm span, arm length palm length, forearm, waist, Fat percentage, hip width, chest width), bio-motor (grip strength, explosive leg strength, strength endurance, agility, flexibility, shoulder flexibility, leg strength, back strength, speed, endurance, upper body strength, lower body power, counter movement jump, sit-ups, Arm & shoulder strength, explosive strength, endurance of legs, sprinting speed, Abdominal strength, Arm & shoulder flexibility, Trunk flexibility, vo2max), physiological (Breath holding capacity, Resting pulse rate, Resting respiratory rate, Vital capacity, resting heart rate, resting, Aerobic power and Anaerobic power, oxygen consumption, peak expiratory flow rate, aerobic capacity), psychological (self-efficiency, anxiety, self-confidence, state and trait anxiety, motivation, personality inventory, group test of intelligence, sports achievement motivation, test of group cohesion, Task Orientation, Ego Orientation, Rebound Ability, Ability to Handle Pressure, Concentration Ability, Attraction to Group Task, Group Integration Task, Attraction to Group Social, Group Integration Social, Mental toughness, concentration ability, pressure tolerance, motivation level, confidence level, rebound ability), technical (dribble performance in a peak and repeated shuttle run), tactical (general tactics; tactics for possession and non-possession of the ball), game skill (passing for accuracy, kicking for distance, shooting in the goal, receiving dribbling feinting heading, tackling and ball sense), playing ability, maturation, cognition, sociological, cultural, morphological, and train-abilility (Asteya 2015; Ahamad et al., 2015; Dachen 2012; Yadava 2012; Matthys et al., 2011; Amir & Navid 2011; Gray 2010; Hadavi, & Zarifi 2009; Vaeyens et al., 2008; Pearson et al., 2006; Singh 2006; Abbott, & Collins 2004; Elferink-Gemser, Visscher, Lemmink, & Mulder 2004; Gogia 2002; Reilly et al., 2000; Williams, & Reilly 2000; Hoare & Warr 2000; Elferink-Gemser et al., 2006; Williams & Frank, 1998; Bompa, 1985; Gimbel, 1976 and Toohey, Beaton, & Auld) should be considered while addressing talent identification in different sports, to differentiate elite and sub-elite, to differentiate the players based on playing position (Singh 2011).Elite players differs significantly from their sub-elite counterparts in counter movement jump, sit-ups and handgrip strength, counter movement jump, five jump test) speed, flexibility and agility respectively (Matthys et al., (2011), but not differ in psychological variables Singh (2011). Further Williams, & Reilly (2000) revealed no characteristics from among anthropometrical, physiological, psychological and sociological variables can be isolated with confidence but suggested that they can play a role in talent identification process. Reilly et al., (2000) slow sprinters are likely to be higher performers.

2.3 Country wise approach to talent identification

Jones & Watson (1977) suggested a different view on talent identification, recommended that while attempting to identify talent the first step is to identify target performance, select criterion which represent target performance, select predictors of performance and verify the predictive power than one should use these results to scout or recommend a talent in different games for different sports. Du Randt et al., (1992) summarized the approach of the communist-socialist countries (China, Cuba, earlier

Germany and USSR) in the process of talent identification and development in sports. Findings suggested that they have centrally controlled & planned model for talent identification specific to each sports. In these countries there is a strong emphasis is being laid on fitness and health program of school children's from very gross root level. School physical education teachers and sports clubs work in unison. Talent is screened out at school level as well as club level at early age. Physical education teachers and coaches are much educated especially in talent identification and development that at least first two stages takes place in school itself. Selection and identification process includes several performance parameters with age appropriate level and anthropometric measurements. In such a system children's starts planned training program based on sound scientific principles, further youth competitions assist in talent identification process. A large number of sports schools exist in these countries in comparison to capitalist countries (Newzeland) where there is no uniform talent identification criteria exists and limited financial support from government and private sector. Riordan (1988) Eastren Europian countries too identified children's in school by physical education teachers, coaches or clubs through measurement in height, weight, speed, endurance, work capacity, power, sports specific tests and technical efficiency. Selection to stage 2 takes place after 18 months of stage one by assessing the progress made in sports specific tests, physical abilities, rate of physical growth, biological age and psychological aptitude etc. At this stage students were selected into group of sports similar characteristics or in a single individual sports. Stage 3 the final selection phase begin after 3-4 years leading to phase 1 in this phase the selection of the children's is primarily based on level of performance achieved in sports, performance stability, rate of progress, results in physical capacity test, sports specific tests, psychological and anthropometrical tests, now once it is ascertained that an individual possess talent the child is put into the residential sports schools as these schools provide high quality scientific coaching facilities, special diet and medical staff etc. In the ewe of Sydney Olympics 2000 Australia initiated a systematic and scientific approach for talent identification and development. Government provides a huge necessary supports with additional funding as well and Australian institute of sport came into existence (2003). Australia follows three stage talent search program. In first phase children's are screened out in school itself by physical education teachers and coaches using a test battery consisted of 8 simple physical assessment and the top 2% students in any of the test were eligible to take part in part in phase 2, where some sports skill tests were administered along with tests of phase 1, further this assisted in categorizing the students game wise and thus top 1% were invited to attend the specialized training program to further horned the sporting skills in the third phase of talent development.

China has a fool proof school sports system funded by government. They recruit talent based on the recommendation from physical education teachers, coaches and parents followed by a screening test. In China children's with talent enrolled from primary and secondary schools and then sports classes were conducted after regular academic classes Rizak (1986).

Newzeland follows a "Pyramid principle" of scouting talent, more competitions were organized at beginning/school level, physical education, sports and recreation is the basic essence of school educational curriculum. They follow the premise that if the base is wider and broader than there will be greater chances of talent being discovered (Hugo 2004).

2.4 Principles & Criticism of Talent identification

Clark (2012) there is lot of burden on identified young children as a talented i.e. to carry a beacon of excellence to fulfill their potential, children's loss interest in sports as they progress to secondary school. Early talent identification at an early age make them averse of participation in single sports, pressure of expectations, winning rather the process should be enjoyable. The girls transition to upper secondary school is a key point at which girls athlete disengage or dropout from physical activity or sports because of numerous reasons: Boys comment about their physical appearance.

Carlos, Luis, & Antonio (2012) recognizing the importance of the anthropometric variables in talent identification and its development is the biggest problem in sports science out of large group of children's engaged in sports very few attain highest level. Deliberate practice theory exerts that experts are always made not born, select the players into the particular sports on the basis of some pre-requisites and then through hard and rigorous training anyone can be made genius.

Turnbull (2011) studied mediators and factors that can significantly affect successful talent identification and development in field hockey and ascertained that family support, type of school attended, clubs, support facilities and infrastructure provided by school and luck are vital factor in achieving top performance.

Gray (2010) identified key road locks in identifying athletic talent flawed talent identification and lacking coaches teachers and parents education regarding properly identification of talent. Findings of the study suggest that the athletes who have successful experiences and high ability level are likely to sustain sports participation. However literature is limited in the past decades and yet to define and the exact science in developing and discovering the athletic talent.

Vaeyens, & Philippaerts (2008) threw light on the talent identification and development Program which have been adopted continuously and gained popularity in recent decades revealed that due to lack of agreement among sporting scholars regarding the way to defined or identify talent. There is no uniformly accepted theoretical framework which can guide this current practice. Further very rarely the success rates of the current talent identification and development program been assessed and validated. Study suggested the problem related to the identification of gifted or talented youth adolescents. The major one is late maturing, 'Promising' due to dynamic and multi-dimensional natural of sports and advocated that the program aimed at talent identification and development in sports should be dynamic and inter connected taking into account maturation and potential to develop further rather than to exclude at an early age. Finally opined that a real world multidimensional approach to identify talent should be used to increase the efficacy of talent identification and development programs.

Baker et al., (2003) proved successful interaction between three factors i.e. psychological, biological, sociological constraints for the development of expertise in sport. Study also scrutinizes the environmental factors and training which influence the player to become elite and gain maximum. Research examining the quantity and quality of training specify that these two elements are important in attaining expertise. Irrespective of this the possession of resources such as adequate coaching, parental support and relative age effect, sociological factors such as cultural influences are also crucial for sport expertise. Although it is crucial to have adequate environment to develop sports expertise, further research is clearly required.

Davids, Lees, & Burwitz (2000) explored the role of biomechanics and motor control in identifying the most potential. The studies recommend that the relationship between motor control and biomechanics can play an important role in developing a scientific program for talent identification and development.

Attainment of expertise in sports can be based on physique and body composition, personality characteristics related to being a tough competitor while be in self-control, bio-motor abilities such as power, agility, speed and flexibility, training adaptation, information processing abilities and effective decision making ability and health (Singer & Janelle 1999).

Harre (1983) model suggests that only through training it would be possible to predict whether a playful active child possess required attributes needed to succeed in future in first step large number of athlete should be selected for training. He further suggest four principals of talent detection, first rule children's by keeping general specific procedure in mind in general child with all-round athletic ability i.e. height, weight, running speed, endurance, coordination, athletic versatility would be selected, in specific stage individuals shall be classified according to skill in particular sports on the basis of level of performance reached, rate of performance improvement, Performance stability under changing conditions, reaction and receptivity to training. Second rule talent detection must base on the factors chiefly determined by heredity. Rule three biological ages, development should be given special consideration characteristics should be evaluated in relation to biological development. Rule four it is worthless to rely only on the physical attributes, psychological and social; variables can help to a larger extent. (du Randt & headley 1992b; Regnier et al., 1993; Harre 1999; spammer 1999; Durand bush & Salmela 2001).

Havelicek et al., (1982) this model is somewhat similar to the Harre's (1982) which suggest certain principles important to detect talent. The first principle is that as the main purpose of talent identification is to ensure those who have talent for particular sports must be trained specifically for that sport only, the gifted children's should be identified in the physical education classes, specialization in one sports family should be made depend on the attributes and abilities, than the prediction of success, Not too early specialization in one sports is required, criteria to identify the talent must be based on the factors that must have strong and stable genetic influence, in the last principle he suggest that this problem should be tackled through multidimensional aspects.

Gimbel, (1976) suggest three major criteria's which are important for talent detection these three measures are physiological and morphological characteristics, Trainability (Reaction and receptivity to training) and Motivation. He further points out that genetic factors are crucial in predicting the talent but this require suitable environmental conditions otherwise genetic potential will be stifled (du Randt & headley 1992b; Regnier et al., 1993; Durand bush & Salmela 2001). This model consists of four steps, suggested that a sports person achieve peak performance in sports at the age of about 18-20 after decade of strenuous training therefore promising athlete need to be identified at 8-9 years of age, In the first step psychological, physical and morphological factors are identified, second step application of these variables on children's and data was collected for suggesting further development, In the third step He has monitor the children regularly for up to 12-24 months, After monitoring prediction is made about the chance of success in the future, The major advantage of this model is late developer are properly accommodated. He further suggested three reasons that why athlete who previously were identified as talented didn't succeed because the psychological variables were neglected in predictive process, difference in biological age in relation to chronological age and the tests which are being used in the studies are not valid, reliable or objective.

Bar-Or's (1975) identify talent in early age by evaluating physiological, performance, morphological and psychological characteristics. Develop a short term training program and test Childs receptivity to training than predict performance by applying regression model by considering family history of the participants in mind.

Summary

Identifying talent into a single specific sports at early age brings huge amount of burden on identified young children's in carrying a beacon of excellence to fulfill the potential, children's lost interest in sports. As early talent identification into single sports make them averse of participation, moreover girls disengage and dropout from sports as they progress to secondary school due to varied reasons (Clark 2012). Turnbull (2011); Baker et al., (2003) revealed except identifying talent there are numerous other factors, should be considered such as family support, type of School attended, clubs, sports facilities, relative age affect, adequate coaching and training environment and infrastructure provided by the schools and luck are important factors in achieving top performance. Gray (2010) suggested key limitation of talent identification process i.e. lack of coaches, teachers and parents education and pointed out that lack of exact science in discovering and developing talent. (Harre 1983; Havelick et al., 1982) children's with all-round athletic ability (height, weight, running speed, endurance, coordination, athletic versatility) performance level reached, rate of performance improvement, receptivity to the training, performance stability, second factors having strong and stable genetic influence should be considered, biological age should be considered irrespective of chronological age. Coaches should rely on multidimensional talent predictors, no too early specialization in one sports is required. Gimbel (1976) suggested physiological, morphological characteristics, trainability and motivation are important for talent detection. Multiple factors should always be considered while attempting to identify talent (Hugo 2004).

2.5 Research Gap

Talent identification, development, appraisal, deployment & retention of highly potential individual, is still in infancy state, researchers need to use different methodology for solution, much improvement is required in the process of identifying, managing, positioning and retention of right individual at right role, (Mcdonnel 2016). Talent identification process lacks accuracy and the methods employed are often lack criterion and sporadic (Hugo 2004). Baloni (2014) Lack of objective criteria of talent identification and unscientific selection continuously influencing development of sports in the India. In the coming decades due to workforce demo-graphics and skill shortage can leads to the “war for talent”, talent identification and its effective management will be the greatest challenge and is a competitive necessity. We are yet to define an exact science in discovering or developing athletic talent and suggested multidimensional factors should be considered while attempting to identify talent (Gray 2010). Pearson et al., (2006) emphasized the importance of identifying talent at youngest possible age in streamlining the resources and getting maximum output from individuals. Therefore, if a talent identification model has to succeed a multidimensional and reliable testing procedure must be adopted. As the performance and talent as well is naturally multidimensional, but most researches in the domain till date has displayed a unidimensional focus i.e. concentrating solely on the anthropometric measurements with no attentions being paid to any other factor of crucial interaction.

The research in this area has gained popularity in recent decades, where numerous studies have taken place and talent identification models have been developed. Such as (Williams & franks 1998; Gimbel 1996; Regnier et al., 1993; Elferink 2011) some sports specific talent identification models (Asteya 2015; Dachen 2012; Gogia 2002;

Singh 2006; Nieuwenhuis et al., 2002; Suthamathi & Suganthi 2014) etc. But these Models have numerous limitations such as they didn't give precedence to any particular variable. In some of the studies it was observed that there is no standardized test to measure the variables given in the model (Williams et al., 1998, 2000). No explanation of how the variables are selected, moreover most of them are conceptual and revival further some studies were conducted to know the coaches perspective in Identifying most talented without considering child, whereas focusing only on one aspect as Harre (1982) stated that only through training it would be possible to ascertain whether an individual has required attribute to success, this raised huge number of questions on the practices of geneticall identifying the talent. Further some of the models were sports specific inapplicable for other sports, further there is no unanimous acceptance among the sporting scholars about variable's selected by the researcher that they would discriminate between elite and non-elite i.e. successful and less successful. No attempt has been made to standardize these models which always remain highly debatable and there is no theoretical framework which can be universally accepted. In summing all these researchers and sports scientists stressed demand on more specific and scientific criteria for Talent Identification which should be different from sports to sports as each sport requires unique attribute including the performance, talent is also a multidimensional concept which can't be solved following a unidimensional aspect. Till date there is no Indian model to identify talent Chengappa (2013). Most number of Talent Identification models is used in China, followed by Russia, USA and Cuba which shows their supremacy in International competitions like Olympics, Asian games and Commonwealth games. Indian sports scientists, researchers; physical educationists also stress on urgent need to develop Indian sports specific talent identification model. Further there should be a talented identification scheme owned by government similar to Australia.

CHAPTER-III

METHODOLOGY

The chapter deals with the research methodology adopted for achieving the objectives of current study. The chapter explained about the subjects taken for the study, selection of variables, selection of measuring tool/tests, Authenticity of tools to be used, administration of the tests, procedure for data collection, tester's competency, reliability of the data and statistical technique applied in detail.

3.1 Selection of subjects

A total of 207 subjects, were purposively selected, from among the talented Indian youth male field hockey players of age group 14-17 years. The mean age of the subjects was (15.87±1.31years) and having a playing experience of (4.61±1.56years). The subjects were taken from the following different renowned sports academies and stadiums where regular practice was carried on:

1. Surjit Singh Hockey academy Jalandhar.
2. District sport association, Nainital.
3. Chandigarh football and hockey academy.
4. Mata Sahib Kaur Jarkhar Hockey academy Ludhiana.
5. Maharaja Ranjit Singh Hockey academy Amritsar.
6. Hockey stadium Mithapur.
7. Kendriya Vidyalya No.2 Ambala Cantt.
8. Punjab Armed Police Hockey stadium Jalandhar.
9. Government Higher Secondary School Barta.

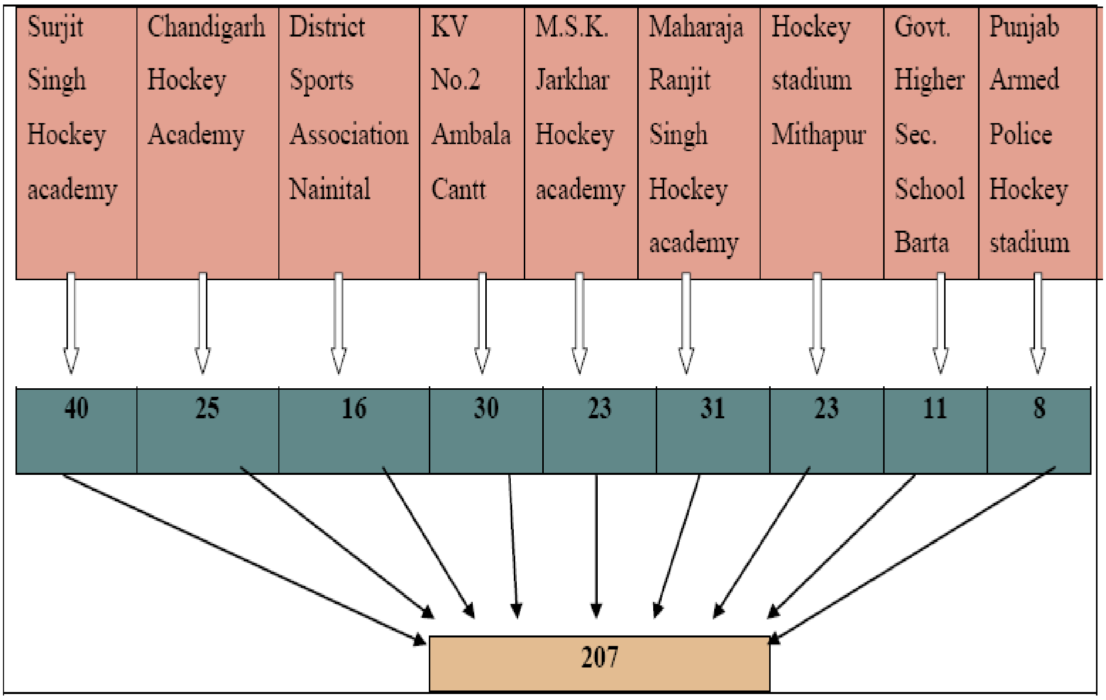

Figure 3.1.1 Sampling Flow Chart

Rationale for the Selection of Subjects

The age group of 14-17 years was selected because the sports talent can be judged fairly, accurately in this age and in this age child should be picked in one particular sport for higher performance training stage (Singh 2012). KMO test revealed the number of subjects were large enough to draw the meaningful conclusions and further for making generalizations.

3.2 Selection of Variables

The investigator had reviewed substantial related literature to inherit the knowledge in selecting different variables for developing a model, various peer-reviewed, refereed national, international and UGC indexed journals, books, e-resources, academic databases Scopus, science direct, Elsevier, research gate, J-Star, J-gate, Google scholar, PhD thesis and dissertations were studied thoroughly. Moreover many sports scientists, physical education and hockey experts, SAI coaches, hockey players and scholars those who have done similar studies in other sports discipline were also contacted and discussed before selection of the variables and finally by also keeping acceptability to the subjects, feasibility and availability of reliable measuring tools in mind research scholar had selected following variables for the study.

3.2.1 Sports Specific Bio Motor Abilities:

1. Hand grip strength (LHGS &RHGS)

2. Strength Endurance

(i) Arm & Shoulder Strength (PU)
(ii) Core Strength (FAP)
(iii) Leg Strength (LLWST & RLWST)

3. Leg explosive power (SBJ)

4. Speed (SP)

5. Flexibility (FL)

6. Agility (AG)

3.2.2 Anthropometric variables:

1. Body weight (BW)
2. Standing height (SH)
3. Arm length (AL)
4. Leg length (LL)
5. Body Mass Index (BMI)
6. Upper arm Girth (UAG)
7. Forearm Girth (FAG)
8. Thigh Girth (TG)
9. Calf Girth (CG)
10. Chest Girth (CHG)
11. Wrist diameter (WD)
12. Humerus Bi Condyle diameter (ED)
13. Femur epicondyle diameter (KD)
14. Ankle diameter (AD)

3.2.3 Physiological variables:

1. Resting heart rate (RPR)
2. Percent body fat (PBF)
3. Basal metabolic rate (BMR)
4. Skeletal muscle mass (SMM)

5. Aerobic power (Vo2 MAX)

3.2.4 Game Skill Variables:

1. Shooting in the target (SIT)

2. Balancing the ball on the stick (BBS)

3. Moving with the ball (MWB)

Table: 3.2.1 Details of Experts Reviewed

S. No.	Name	Specialization	Level	Affiliation
1	Dinesh Singh Yadav	NIS Qualified, Hockey Coach	National	NSNIS, PATIALA
2	Heera Singh	SAI, Hockey Coach & Selector	National	NSNIS, PATIALA
3	Kuljit Singh Bamra	Hockey Coach & Selector	National	Maharaja Ranjit Singh Hockey academy Amritsar
4	Gurminder Singh	Hockey Coach & Selector	National	Sports Dept. Chandigarh
5	Dr. K. S Khandwe	Hockey Coach & Selector	University	DCPE, HVPM Amravati
6	Dr. Pramod kumar Das	Hockey Coach & Selector	University	LNIPE, Gwalior
7	Simardeep Kaur	Hockey Coach & Selector	National	Chandigarh
8	Haramanpreet Singh	Hockey	International player	Manager IOB
9	Dr. P Rajnikumar	Hockey Coach & Selector	University	Tamilnadu university of physical education and sport
10	Mr. Mohit Singh	NIS Qualified, Hockey Coach	National	Sports Dept. Nainital
11	Mr. Maheshwar	NIS Qualified, Hockey Coach	National	Uttarakhand
12	Mr. Vishal	Hockey Coach, (TGT P&HE) &Selector	National	Haryana
13	Saurabh Vishwakarma	(TGT P&HE) &Selector	National	Delhi

14	Kuldeep Singh	Hockey Coach, (TGT P&HE) &Selector	National	Rewari
15	Vimal Chouhan	College Director of Physical education and sports	Government Degree College Kishtwarh, Jammu & Kashmir	
16	Mukesh Kumar	College Director of Physical education and sports	Government Degree College Ramnagar Jammu & Kashmir	
17	Jaswant Singh	College Director of Physical education and sports	Government Degree College Doda Jammu & Kashmir	
18	Arjun Singh	College Director of Physical education and sports	Government Degree College Chatroo, Jammu & Kashmir	
19	Dr. Rana K Cheengapa	Sports Scientist		
20	Prof. JP Verma	Sports Statistician		
21	Dr. Tomy Jose	Exercise Physiologist		DCPE, HVPM Amravati
22	Professor Lalit	Sports Psychologist		IGIPESS Delhi

Investigator has taken the experts view by consulting with twenty two different sports science experts, to select variables for the study and further some of their recommendations and observations were presented as: talent identification is a continuous long term process and should be done at every stage in multiple of times, for talent identification to work better coaches, researchers, sports scientists has to work together and asserts the urgency in developing such criteria. Their focus remained on continuous deliberate practice (training age) is of utmost importance for the realization of the talent; further scope of development is also of importance (Yadav 2012). There is difference in talent to be identified for team (open looped) and individual game (closed loop sports), talent can be identified at later stage (after 13-14 years) to the team sports based on general fitness status as compare to individual sports. Physical education and sports encompasses holistic education in itself and this should be promoted from kindergarten itself. Appropriate talent development is of supreme importance along with talent detection, selection and talent identification at early age. All of the experts unanimously accepted that the selected variables were detrimental in determining the field hockey performance and the model developed after filtering these variables may significantly identify the talent.

3.3 Data collection Tools

The data on selected variables was collected using following available authentic tools. The tools were considered as valid and reliable as these tests/tools were continuously being used by many researchers in numerous previous scientific studies and also presented in one or the other textbooks, further the university department had purchased them from the authorized organizations.

Criterion measure

Table 3.3.1 Anthropometrical Variables

S. No.	Variable	Tools/Tests	Measuring Unit
1	Body weight	OMRON Body composition monitor with scale Model HBF-362	Kg
2	Standing height	Stadiometer (Anthropometric Rod)	In centimetres
3	Arm length	Steel Tape	
4	Leg length	Steel Tape	
5	Upper arm Girth	Steel Tape	
6	Forearm Girth	Steel Tape	
7	Thigh Girth	Steel Tape	
8	Calf Girth	Steel Tape	
9	Chest Girth	Steel Tape	
10	Wrist Diameter	Sliding Calliper	
11	Humerus Bi Condylar Diameter	Sliding Calliper	
12	Femur epicondyle diameter	Sliding Calliper	
13	Ankle Diameter	Sliding Calliper	
14	Body Mass Index	OMRON Body composition monitor with scale Model HBF-362	Kg/M^2

Table 3.3.2 Sports specific Bio-Motor Abilities

S. No.	Variable	Tools/Tests	Measuring Unit
1.	Hand grip strength	Dynamometer	Kgs
2.	Strength Endurance Arm & Shoulder	Push-ups (Maximum)	Number of Push Ups in 60 Seconds
	Core Strength	Fore arm plank	Time in minute and Seconds
	Leg Strength	Wall Sit Test	Time in minute and Seconds
3.	Leg Explosive strength	Standing broad Jump	Centimetres
4.	Speed	30 Meter Run	Time in Seconds
5.	Flexibility (Hamstring & Lower Back)	Forward Bend and reach	Centimetres
6.	Agility	Semo Agility Test	Time in Seconds

Table 3.3.3 Physiological capacities

S. No.	Variable	Tools/Tests	Measuring Unit
1.	Resting Pulse Rate	Manual	Number of Beats Per Minute
2.	Percent body fat	OMRON Body composition monitor with scale Model HBF-362	Percentage
3.	Basal metabolic rate	OMRON Body composition monitor with scale Model HBF-362	Calories
4.	Skeletal muscle mass	OMRON Body composition monitor with scale Model HBF-362	%age
5.	Aerobic power (Vo2 MAX)	Beep test	ml/kg/min

Table 3.3.4 Game Skill Variables

	Variable	Measuring tool
1	Shooting in the target	SAI Hockey Skill Test
2.	Balancing the ball on the stick	
3.	Moving with the ball	

3.4 Administration of the tests

Hand Grip Strength

Purpose: to measure the maximum isometric strength of forearm and hand (Metacarpophalangeal) muscles.

Equipment: Hand Grip dynamometer, paper and pen.

Procedure: after demonstration by the investigator, subjects was asked to perform the same by holding the dynamometer in one hand and start pressing by straighten the elbow up-to the shoulder level parallel to the ground with arm at right angle and the elbow by the side of the body. If required the handle of the dynamometer can be adjusted according to the hand length of the subject, so that the base of the dynamometer bar should rest on first metacarpal (heel of palm), whereas, the handle should rest on middle of four fingers of the hand. After command started squeezing the dynamometer with maximum isometric effort as possible, the maximum effort should maintain for approx. 5 seconds. During this process other body movement was not allowed. Two trials were given with having one minute rest between squeezes.

Scoring: The higher of two trials in kilogram was considered as score. Right hand trial gave scoring of right hand strength and left hand trial gave the scoring of left had strength (Clarke & Clarke 1988; Gogia 2002; Kansal 2008; Natarajan 2010 & Asteya 2015).

Arm and shoulder strength endurance (Push Ups Test)

Purpose: to measure strength endurance of upper limbs.

Equipment required: stopwatch and Floor mat or smooth surface.

Procedure: ask the subject to lie down on the flat smooth surface and take the pushups position facing chest to the ground with arms shoulders width apart. Ask the subject to perform maximum pushups possible continuously for one minute.

Scoring: number of pushups performed in one minute will be recorded as a score of an individual.

Core Strength endurance (Floor Forearm Plank)

Purpose: To measure core strength endurance of back and core stabilizing muscles.

Equipment: Stop Watch, Mats, recording sheet, pen.

Procedure: The subjects had to lie down on the mats in prone position, on the command "UP" the subjects raised hips and whole torso region up from the ground for as long as possible, so that the whole weight of the body was focused on forearm and toes.

Instructions: Body had to be in straight line.

Scoring: Maximum time the subjects can hold the position in minutes and seconds (Boyer et al., 2013; Tong et al., 2014 & Jernstedt et al., 2015)

Leg strength endurance (Wall Sit Test)

Purpose: was to measure the Subjects strength endurance of the leg's right and left leg separately.

Equipment: Stop watch, a vertical smooth ball.

Procedure: The subjects had to stand comfortably erect facing opposite to the vertical smooth wall at a suitable distance with feet the shoulder width apart. On the command the subject slides the back down against the smooth wall till the knees and the hip makes 90^* angle, The time starts as the subject lift one leg from the ground and stops as the foot descends or returned to the ground, after rest same procedure to be repeated with other leg.

Scoring: Total time in minutes and seconds recorded for each leg holding.

Leg Explosive strength (Standing broad jump)

Purpose: To measure explosive strength of the legs in jumping horizontally.

Equipment: measuring tape, flat surface area, Soft landing area and paper pencil.

Procedure: After giving complete demonstration. The subjects were asked to stand behind the starting line marked on the ground with feet apart and the toes pointed straight ahead. To get ready for the jump the subjects were instructed to swing the arms backward and bend the knees to get forward drive. To execute the jump, the subjects were instructed to swing the arms forward; extend the knees and jump forward as far as possible, attempting to land on the feet and fall forward instead of backward if balance lost. Two trials were given.

Scoring: The standing broad jump performance was measured from take-off line to the nearest point of contact after landing (back of the heels). The longest of the two attempts was recorded as score. The measurement is recorded to the nearest 0.5cm (Clarke & Clarke 1988; Singh 2006; Dubey 2006; Kansal 2008 & Natarajan 2010).

Speed (30m Sprint)

Purpose: to measure the speed.

Equipment: Stop watch, recording sheet, pen and minimum 40-50 meter area on playground or track with marked starting and finishing line.

Procedure: The subjects had to take position behind starting line. The start was given by blowing of the whistle. The subject runs across the finish line.

Scoring: The score was the time taken to the nearest of $1/100^{th}$ of a second between the starting signal and the moment the subject crosses the finish line. The best timing of the two trails was recorded as score (Kansal 2008).

Flexibility (Forward Bend and Reach test)

Purpose: Measuring lower back and hamstring muscles range of motion.

Equipment: A 40 cm high wooden box/or stair, on one side of the box mark scale up to 30cms.

Procedure: Subjects were asked to stands barefooted on the stair with both feet together keeping toes in line with the edge of the box/stair. From this position subject had to bend forward and downward while keeping the knees straight. Both the hands should be parallel and holds the position for about 2 seconds.

Scoring: The best of the two attempts with 30 seconds interval between the test was recorded as the score. In case a subject not able to extend hands even to the level of the box then the distance from the 0 cm mark to the tip of middle finger was recorded in negative as score (Kansal 2008).

Agility (Semo agility test)

Purpose: To measure agility during forward, backward and sideward turning movements.

Equipment: Four plastic cones, Stop Watch, Measuring tape, smooth area measuring 12 feet in breadth and 19 feet in length.

Test Area: Mark 4 points in square by measuring the distance of 12feet in breath and 19feet in length place cones at respective points. Mark starting and finishing point.

Procedure: After complete demonstration has been given, ask the subjects to take the position at starting point outside of the marking area facing front, On the whistle, subject have to start right side stepping at the same time stop watch will be started, after reaching the corner subject have to immediately start backward paddling diagonally from the outer corner of the second cone towards inner corner of cone number 3, from where the subject has to sprint straight to cone number 1, than backward paddling towards diagonally inner corner of cone number 4, once again straight sprint towards cone number 2, from where subject have to perform sidestepping towards his left to reach the finishing point quickly.

Scoring: The better of the two trials noted accurately up to 0.1 second will be considered as the score. The lesser time of the two trials will be considered. (Pramanik 2002 & Kansal 2008).

Body Weight

Equipment: OMRON Body composition monitor with scale Model HBF-362, A plane surface.

Procedure: Firstly measure the height of the subject with stadiometer, than feed age and height into the machine, and ask the subject to stand by removing shoes and socks with clean feet directly on the electrodes. Subject should hold the hand grip electrodes by placing both forefingers along the dents of grip electrodes; extend your arms straight at 90 degree angle at your body and stand erect. Record the weight.

Instructions: Reading was taken before food or after two or more hours after food.

Standing Height

Equipment: anthropometric rod, score sheet and pen.

Procedure: The subjects were asked to stand barefooted on the horizontal surface. Ask the subject to stand erect, facing straight and stretch up without lifting the heels. The rod has to be kept in front and then the crossbar of the anthropometric rod should be adjusted so that it touches the highest point of subjects head. The height was measured from the heel to the top of the head in centimeters (Clarke & Clarke 1988; Gogia and Pramanick 2002; Kansal 2008; Natarajan 2010).

Arm Length

Equipment: steel tape.

Procedure: The subjects were required to stand erect with hanging arms. Arm Length of the subjects was measured from acromion process to the tip of finger third. Measurement was taken to the nearest of the 0.1cms centimeter (Clarke & Clarke 1988; Gogia & Pramanick 2002 & Natarajan 2010).

Leg length

Equipment: steel tape

Procedure: The subjects were asked to stand erect with arm sideways, weight of the body must be equally distributed on both the feet length of leg was measure from anterior superior iliac spine to the floor in centimeters (Gogia & Pramanick, 2002).

Upper Arm Girth

Purpose: the purpose was to measure the maximum Upper Arm circumference.

Equipment: steel tape, Skin marking pencil, recording sheet and pen.

Procedure: The subjects were asked to stand erect at ease with keeping equal weight on the feet and while both the hands hanging freely. The measurement on upper arm Girth was taken from naked left upper arm. Locate the acromial and radial point on naked left upper arm and find the midpoint and mark with the skin marking pencil by drawing horizontal line. Then wrap the steel tape around the marked area of left upper arm while keeping the tape horizontal and should touch the skin all around lightly. The Girth distance was measured in CM (Clarke & Clarke 1988 & Kansal 2008).

Forearm Girth

Purpose: the purpose was to measure the maximum Forearm Girth.

Equipment: steel tape, recording sheet and pen.

Procedure: The subjects were asked to stand erect at ease with keeping equal weight on the feet and while both the hands hanging freely. Record the forearm circumference using steel tape just below the elbow joint. The steel tape can be adjusted slightly up and down to measure the thickest part of the forearm.

Scoring: The reading of the forearm Girth measured in centimeters was considered as the score (Kansal 2008).

Thigh Girth

Purpose: the purpose was to measure thigh Girth.

Equipment: steel tape, skin marking pencil, recording sheet and pen.

Procedure: The subjects were required to stand erect at ease in shorts with equal weight on both the feet on the horizontal surface, without stretch up and lifting the heels. Then measure the full length of the thigh from trochanterion to the knee joint i.e. lowest point on lateral condyle of femur, mark the middle of thigh by horizontal line. The Steel tape must be horizontally wrapped around the thickest marked area of thigh, touching gently thigh's surface all around and record the measurement in cm.

Scoring: The reading of the thigh measured in centimeters considered as a score of the individual for thigh Girth (Pramanick 2002 & Kansal 2008).

Calf Girth

Purpose: To measure the maximal calf Girth of an individual.

Equipment: steel tape, score sheet and pen.

Procedure: The subjects were required to stand erect at ease in shorts with equal weight on both the feet on the horizontal surface, without stretch up and lifting the heels. The Steel tape was wrapped horizontally around the naked lower leg of the subject on the maximal bulge off the calf muscle and take the maximal measurement.

Scoring: The reading of the calf measured in centimeters and considered as a score of an individual (Pramanick 2002 & Kansal 2008).

Chest Girth

Purpose: To measure the chest Girth of an individual.

Equipment: non stretchable Steel tape, score sheet and pen.

Procedure: The subjects were asked to stand naked in relaxed position and investigator place the measuring tape on the chest just above nipples and note the reading in centimeters. The subjects were asked to breathe normally to record normal chest circumference (Kansal 2008).

Wrist diameter (Wrist Diameter)

Purpose: To measure straight distance between two lateral points of radius and ulna.

Equipment: Sliding caliper, recording sheet.

Procedure: The subject was asked to raise the arm, so that it becomes parallel to the ground with dorsal surface upward by bending elbow. The two arms of the sliding caliper were applied with strong pressure on the lateral part of the Wrist Diameter process of radius and ulna.

Scoring: In centimeters recorded correct up to 0.1cm (Kansal 2008).

Humerus Bi Condylar Diameter (elbow diameter)

Purpose: To measure the straight distance from the outermost point on the two lateral condyles on the lower end of humerus.

Equipment: Sliding caliper, recording sheet.

Procedure: The subject was asked to raise the left arm by $90^{*,}$ so that upper arm becomes parallel to the ground and then make a 90^{*} angle by bending fore-arm vertically up. The tester stands on the opposite side of the testee than applying two arms of the sliding caliper on the outer point of the condyle, with sufficient pressure to minimize the effect of soft tissues.

Scoring: In centimeters recorded correct up to 0.1cm (Kansal 2008).

Femur Epicondyle Diameter (Knee Diameter)

Purpose: To measure straight maximum distance at the lower end of the outer most point on the condyles of an individual.

Procedure: The subject was the asked to sit down in shorts on a horizontal surface with lower leg hanging and having no clothing on the knees. The arm of the Sliding Caliper was applied on the outermost point of the condyles of femur with full pressure so as to compress the soft tissue.

Scoring: The measurement was recorded in centimeters correct upto in 0.1 centimeter (Kansal 2008).

Ankle Diameter

Purpose: To measure straight maximum distance at the lower end of tibia and fibula (malleoli) across ankle joint.

Equipment: Sliding Caliper, recording sheet and pen

Procedure: The subject was asked to sit on the chair in relaxed position along with both legs on the ground with 90 degree angle at knee joint. Then the two arms of the Sliding Caliper are applied with full pressure on the outermost Bony projection of the ankle and take the reading of ankle in centimeter.

Scoring: The reading of ankle Girth measured in centimeters correct up to 0.1 centimeter (Kansal 2008).

Resting heart rate

Purpose: To record the resting heart rate of the youth male field hockey players.

Equipment: Stop watch

Procedure: The data on resting heart rate of each of the subjects was recorded in morning between 6.00 and 8.00 am as the subjects were instructed one day prior to the recording, so that they have complete sleep and rest before the recording were taken. The score was in terms of number of pulse beats in one minute (Clarke 1976; Gogia & Pramanick 2002; Singh 2006; Natarajan 2010 & Emmanuel 2012).

Percent body fat

Equipment: OMRON Body composition monitor with scale Model HBF-362 in KG.

Procedure: Firstly measure the height of the subject with stadiometer and feed age and height into the machine, than make the subject to stand by removing shoes and socks with clean feet directly on the electrodes. Subject should hold the hand grip electrodes by placing both forefingers along the dents of grip electrodes; extend arms straight at 90 degree angle to your body and stand erect. After scanning press the display/set button to view the desired measurement result, the display changes with each press of display/set button.

Instructions: Reading was taken before food or after two or more hours after food.

Body mass index

Equipment: OMRON Body composition monitor with scale Model HBF-362 in KG.

Procedure: Firstly measure the height of the subject with stadiometer and feed age and height into the machine, than make the subject to stand by removing shoes and socks with clean feet directly on the electrodes. Subject should hold the hand grip electrodes by placing both forefingers along the dents of grip electrodes; extend arms straight at 90 degree angle to your body and stand erect. After scanning press the display/set button to view the desired measurement result, the display changes with each press of display/set button.

Instructions: Reading was taken before food or after two or more hours after food.

Basal Metabolic rate (BMR)

Equipment: OMRON Body composition monitor with scale Model HBF-362.

Procedure: Firstly measure the height of the subject with stadiometer and feed age and height into the machine, than make the subject to stand by removing shoes and socks with clean feet directly on the electrodes. Subject should hold the hand grip electrodes by placing both forefingers along the dents of grip electrodes; extend arms straight at 90 degree angle to your body and stand erect. After scanning press the display/set button to view the desired measurement result, the display changes with each press of display/set button. Instructions: Reading was taken before food or after two or more hours after consumption of food.

Skeletal muscle mass

Equipment: OMRON Body composition monitor with scale Model HBF-362.

Procedure: Firstly measure the height of the subject with stadiometer and feed age and height into the machine, than make the subject to stand by removing shoes and socks with clean feet directly on the electrodes. Subject should hold the hand grip electrodes by placing both forefingers along the dents of grip electrodes; extend arms straight at 90 degree angle to your body and stand erect. After scanning press the display/set button to view the desired measurement result, the display changes with each press of display/set button.

Aerobic power (Beep Test)

Purpose: To measure cardio respiratory endurance or aerobic power of youth male field hockey players.

Equipment: smooth flat surface, audio tape of beep test, measuring tape, good quality speaker, whistle, cones, line powder, paper, pen, desktop, cart board and recording sheet.

Procedure: Two lines parallel to each other 20 meters apart was drawn on the smooth surface. The participants were asked to stand after starting line face towards the second line, and began running as instructed and on the sound of beep. The speed will continuously progressed from slow to fast. The subjects have to sprint between the drawn two lines, after reaching at the end subjects have to wait for the sound of beep to turn and start running. With every passing time a beep sound indicated an increase in speed, this continues till exhaustion. If the subject reached line before the beep sounds, the subjects have to wait until the beep before start running. If the subjects could not reached line before the beep sounds, the subjects must be given warning to catch up with the pace within two more ‘beeps’. The test must be stopped if the subjects failed to reach the line for two repeated ends after a warning.

Instructions: Before the test was conducted the players were instructed to do warm up for about 10 minutes. Mark a 20 meter area and place cones at the end.

Scoring: The subject’s score was determined by the number of shuttles and level successfully completed before exhaustion or until subjects were not able to run with the recorded beep. Last level completed should be recorded as score.

The following equation was used to estimate VO2max:

VO2max (ml/kg/min) = 0.38 x total number of shuttles completed + 25.98 (Kilding et al., 2006).

Game Skill Variables:

SAI Hockey skill test (Kansal 2008):

Objective: to spot talent in young age players.

Shooting ability (Shooting in the target):

Objective: measure shooting ability of the hockey player

Equipment's: Hockey sticks, two flag post or cone, measuring tape, hockey corkball and marking powder.

Procedure: In the marked dimension players were asked to hit the ball from the kicking spot at restraining line towards the flag posts, ball must passes through the 1 meter gap between the flags/cones. Total 10 trials will be given.

Scoring: The number of accurate hits will be recorded as the score.

Ball Balancing (Balancing the ball on the stick)

Objective: To measure ball balancing ability of the player.

Equipment's: hockey sticks, cork ball and stop watch.

Procedure: The subjects were to lift the ball to stick's blade and balance ball on the hockey stick blade for maximum duration possible.

Scoring: maximum holding time will be recorded as score.

Ball controlling ability (Moving with ball)

Objective: To measure the ball controlling ability.

Equipment's: hockey sticks and cork ball, stop watch, measuring tape and marking powder.

Procedure: Ask the player to stand behind starting line while holding the hockey stick with both hands. On the whistle the subjects started running with the ball with ball in control constant contact with the ball should be ensured.

Scoring: The minimum time will be recorded as score.

Data collection: Prior testing the purpose of the study was explained to the players and coaches as well, during the process requirement of the testing procedures, demonstration and explanation of various bio motor, anthropometric, physiological and game skill tests to be administered were given to acquaint them with the requirement of the study. All the players voluntarily participated in the study, their coaches exhorted them as well to put in their best effort in this scientific investigation, though no special motivational technique was used yet the players were very enthusiastic and cooperative throughout the process of data collection.

3.5 Reliability of the data

The reliability of the data was ensured by establishing instruments reliability and tester's competency.

Instruments reliability All the instruments used in the study were obtained from standard firm by Lovely professional university which cater to the need of various research laboratories globally and there calibration was considered precise.

Tester's competency: ensuring the investigator was acquainted with the technique in examining the tests, investigator had various trial and practice session. Reliability of the tests and Testers competency was evaluated together by test- retest method (Gogia 2002; Dubey 2006).

The data collected from a random selection of 15 players on two occasions were computed using SPSS for each variables and correlation thus obtained have been presented in table.

Table 3.5.1 Reliability Coefficient of test-retest scores

S. No.	Variables	Coefficient 'r'
1	Left hand Grip strength	0.88**
2	Right hand Grip strength	0.87**
3	Leg explosive strength	0.93**
4	Arms & Shoulder strength endurance	0.94**
5	Core strength endurance	0.99**
6	Left Leg strength endurance	0.94**
7	Right Leg strength endurance	0.99**
8	Speed (30meters)	0.84**
9	Flexibility	0.95**
10	Agility (Semo Agility)	0.90**
11	Resting pulse rate	0.90**
12	Body Fat	0.99**
13	Body Mass Index	0.99**
14	Basal Metabolic rate	0.95**
15	Skeletal Muscle Mass	0.81**
16	Vo2 Max	0.99**
17	Body Weight	0.92**
18	Standing Height	0.99**
19	Arm Length	0.92**
20	Leg length	0.99**
21	Upper arm Girth	0.96**
22	Forearm Girth	0.99**
23	Thigh Girth	0.99**
24	Calf Girth	0.99**
25	Chest Girth	0.99**
26	Wrist Girth	0.98**
27	Elbow Diameter	0.94**
28	Knee Diameter	0.95**
29	Ankle Diameter	0.99**
30	Shooting the wall in the target	0.65**
31	Balancing the wall on the stick	0.75**
32	Moving with the wall	0.88**

Value of 'r' required for its significance at 0.01 level =0.641 df.=N-2=13

**Significant at 0.01 level

The correlation coefficient on data obtained on two occasions showed high coefficient among all variables.

3.6 Statistical techniques used

The data was analyzed by using following statistical techniques:

Descriptive statistics was computed for understanding and interpreting the nature of the data. Investigator had calculated mean as a measure of central tendency which represented average score of the particular distribution. Standard error of mean measures sampling fluctuation of any statistics i.e. if we take 'n' number of different group of samples from the same population, there mean will not be same; the variation in this mean is termed as standard error of mean. It gives a measure of, how well a particular group sample is true representative of population. The small the value of standard error of mean would be the more will be the probability of sample to be a true representative of population. If the value of standard error of mean is less than -2 or greater than +2 indicated more fluctuation. Investigator had calculated standard deviation as a measure of absolute reliability (used to measure dispersion of the data points and is restricted to uniform units of measurement, hence cannot used to compare variability in two groups having different unit of measurement) and coefficient of variance as a measure relative variability (used to measure variability in two set of variables having different units). Symmetricity in the data set was tested using skewness, as per the guidelines, if the statistical value of skewness is more than twice of the standard error of skewness, indicated departure from symmetricity and such data will be considered as skewed either positively or negatively (depend on the sign), and if found less than twice of standard error of skewness the data will be considered as symmetrically distributed. Investigator had calculated kurtosis to test whether the distribution was leptokurtic, mesokurtic, or platykurtic. If the value of kurtosis for any variable is positive meant there is less fluctuation in distribution, and the observation clusters more around the mean value. Zero kurtosis meant the data is normal and negative value of kurtosis meant larger degree of variance and the distribution of the data is less around its mean, such distribution is termed as platykurtic. The statistical value of kurtosis is interpreted in light with the standard error of kurtosis i.e. if the value of kurtosis for any variable is more than twice of its standard error either in positive or in negative direction (based on sign), the distribution of the data will be considered as leptokurtic and platykurtic respectively.

Kaiser Meyer-Olkin test was used to measure the adequacy of sample size.

KMO test, (Kaiser meyer Olkin) test whether the sample size taken for the study was sufficient or not, its value ranges from 0-1. For applying factor analysis reliably the value of KMO must be closer to 1. The KMO value more than 0.5 is considered as sufficient for applying factor analysis reliably.

Factor analysis was applied on the data obtained on junior national players to find out the factors and the variables with highest factor loading to develop a model. Factor analysis is used to measure latent/unobservable construct or constructs by focusing on large number of observable instances. It is a multivariate dimensionality/redundancy reduction parametric statistical method used to identify few important factors from huge number of variables by means of clubbing associated variables in the identical factor. Total factors to be retained in the model is determined by the eigenvalue only those factors were retained in the model whose eigenvalue is more than 1, and which variable to be included in the factor is determined by the magnitude of variable's loading on that factor.

Preparation of correlation matrix

Applied Bartlett's sphericity test for testing the null hypothesis i.e. correlation matrix is an identity matrix (indicated strength of relationship among the variables where all diagonal elements are one and off diagonal elements are close to zero). The value of Bartlett's test should be significant i.e. the value must be below 0.05 level which will conclude that correlation matrix was not an identity matrix hence factor analysis can be run appropriately.

Scree test will show graphical representation of the eigenvalue plotted on y-axis against the factor on x-axis, as one moves upward on y-axis increase in eigenvalue can be observed whereas it drops towards the lower side on x-axis. Cattell's scree test recommends drop in all the further components when decline ceases on elbow bent.

Principal component analysis will obtain unrotated factor solution, which will provide number of factors along with their initial eigenvalues which is the base to select factors only those factors whose eigenvalue is more than 1 will be retained in the analysis. The solution will provide percentage of variability explaineded by each factor individually, report extracted factors, total variability explaineded by all the extracted factors and the solution will too provide factor loading of variables on different factors.

Obtained rotated factor solution using varimax rotation with Kaiser normalization while using principal component analysis as an extraction method. As in unrotated factor solution some of the variables may belong to more than one factor and it is not possible to identify the variables to be included in the factor for sorting out this problem appropriate rotational technique was used to obtain final solution. If the variable's factor loading on a particular factor is equal to or more than .7 the variable should belong to that factor, whereas other variables may be identified in the factor whose factor loading is <.7 on the basis of explainability of the variable.

Identified factors should be given names

Based on magnitude of the factor loadings one to two variables may be selected from each factor to develop a test battery with proper weightage given to factors explaining maximum variability.

Suggestion of criteria for talent identification in field hockey

In this study, factor analysis was applied on the data obtained on the selected anthropometric, motor fitness, physiological and technical factors of male youth field hockey players. Thus, four separate factor analyses were carried out on all these four factors, further one factor analysis was conducted for all the factors taken together using SPSS version 20. The results obtained in the analysis are shown in different sections of next chapter.

Assumptions for applying Factor Analysis

the observable instances which measure the concept should have been included in the study, moreover investigator also had tested the reliability of the variables included in the study using communality (which measures the percentage of variance in a given variable jointly explained by the factors and may be ensure reliability of the variable, a variable having communality <.4 is useless and should be dropped from the study, the more the value of community of the variable the more will be its reliability) & had found that all the variables included in the study were very important hence can be the reliable observable instances to measure the construct. Communality table for each variable reported in the appendix.

Sufficient sample size

Investigator has taken sufficient sample size as it has been reported on multiple books of statistics, that to apply factor analysis reliably the sample size must be minimum 5 times to the number of variables selected in the study. So in the present study investigator has collected the data on 207 samples, while having included 32 variables in the study, thus the ratio becomes 6.47 times to the number of variables taken for the study. Further, investigator has applied KMO test to test the adequacy of sample size taken in the study. Kaiser designate levels to interpret KMO value such as KMO value >.9 represents marvelous sample size, >.8 is meritorious, >.7 middling, >.6 represents mediocre, >.5 represents miserable and up to <.5 is unacceptable.

1. No outlier is present in the data; investigator had tested the data to ascertain whether any outliers present, using QQ plot test.

2. Multicollinearity should not exist among the variables.

   The problem of multicollinearity was sorted out using Principal Components Analysis and factor analysis to the independent factors and ascertains that multicollinearity was not present in the data set.

3. Homoscedasticity may not exist among the variables.

   Investigator has applied Bartlett's test of sphericity to test homoscedasticity/homogeneity of variance and successfully fulfilled the assumption. The result of Bartlett's test is presented later in this chapter.

4. Data should be based interval and ratio scales all the data in the present study is metric data and is based on interval and ratio scale.

Pearson's product moment correlation coefficient was used to determine tester's competency and reliability of the data.

Cronbach's alpha was used in the factors to establish internal consistency.

3.6.1 Norms

Standard Score

Standard score is a raw score converted into standard deviation units above or below marked either aide of mean interpreted in relation to normal probability curve. Score above mean has +ve and below mean has –ve value. Z-score has a standard deviation of '0' and having mean '1', which makes the interpretation of Z-score cumbersome as most of the scores are in decimals. For making Z-score easily understandable and for further calculation, Z-score must be transformed into easily understandable standard score simply by multiplying Z-score to a new sd. and adding it to a new mean.

Transformed T- score

Transformed standard score is a Z-score in linear scale with equal unit of measurement, transformed using 10 as SD. and 50 as a mean which explained the level of deviation of score from mean. Transformed 'T' standard score has limitations that it is hard to understand and meaningless to those who are unaware about statistical testing.

3.6.2 Percentiles

Investigator had framed percentile scale norms on the basis of performance of subjects studied. Percentile norms are easily interpretable and easy to use, these types of norms directly indicated the excellence or weakness of the performer in percentage of the subject studied and anyone can easily compare the obtained score on the variable of interest and got to know about their status in the population using percentile scale norms. Percentile provides percentage of scores that a given value is greater than the given percentile or below which certain percent of observation lies.

Norm's table has described percentile rank and percentile scores, percentile rank ranges from 1-99 defines the score point in the unit of measurement above or below which a specified percentage of score fall, whereas centile point can have any value in the unit of measurement.

In the present study for the purpose of preparing percentile scale norms investigator has calculated $p^{3,10,25,50,75,90 \text{ and } 97th}$ percentile, here subjects were not assigned exact percentile rank, but only a range that the individual would lie below 3rd percentile, between 3rd to 10th, between 10th and 25th, between 25th and 50th, between 50th and 75th, between 75th and 90th, between 90th and 97th.

P^3= The score in the given distribution which was more than the score of 3% of the subjects or 3% of the subjects have lower score than the given score, in other word the score was less than 97% of the subjects.

P^{10}= The score in the given distribution which was more than the score of 10% of the subjects or 10% of the subjects have lower score than the given score, in other word the score was less than 90% of the subjects.

P^{25}= The score in the given distribution which was more than the score of 25% of the subjects or 25% of the subjects have lower score than the given score, in other word the score was less than 75% of the subjects.

P^{50}= The score in the given distribution which was more than the score of 50% of the subjects or 50% of the subjects have lower score than the given score, in other word the score was the center i.e. above or below which 50% of the observations' lies.

P^{75}= The score in the given distribution which was more than the score of 75% of the subjects or 75% of the subjects have lower score than the given score, in other word the score was less than 25% of the subjects.

P^{90}= The score in the given distribution which was more than the score of 90% of the subjects or 90% of the subjects have lower score than the given score, in other word the score was less than 10% of the subjects.

P^{97}= The score in the given distribution which was more than the score of 97% of the subjects or 97% of the subjects have lower score than the given score, in other word the score was less than 3% of the subjects.

3.7 Abbreviations Used

LHGS	= Left Hand grip strength
RHGS	=Right Hand grip strength
PU	=Push Ups
FAP	=Fore arm plank
LLWST	=Left leg wall sit test
RLWST	=Right leg wall sit test
SBJ	=Standing Broad Jump
SP	=Speed
FL	=Flexibility
AG	=Agility
BW	=Body weight
SH	=Standing height
AL	=Arm length
LL	=Leg length
UAG	=Upper arm Girth
FAG	=Forearm Girth
TG	=Thigh Girth
CG	=Calf Girth
CHG	=Chest Girth
WD	=Wrist diameter
ED	=Humerus Bi Condyle diameter
KD	=Femur epicondyle diameter
AD	=Ankle diameter
RPR	=Resting heart rate
PBF	=Percent body fat

BMI	=Body mass index
BMR	=Basal metabolic rate
SMM	=Skeletal muscle mass
VO2 MAX	=Aerobic power
SIT	=Shooting in the target
BBS	=Balancing the ball on the stick
MWB	=Moving with the ball
PCA	= Principal Component Analysis
FA	= Factor Analysis

CHAPTER- IV

RESULTS & DISCUSSION

Keeping in view, the very purpose of developing multidimensional talent identification criteria, for identifying the talent in male field hockey at early age, considering anthropometrical, bio-motor, physiological and game-skill factor. A detailed statistical analysis and results of the data on youth male field hockey players is described in this chapter:

Results and Interpretation

After the data collection, the nature of the data was studied by the measurement of central tendency (standard error of mean), dispersion, symmetricity and distribution was calculated and presented in table (4.1.1-4.1.4). As the data was collected on interval and ratio scale mean was used to measure central tendency, dispersion was measured using standard deviation, whereas for asymmetrical data central tendency was measured using median and quartile deviation was reported to measure dispersion, symmetricity was measured using skewness statistics whereas kurtosis was used to understand distribution of the data. To accomplish the aim of the study i.e. to develop a model to identify the talent in male field Hockey, factor analysis was applied and presented in section 4.1 to section 4.12 below. Before applying parametric statistics like factor analysis on the metric data and to yield reliable results, there were certain assumptions which need to be reported and taken care off. Investigator has tried to the fullest to fulfill all the assumptions and had also tested them well in advance and is presented later in the chapter.

4.1 Descriptive Statistics

Table 4.1.1 Descriptive analysis on the data of anthropometric variables

Variables	Central Tendency		Variability		Symmetricity		Distribution	
	Mean		Sd.	Coefficient of variance	Skewness		Kurtosis	
	Statistic	Std. Error			Statistic	Std. Error	Statistic	Std. Error
Body Weight	58.14	0.55	7.85	13.5	0.162	0.169	-0.176	0.337
Standing Height	170.21	0.44	6.27	3.68	-0.296	0.169	-0.531	0.337
Arm Length	76.82	0.24	3.48	4.53	-0.075	0.169	0.353	0.337
Leg Length	104.13	0.31	4.47	4.29	-0.145	0.169	-0.542	0.337
Body Mass Index	20.01	0.14	2.05	10.24	-0.299	0.169	2.003	0.337
Fore Arm Girth	23.7	0.1	1.48	6.24	-0.228	0.169	-0.213	0.337
Upper Arm Girth	24.5	0.14	2.12	8.65	-0.083	0.169	-0.278	0.337
Thigh Girth	49.76	0.27	3.86	7.76	-0.112	0.169	0.138	0.337
Calf Girth	33	0.15	2.22	6.73	-0.333	0.169	-0.082	0.337
Chest Girth	83.06	0.37	5.39	6.49	-0.046	0.169	0.471	0.337
Wrist Diameter	4.99	0.02	0.35	7.01	-0.019	0.169	0.277	0.337
Elbow Diameter	6.32	0.03	0.42	6.64	-0.327	0.169	0.001	0.337
Knee Diameter	8.85	0.04	0.55	6.21	0.08	0.169	1.76	0.337
Ankle Diameter	6.68	0.03	0.46	6.89	0.226	0.169	1.594	0.337

In the table 4.1.1 above mean of each anthropometrical variable has been given along with standard error of mean. In the present analysis the standard error of mean for all the variables were within the range, indicated sample taken in the study were the true representatives of the population, while standard error of mean was least for wrist diameter and maximum for the body weight. Whereas standard deviation was calculated as a measure of absolute variability of the distribution. Coefficient of variance (a measure of relative reliability) revealed the data was more varied on body weight and least on standing height. Symmetricity in the distribution tested using skewness statistics and was found lesser than the twice of its standard error

(2×.169=.338), hence it might be concluded, that the data on all of the variables was symmetrically distributed. At last investigator has reported kurtosis in order to test the distribution of the collected data. The value kurtosis for ankle and knee diameter was significant i.e. more than twice of their standard error (2×.337=0.674) on positive direction, thus the distribution of the data on these variables was clustered more around their mean value. Whereas on all other variables, the value of kurtosis was not significant, hence the distribution of all the variables was mesokurtic and normal. The above statistical analysis was done for general in-depth understanding about the characteristics subjects taken in the study and was having no influence on final outcome of the study.

Table 4.1.2 Descriptive analysis on the data of Bio-motor abilities

Variables	**Central Tendency**		**Variability**		**Symmetricity**		**Distribution**	
	Mean		**Sd.**	**Coefficient of variance**	**Skewness**		**Kurtosis**	
	Statistic	**Std. Error**			**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
Left Hand Grip Strength	38.69	0.42	5.99	15.48	-0.203	0.169	-0.017	0.337
Right Hand Grip Strength	38.71	0.41	5.95	15.37	-0.051	0.169	0.096	0.337
Standing Broad Jump	213.68	1.43	20.5	9.6	-0.315	0.169	-0.3	0.337
Push Ups	40.78	0.64	9.19	22.53	-0.007	0.169	0.306	0.337
Fore Arm Plank	3.065	.10	1.48	48.29	.896	0.169	-.070	0.337
Left Leg wall sit test	1.57	0.05	0.67	42.67	0.163	0.169	-0.072	0.337
Right Leg wall sit test	1.46	0.05	0.67	42.89	0.248	0.169	-0.326	0.337
Speed	4.69	0.02	0.33	7.04	-0.211	0.169	0.941	0.337
Flexibility	10.25	0.33	4.8	46.83	0.015	0.169	-0.896	0.337
Variables	**Median**		**QD**					
Agility	10.9		2.09	19.17	0.572	0.169	-0.897	0.337

The table 4.1.2 above showed mean of each variable, along with their standard error. In the present analysis the standard error of mean for all the variables, was within the range, indicated samples taken in the study, were the true representative of the population, while standard error of mean was least for speed and maximum for the standing broad jump. Whereas standard deviation was calculated to measure absolute variability in the distribution. Coefficient of relative variability revealed that the performance of the subjects was more varied on flexibility followed by wall sit test and least varied in speed. Skewness was calculated to test the symmetricity in the data. Symmetricity statistics skewness revealed that the statistical value of skewness on left and right hand grip strength, standing broad jump, push-ups, left and right leg wall sit test, speed and flexibility was insignificant and concluded that the data on all these variables was symmetrically distributed i.e. there was no outlier was there present in the data and most of the observations were clustered around the mean. Whereas the statistical value of skewness for forearm plank and agility was found more than twice of their standard error (2×.169=.338), which concluded that the data on these variables was not symmetrically distributed i.e. the outliers were present in the distribution, hence median to measure central tendency and quartile deviation for dispersion was reported for these variables. At last investigator has reported kurtosis in order to test the distribution of the collected data. The value of kurtosis revealed that the statistical value of kurtosis for speed (positive), flexibility and agility (negative) was significant i.e. more than twice of their standard error (2×.337=0.674). Thus the positive kurtosis value of the speed indicated distribution was clustered more around their mean, revealed a leptokurtic curve, meant the data was least scattered. Whereas the negative value of kurtosis on flexibility and agility indicated the distribution was clustered less around mean a platykurtic curve, meant the data was significantly scattered around the mean value, on the other hand the value of kurtosis for all other variables showed in the table above was not significant, hence the distribution of all the variables was mesokurtic and normal, meant the data was normally distributed around the mean value. The above statistical analysis was done for general in-depth understanding about the characteristics subjects taken in the study and was having no influence on final outcome of the study.

Table 4.1.3 Descriptive analysis on the data of Physiological variables

Variables	Central Tendency		Variability		Symmetricity		Distribution	
	Mean		Sd.		Skewness		Kurtosis	
	Statistic	Std. Error		Coefficient of variance	Statistic	Std. Error	Statistic	Std. Error
Resting Pulse Rate	69.49	0.46	6.65	9.57	0.096	0.169	0.731	0.337
Body Fat	12.99	0.22	3.16	24.33	0.297	0.169	0.311	0.337
Basal Metabolic Rate	1461.13	8.71	125	8.57	-0.04	0.169	-0.111	0.337
Skeletal Muscle Mass	37.97	0.11	1.62	4.27	-0.315	0.169	-0.022	0.337
Variables	Median		QD					
Vo2 Max	64.74		9.5	14.67	-1.441	0.169	4.541	0.337

The table 4.1.3 above showed mean of each physiological variable, along with their standard error. In the present descriptive statistical analysis the standard error of mean for all the variables except that of basal metabolic rate was within the range, indicated samples were the true representative of the population, while standard error of mean was least for skeletal muscle mass and maximum for basal metabolic rate. Whereas standard deviation was calculated to measure absolute variability in the distribution, coefficient of variance revealed the physiological performance of the subjects was more varied on body fat followed by vo2max and least varied in skeletal muscle mass. Symmetricity in the data set was tested using skewness, present descriptive statistical analysis revealed the statistical value of skewness on all other variables except Vo2 Max was insignificant and concluded that the data on all these variables was symmetrically distributed. The statistical value of skewness for Vo2 Max was found more than twice of its standard error (2×.169=.338), ascertained that the data on Vo2 Max was not symmetrically distributed, hence median and quartile deviation was reported for Vo2 Max. Investigator has calculated kurtosis to test whether the distribution was leptokurtic, mesokurtic, or platykurtic and revealed that the statistical value of kurtosis for resting pulse rate and vo2max was significant in positive direction i.e. more than twice of their standard error (2×.337=0.674), meant the distribution was leptokurtic, thus most of the data was clustered around mean. The value of kurtosis for all other variables showed in the table above was not significant, hence the distribution of all the variables was mesokurtic and normal. The above statistical analysis was done for general in-depth understanding about the characteristics subjects taken in the study and was having no influence on final outcome of the study.

Table 4.1.4 Descriptive analysis on the data of game skill variables

Variables	Central Tendency		Variability		Symmetricity		Distribution	
	Mean		Sd.	Coefficient of variance	Skewness		Kurtosis	
	Statistic	Std. Error			Statistic	Std. Error	Statistic	Std. Error
Shooting in the target	7.16	0.083	1.21	16.9	-0.143	0.169	-0.259	0.337
Balancing the ball on the stick	2.81	0.105	1.52	54.09	0.081	0.169	-1.261	0.337
	Median		QD					
Moving with the ball	9.51		0.77	8.097	0.455	0.169	1.237	0.337

The table 4.1.4 showed mean for each variable, along with their standard error. In the present descriptive statistical analysis of the game skill variables, revealed that the standard errors of mean for all variables was within the range and indicated that the samples taken were true representative of the population. While standard error of mean was least for moving with the wall and maximum for balancing the ball on the stick. Standard deviation was calculated to measure absolute variability in the distribution, coefficient of variance revealed the game skill performance of the subjects was more varied on balancing the ball on stick and least varied in moving with the wall.

Symmetricity statistics skewness revealed the statistical value of skewness on all other variables except moving with the ball was insignificant and concluded that the data on all these variables was symmetrically distributed. Whereas the statistical value of skewness for moving with the wall was found more than twice of their standard error (2×.169=.338) which concluded that the data was not symmetrically distributed, hence median and quartile deviation was reported for such data, further this does not had any influence on the findings of the study. Investigator has calculated kurtosis to test whether the distribution was leptokurtic, mesokurtic, or platykurtic. The descriptive statistically analysis of the data revealed statistical value of kurtosis for balancing the ball on the stick (negative value meant high level of data fluctuation) and moving with the ball (positive value indicated low level of data fluctuation) direction was significant i.e. more than twice of its standard error (2×.337=0.674). On the other hand the value of kurtosis for remaining variable showed in the table above was not significant, hence the distribution of this variable was considered mesokurtic and normal. The above statistical analysis was done for general in-depth understanding about the characteristics subjects taken in the study and was having no influence on final outcome of the study.

Factor analysis for understanding the structures of the variables and developing criteria for identifying talent in field hockey

4.2 Application of Factor analysis on anthropometrical variables of field hockey players

The data collected on different selected anthropometrical variables was subjected to factor analysis; the result so obtained was presented in the table 4.2.1 to 4.2.9 & figure 4.2.1 below:

Table 4.2.1 Correlation matrix for the data on selected anthropometrical variables of the field hockey players

	BW	SH	AL	LL	UAG	FAG	TG	CG	CHG	WD	ED	KD	AD	BMI
BW	1	**.0.7	**.0.59	**.0.56	**.0.8	**0.78	**0.78	**0.66	**0.85	**0.45	**0.54	**0.5	**0.39	**0.76
SH		1	**0.82	**.0.84	**.0.38	**0.44	**0.4	**0.37	**0.51	*0.36	**0.54	**0.49	**0.37	*0.2
AL			1	**.0.78	**0.29	**0.33	**0.29	**0.28	**0.48	**0.3	**0.52	**0.41	**0.3	0.15
LL				1	**0.23	**0.29	**0.3	**0.26	**0.38	*0.18	**0.41	**0.43	*0.19	0.09
UAG					1	**0.83	**0.83	**0.65	**0.78	**0.33	**0.31	**0.31	**0.25	**0.76
FAG						1	**0.75	**0.59	**0.75	**0.38	**0.33	**0.39	**0.27	**0.65
TG							1	**0.72	**0.72	**0.29	*0.22	**0.3	**0.26	**0.72
CG								1	**0.59	**0.36	**0.32	**0.33	**0.33	**0.59
CHG									1	**0.37	**0.39	**0.43	**0.36	**0.73
WD										1	**0.54	**0.43	**0.51	**0.31
ED											1	**0.45	**0.58	**0.28
KD												1	**0.44	**0.26
AD													1	**0.26
BMI														1

Value of 'r' required for its significance at 0.05 level =0.164 df.=N-2=205 *Significant at 0.05 level

Value of 'r' required for its significance at 0.01 level =0.230 df.=N-2=205 ` **Significant at 0.01 level

Correlation coefficient among different anthropometrical variables of field hockey players was shown in table 4.2.1. Significant correlation was evident from the table within some of the variables both at 0.01 and 0.05 level of significance. The variables were grouped into different factors on the basis of correlation matrix. The table is self-explanatory, thus many more significant conclusions can be drawn using the table.

BW= Body weight SH= Standing Height AL= Arm Length LL= Leg length UAG= Upper Arm Girth FAG= Fore arm girth TG= Thigh Girth CG=Calf-Girth CHG= Chest Girth WD= Wrist Diameter ED=Elbow-Diameter KD= Knee Diameter AD=Ankle Diameter BMI= Body Mass Index

Table 4.2.2 KMO and Bartlett's Test of sphericity for anthropometrical variables

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.884
Bartlett's Test of Sphericity	Approx. Chi-Square	2658.708
	Df	91
	Sig.	.000

Above table has reported KMO value, along with Bartlett's test. The KMO value (.884) was found more than .05, hence it could be concluded that the sample size taken for the present study & for applying factor analysis was sufficient. If the value of KMO test found less than .05 than the null hypothesis might be rejected and the inference could be drawn that number of samples were not sufficient. Further Bartlett's test of sphericity revealed significance value (p value) .000 was significant at .05 level of significance, which concluded that the correlation matrix was different to identity matrix, which revealed factor analysis can be reliably done.

Table 4.2.3 Total Variance Explained by the Anthropometric Factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.212	51.513	51.513	7.212	51.513	51.513	5.133	36.661	36.661
2	2.247	16.048	67.561	2.247	16.048	67.561	3.106	22.183	58.844
3	1.349	9.635	77.196	1.349	9.635	77.196	2.569	18.352	77.196
4	.595	4.249	81.444						
5	.513	3.665	85.109						
6	.492	3.514	88.623						
7	.381	2.721	91.344						
8	.330	2.354	93.698						
9	.254	1.817	95.516						
10	.181	1.295	96.811						
11	.151	1.079	97.890						
12	.141	1.006	98.896						
13	.118	.843	99.739						
14	.036	.261	100.000						
Extraction Method: PCA									

The table 4.2.3 consisted of four different sections i.e.

components (list of variables included in the study), second initial eigenvalues, third extraction sums of squared loadings and fourth rotation sums of squared loadings

Initial eigenvalues

Total: gives total variance accounted for by each factor was the first step to calculate the percentage of variance can be attributed to each factor.

Percentage of variance: it showed the percentage of variance attributable to each factor can be explained, could be obtained by dividing eigenvalue with total number of factors.

Cumulative %: indicated sum of variance by adding to the previous factor ends up with 100% variance.

Extraction sums of squared loadings

Total: showed total variance after extraction.

Percentage of variance: it was the percentage of variance might be attributed to each extracted factor, was of greater significance. It ascertained only three factors were extracted on the basis of their contribution towards talent identification. It was clearly depicted in the table that eigenvalue for first three factors was more than one, hence might be retained in the model. The extracted factor one showed 51.513% of the total variance, factor 2 showed 16.048% and factor three shared 9.635% of the total variance explained. In total extracted three factors jointly explained 77.196% of the total variance.

Cumulative %: was a cumulative percentage of variance of factor after adding to the previous factor.

Rotation sums of squared loadings:

Total: Total variance/eigenvalues attributable to each factor after rotation.

Percentage of variance: was the percentage of variance attributable to each factor after rotation. After rotation the first factor explained 36.661%, second factor 22.183% and the third factor explained 18.352% of the total variance. Thus when three factors taken together they explained 77.196% of the entire variance.

Cumulative %: indicated cumulative percentage of variance by adding to the previous factor after rotation.

Table 4.2.4 Component Matrix: Unrotated Factor Solution

	Component		
	1	2	3
Body Weight	.958	-.065	-.117
Standing Height	.729	.542	-.272
Arm Length	.637	.579	-.310
Leg Length	.579	.595	-.451
Upper Arm Girth	.814	-.443	-.085
Fore Arm Girth	.812	-.324	-.063
Thigh Girth	.795	-.426	-.149
Calf Girth	.723	-.284	.033
Chest Girth	.861	-.212	-.084
Wrist Diameter	.553	.174	.582
Elbow Diameter	.612	.428	.381
Knee Diameter	.594	.314	.228
Ankle Diameter	.515	.255	.616
Body Mass Index	.713	-.523	.067
Extraction Method: PCA			

Table 4.2.4 showed the loadings (extracted value of each variable under three factors) of thirteen different anthropometrical variables on the three extracted factors. The higher the value of factor loading would be, the more the factor might contributes to the variables. Here thirteen variables were divided into three factors according to the most important variable with similar response in factor 1 and simultaneously in factor 2 & 3. Since it resulted from unrotated factor solution, consequently some of the variables showed their contribution exceeding one factor such as leg length, Arm Length etc., Hence this situation must be sorted out. To sort this problem factors was rotated using varimax rotation to get the final rotated solution.

Figure 4.2.1 Scree Plot for anthropometrical variables

Figure 4.2.1 below showed eigenvalues for each of the anthropometrical variable taken in the present investigation plotted on y-axis against the factors on x-axis. Plot clearly showed only three factors were having eigenvalues more than 1 and thus were retained in the model. Note: curve starts flatten after factor three and also factor three onwards each factor has an eigenvalue of less than one. Thus only those factors could be retained which are having eigenvalue more than one.

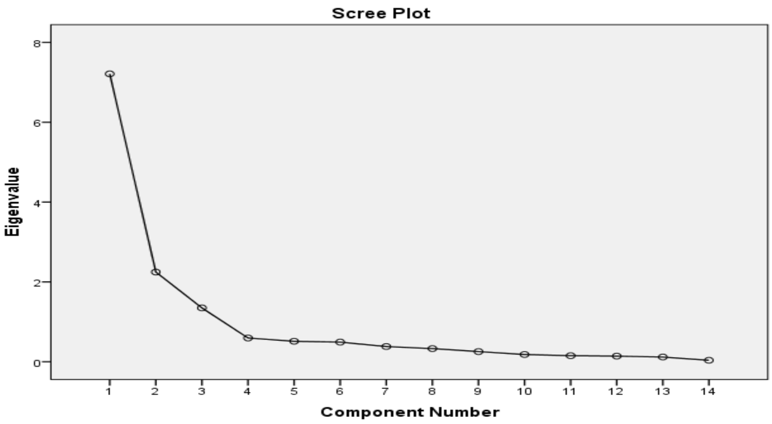

Table 4.2.5 Rotated Component Matrix:Varimax Rotated Solution

	Component		
	1	**2**	**3**
Body Weight	.788	.475	.296
Standing Height	.251	.869	.284
Arm Length	.162	.872	.225
Leg Length	.126	.932	.088
Upper Arm Girth	.913	.128	.127
Fore Arm Girth	.833	.197	.186
Thigh Girth	.896	.166	.071
Calf Girth	.727	.130	.241
Chest Girth	.803	.309	.230
Wrist Diameter	.236	.066	.784
Elbow Diameter	.148	.379	.733
Knee Diameter	.226	.376	.559
Ankle Diameter	.151	.086	.824
Body Mass Index	.866	-.059	.180
Extraction Method: PCA Rotation Method: Varimax			

After applying varimax rotation the final solution so obtained was presented in the table 4.2.5 above and it showed clear picture regarding explain ability of the factor by the variables correctly and facilitated the variable to appeared in one factor. The variables were to be identified in three different factors on the basis this final rotated solution obtained, in the present problem investigator has identified the variables with loadings equals to or more than .8. Owing to this criterion variables were grouped in each of the three factors shown in (Tables 4.2.6-4.2.8). Hence in factor one five variables were selected these variables were UAG, FAG, TG, CHG and BMI. Three variables SH, AL and LL were selected into factor two whereas one variable AD with loading of .824 was selected in factor three explained as below.

Table 4.2.6 Factor 1: Circumference Factor

S. No.	Items	Loadings
1	Upper Arm Girth	.913
2	Thigh Girth	.896
3	BMI	.866
4	Fore Arm Girth	.833
5	Chest Girth	.803

The factor 1 in table 4.2.6 contained variables such as upper arm girth, thigh girth, body mass index, fore arm girth and chest girth respectively, that measure circumference of the different body parts hence named as “circumference factor”. All the variables extracted in factor one were having higher loading on the factor ≥.8 thus extracted sufficient variance in explaining circumference factor satisfactorily.

Table 4.2.7 Factor 2: Length Factor

S. No.	Items	Loadings
1	Leg Length	.932
2	Arm Length	.872
3	Standing Height	.869

The factor 2 in table 4.2.7 contained variables leg length, arm length and standing height respectively that measures body stature i.e. length of upper and lower limbs, individuals height hence can be named as “Length factor”. All the loaded variables on stature factor showed significantly higher factor loading >.8 and thus extract sufficient variance in explaining the factor.

Table: 4.2.8 Factor 3: skeletal diameter

S. No.	Items	Loadings
1	Ankle Diameter	.825

The factor 3 in table 4.2.8 contained one variable ankle diameter which measured skeletal/bone diameter of the human body taken by pressing hard the sliding caliper against the bone near joint hence named as "skeletal diameter". Ankle diameter showed significant higher factor loading on skeletal diameter factor >.8 thus extracts sufficient variance in explaining the factor.

Table 4.2.9 Talent identification criteria based on anthropometrical factor

S. No.	Items	Loadings
1	Upper Arm Girth	.913
2	Thigh Girth	.896
3	Leg Length	.932
4	Standing Height	.869
5	BMI	.866

The Table 4.2.9 gave criteria to identify talent in male youth field hockey based on anthropometrical characteristics. Investigator had thoroughly studied and statistically analyzed, fourteen different anthropometrical variables and found five variables upper arm girth, thigh girth, leg length, standing height and BMI respectively were most important in explaining group characteristics based on anthropometrics, instead of studying too many number of variables. The model so developed comprehensively included all different anthropometric measurements i.e. from general body measurement to circumference and skeletal diameter; these extracted variables explained 88.460% of the total variance in defining talent based on anthropometrical variables.

4.3 Factor analysis on bio-motor components of field hockey players

The data collected on different selected bio-motor variables was subjected to factor analysis the result so obtained is presented in the table 4.3.1 to 4.3.10 & figure 4.3.1 below:

Table 4.3.1 Correlation matrix for the data on selected bio-motor components of field hockey players

	LHGS	RHGS	SBJ	PU	FAP	LLWST	RLWST	Sp	Fl	Ag
LHGS	1	**.835	**.443	**.242	-0.013	**.242	*.168	**-.307	0.147	**-.334
RHGS		1	**.440	*.164	-0.034	**.237	0.114	**-.318	0.144	**-.305
SBJ			1	**.331	-0.068	**.324	**.235	**-.541	0.01	**-.330
PU				1	**.232	**.259	**.290	**-.315	0.01	**-.393
FAP					1	0.094	*.164	0.04	0.163	-0.061
LLWST						1	**.685	**-.362	0.066	**-.287
RLWST							1	**-.296	0.132	**-.326
Sp								1	-0.001	**.490
Fl									1	0.093
Ag										1

Value of 'r' required for its significance at 0.05 level =0.164 df.=N-2=205

*Significant at 0.05 level

Value of 'r' required for its significance at 0.01 level =0.230 df.=N-2=205 `

**Significant at 0.01 level

Correlation coefficient on selected motor fitness variables showed significant correlation within some of the variables both at 0.01 and 0.05 level of significance. The variables were grouped into different factors on the basis of this correlation matrix. Flexibility had no significant relationship with any of the motor fitness variables, Abdominal muscular strength was also found insignificantly related to grip strength, leg explosive power (SBJ), leg strength endurance (LLWST), speed and agility whereas Leg strength endurance (RLWST) was also insignificantly related to grip strength (RHGS). The table is self-explanatory thus many more significant conclusions could be drawn using the table.

LHGS= Left hand grip strength RHGS= Right hand grip strength

SBJ= Standing Broad Jump PU= Pushups

FAP= Fore arm plank LLWST= Left leg wall sit test

RLWST= Right leg wall sit test Sp= Speed

Fl= Flexibility Ag= Agility

Table 4.3.2 KMO and Bartlett's Test of sphericity on bio-motor components

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.710
Bartlett's Test of Sphericity	Approx. Chi-Square	700.497
	Df	45
	Sig.	.000

Above table 4.3.2 reported KMO value, along with Bartlett's test. The KMO value (.710) was found more than .05, which concluded that the sample size taken for the present study & for applying factor analysis was sufficient. If the value of KMO test found less than .05 than the null hypothesis might be rejected and the inference could be drawn that number of samples were not sufficient. Further Bartlett's test of sphericity revealed significance value (p value) .000 was significant at .05 level of significance, which concluded that the correlation matrix was different to identity matrix which ascertained the reliability of the model.

Table 4.3.3 Total Variance Explained by the bio-motor Factors

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	3.438	34.382	34.382	3.438	34.382	34.382	2.246	22.465	22.465
2	1.511	15.107	49.489	1.511	15.107	49.489	1.861	18.606	41.070
3	1.248	12.482	61.970	1.248	12.482	61.970	1.856	18.559	59.630
4	1.012	10.117	72.087	1.012	10.117	72.087	1.246	12.458	72.087
5	.758	7.578	79.665						
6	.624	6.245	85.910						
7	.586	5.863	91.773						
8	.378	3.784	95.557						
9	.287	2.869	98.426						
10	.157	1.574	100.000						
Extraction Method: PCA									

The table 4.3.3 showed eigenvalues for each motor fitness variable, the extracted factors and the explained variance by these factors. As one can see in the table the eigenvalue for four factors was more than 1, hence four factors were retained as their eigenvalue was more than 1. It can also be seen that after rotation the first factor explained 22.465%, second factor 18.606%, third factor explained 18.559% whereas the fourth factor explained 12.458% of the entire variance. Thus the four factors jointly explained 72.087% of the total variance.

Table 4.3.4 Component Matrix: Unrotated Factor Solution

	Component			
	1	**2**	**3**	**4**
Left Hand Grip Strength	.702	-.510	.295	-.046
Right Hand Grip Strength	.673	-.561	.291	-.003
Standing Broad Jump	.706	-.211	-.174	.020
Push Ups	.553	.289	-.078	-.515
Fore Arm Plank	.096	.507	.465	-.551
Left Leg wall sit test	.639	.440	.013	.451
Right Leg wall sit test	.579	.589	.066	.376
Speed	-.700	.009	.316	-.011
Flexibility	.118	.053	.792	.160
Agility	-.656	-.083	.304	.265
Extraction Method: PCA				

Table 4.3.4 showed initial un-rotated factor solution for bio-motor variables, ten variables were divided into four extracted factors according to most important variable with similar response in factor one and simultaneously in factor two, three and four. The factor loadings for each of the variable on four extracted factors were shown in the table. Since it resulted from unrotated factor solution, as a result some of the variables showed their contribution exceeding one factor such as FAP, RLWST etc., the problem was sorted out using varimax rotation to get the final corrected rotated solution.

Figure 4.3.1 Scree Plot for bio motor components

Figure 4.3.1 below showed eigenvalues for all motor fitness variables taken in the study plotted on y-axis against the factors on x-axis. Plot showed the clear picture regarding number of variables to be retained, four factors were retained before elbow bent having eigenvalue more than 1. Note: the curve starts flatten after factor four and too subsequent factors were having eigenvalue below one, thus were removed from the final analysis.

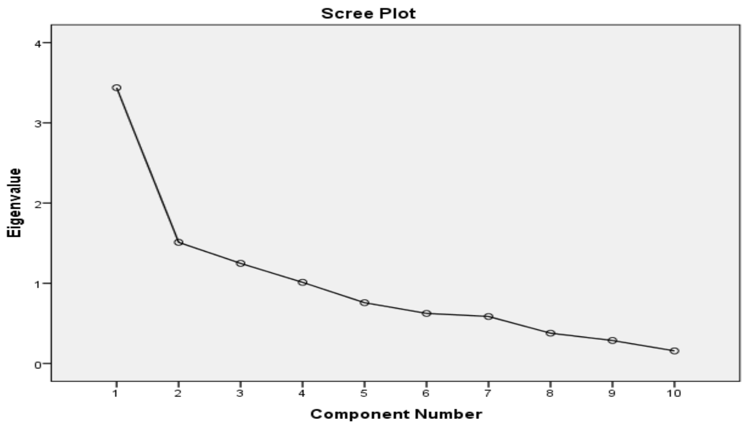

Table 4.3.5 Rotated Component Matrix:Varimax Rotated Solution

	Component			
	1	**2**	**3**	**4**
Left Hand Grip Strength	.900	-.162	.066	.041
Right Hand Grip Strength	.914	-.126	.046	-.019
Standing Broad Jump	.513	-.488	.244	-.117
Push Ups	.127	-.603	.141	.511
Fore Arm Plank	-.075	.004	.053	.882
Left Leg wall sit test	.135	-.172	.871	.008
Right Leg wall sit test	.022	-.144	.885	.151
Speed	-.318	.602	-.343	.093
Flexibility	.379	.565	.257	.375
Agility	-.233	.697	-.207	-.135
Extraction Method: PCA. Rotation Method: Varimax				

Table 4.3.5 provided final corrected solution after applying varimax rotation, which enable the variable to show its significance in one factor only. The variables were to be identified in four different factors on the basis of this final rotated solution obtained, in the present problem investigator has identified the variables with loadings equals to or more than .6. Owing to this criterion variables were grouped in each of the three factors as shown in (Table's 4.3.6-4.3.9).

Identification of variables into four different extracted factors

Table 4.3.6 Factor 1: Grip strength factor

S. No.	**Items**	**Loadings**
1	Right Hand Grip Strength	.914
2	Left Hand Grip Strength	.900

The factor 1 in the table 4.3.6 contained variables, RHGS and LHGS that measure grip strength of the hand hence could be named as "Grip strength factor". The variables loaded on factor one were having significantly higher factor loading ≥.9 thus extract sufficient variance in explaining the factor.

Table 4.3.7 Factor 2: Quickness

S. No.	Items	Loadings
1	Agility	.697
2	Speed	.602

The factor 2 in table 4.3.7 contained variables, agility and speed that measured quickness, hence could be termed as "quickness factor". As the threshold limit to select the variable into second factor had been set at ≥.6 keeping interpretability of the factor in mind, thus extracted variables explained the factor well.

Table 4.3.8 Factor 3: Leg strength

S. No.	Items	Loadings
1	Left Leg wall sit test	.871
2	Right Leg wall sit test	.885

The factor 3 in table 4.3.8 contained variables, left leg wall sit test and right leg wall sit test that measure Leg strength hence could be termed as "Leg strength". The variables loaded on factor three were having significantly higher factor loading ≥.8 thus extract sufficient variance in explaining the factor.

Table 4.3.9 Factor 4: core strength endurance

S. No.	Items	Loadings
1.	Fore Arm Plank	.882

The factor 4 in table 4.3.9 contained one variable fore-arm plank that measure muscular strength endurance hence could be termed as "core strength endurance factor". Fore Arm Plank showed significant higher factor loading >.8 thus explained the factor well.

Table 4.3.10 Talent identification criteria based on bio-motor factor

S. No.	**Items**	**Loadings**
1	Left hand grip strength	.900
2	Right hand grip strength	.914
3	Agility	.697
4	Left leg strength endurance	.871
5	Right leg strength endurance	.885
6	Fore arm plank	.882

The Table 4.3.10 suggested criteria to identify talent in youth male field hockey using bio motor abilities. Investigator had thoroughly studied and statistically analyzed ten varied bio motor abilities ranging from speed, strength to agility thus suggested that four factors (LHGS and RHGS clubbed into one grip strength, agility, Left leg strength endurance and Right leg strength endurance clubbed into one and fore arm plank) were most important and sufficient in explaining group characteristics based on bio motor abilities. The model so developed comprehensively included agility, strength and endurance abilities.

4.4 Factor analysis on physiological parameters of field hockey players

The data collected on different selected physiological variables was subjected to factor analysis the result so obtained was presented in the table 4.4.1 to 4.4.8 & figure 4.4.1 below:

Table 4.4.1 Correlation matrix for the data on selected physiological parameters of field hockey players

	RPR	BF	BMR	SMM	Vo2 Max
RPR	1	0.037	0.025	0.042	**-.268
BF		1	**.372	**-.776	-0.055
BMR			1	*-.176	*.207
SMM				1	0.035
Vo2 Max					1

Value of ‘r’ required for its significance at 0.05 level =0.164 df.=N-2=205

*Significant at 0.05 level

Value of ‘r’ required for its significance at 0.01 level =0.230 df.=N-2=205

`**Significant at 0.01 level

Correlation coefficient on selected physiological variables of youth male field hockey players showed significant correlation within some of the variables at 0.01 and 0.05 level of significance. The variables were grouped into different factors on the basis of this correlation matrix. Table shows resting pulse rate has no significant relationship with PBF, BMI, BMR and SMM but was significantly correlated to vo2 max at 0.01 level of significance, whereas no significant relationship was found between vo2max and body mass index, skeletal muscle mass. The correlation matrix table is self-explanatory thus many more significant conclusions may be drawn from the table regarding relationship among physiological variables.

RPR=Resting Pulse Rate BF= Body Fat

BMR= Basal Metabolic rate SMM= Skeletal muscle mass

Vo2 max= Aerobic Power

Table 4.4. 2 KMO and Bartlett's Test of sphericity for physiological parameters

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.479
Bartlett's Test of Sphericity	Approx. Chi-Square	258.640
	Df	10
	Sig.	.000

Above table 4.4.2 reported KMO value, along with Bartlett's test. The KMO value (.479), concluded that the sample size taken for the present study & for applying factor analysis was sufficient. . If the value of KMO test found less than .05 than the null hypothesis might be rejected and the inference could be drawn that number of samples were not sufficient. Further Bartlett's test of sphericity revealed significance value (p value) .000 was significant at .05 level of significance, which concluded that the correlation matrix and identity matrix are different which ascertained the reliability of the model.

Table 4.4.3 Total Variance Explained by the Physiological Factors

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	1.939	38.776	38.776	1.939	38.776	38.776	1.939	38.772	38.772
2	1.311	26.213	64.989	1.311	26.213	64.989	1.311	26.217	64.989
3	.953	19.055	84.044						
4	.607	12.137	96.181						
5	.191	3.819	100.000						
Extraction Method: PCA									

The table 4.4.3 showed eigenvalues for each physiological variable, the extracted factors and the explained variance by these factors. As one can see in the table the eigenvalue for first two factors was more than 1, hence two factors were retained as their eigenvalue was more than 1. The eigenvalue for factor one was 1.939 and 1.311 for factor two evident from the table above. It can also be seen that after rotation the first factor explained 38.772% and second factor explained 26.217%, of the entire variance. Thus both the factors jointly explained 64.989% of the whole variance.

Table 4.4.4 Component Matrix: Unrotated Factor Solution

	Component	
	1	**2**
Resting Pulse Rate	.003	-.697
Body Fat	.937	-.111
Basal Metabolic Rate	.542	.312
Skeletal Muscle Mass	-.875	.101
Vo2 Max	.031	.839
Extraction Method: PCA		

Table 4.4.4 showed initial un-rotated factor solution for physiological variable, six variables were divided into two extracted factor according to the most important variable with similar response in factor one and simultaneously in factor two. The factor loadings for each of the variable on the extracted factors have been shown in the table. Since the solution is obtained from before rotation, as a result some variables might show their contribution in more than single factor. This problem was sorted out using varimax rotation to get the final corrected rotated solution.

Figure 4.4.1 Scree Plot for physiological parameters

Figure 4.4.1 below showed eigenvalues for each physiological variable plotted on y-axis against the factors on x-axis. Plot showed the clear picture regarding number of variables to be retained, two factors were retained before elbow bent having eigenvalue more than 1. Note: the curve started flattening after second factor and also all exceeding factors were having eigenvalue less than one, hence were not selected for final analysis as they explained insufficient variance.

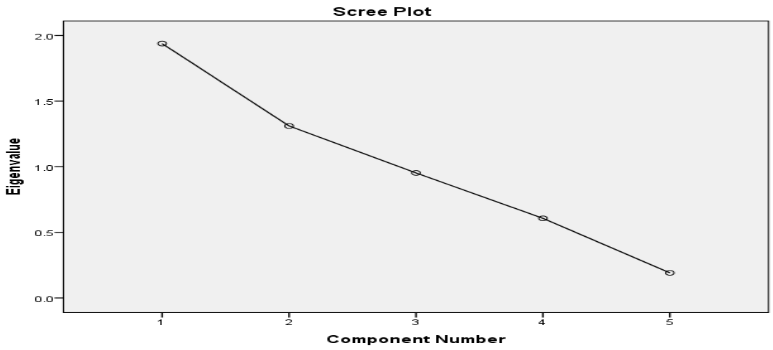

Table 4.4.5 Rotated Component Matrix:Varimax Rotated Solution

	Component	
	1	2
Resting Pulse Rate	.016	-.697
Body Fat	.939	-.094
Basal Metabolic Rate	.537	.322
Skeletal Muscle Mass	-.877	.085
Vo2 Max	.015	.840
Extraction Method: PCA Rotation Method: Varimax		

Table 4.4.5 provided final corrected solution after applying varimax rotation, which enable the variables to appear in one factor only. The variables were to be identified in two factors on the basis of this final rotated solution obtained, in the present problem investigator has identified the variables with loadings equals to or more than .8. Owing to this criterion variables were grouped in each of the three factors as shown in (Table-4.4.6-4.4.7). Hence two variables PBF and SMM were selected in factor one whereas also two variables RPR and Vo2 max were selected into factor two, RPR was selected based on its explainability of the extracted factor.

Identification of variables into two different extracted factors

Table 4.4.6 Factor 1: Body composition

S No.	Items	Loadings
1	Body Fat	.939
2	Skeletal Muscle Mass	-.875

The factor 1, in the table 4.4.6 contained variables body fat and skeletal muscle mass which reflects body composition hence the factor was named as “Body composition factor”. The variables loaded on factor one were having higher factor loading >.8 thus one might concluded that the extracted variables significantly explained the factor.

Table 4.4.7 Factor 2: Aerobic power

S. No.	Items	Loadings
1	Vo2 Max	.839
2	Resting Pulse Rate	-.697

The factor 2, in the table 4.4.7 contained two variable Vo2 Max and Resting Pulse Rate, thus could be termed as "Aerobic power factor". The variable explained the factor well.

Table 4.4.8 Talent identification criteria based on physiological factor

S. No.	Items	Loadings
1	Body fat	.937
2	Skeletal Muscle Mass	-.875
3	Vo2 Max	.839
4	Resting Pulse Rate	-.697

Table 4.4.8 gave talent identification criteria to identify talent in youth male field hockey on the basis of physiological capacities. Investigator had thoroughly studied and statistically interpreted different physiological variables and found that four variables PBF, SMM, VO2 MAX & RPR were most important in explaining group characteristics based on physiological variables, instead of studying too many variables. The model so developed comprehensively included physiological factors ranging from aerobic power to body composition and thus explains 76.210%.

4.5 Factor analysis on game skill variables of field hockey players

The data collected on different selected game skill variables was subjected to factor analysis the result so obtained was presented in the table 4.5.1 to 4.5.5 & figure 4.5.1 below:

Table 4.5.1 Correlation matrix for the data on selected game skill variables of field hockey players

	Shooting in the target	Balancing the ball on the stick	Moving with the ball
Shooting in the target	1.000	**.358	*-.164
Balancing the ball on the stick		1.000	**-.413
Moving with the ball			1.000

Value of 'r' required for its significance at 0.05 level =0.164 df=N-2=205

(*Significant at 0.05 level)

Value of 'r' required for its significance at 0.01 level =0.230 df=N-2=205

(`**Significant at 0.01 level)

Correlation coefficient on selected physiological variables of youth male field hockey players showed significant correlation within some of the variables at 0.01 and 0.05 level of significance. The variables were grouped into different factors based on correlation matrix. The correlation matrix table is self-explanatory thus many more significant inferences can be drawn from the table regarding relationship between game skill variables.

Table 4.5.2 KMO and Bartlett's Test of sphericity for game skill variables

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.563
Bartlett's Test of Sphericity	Approx. Chi-Square	66.248
	Df	3
	Sig.	.000

Above table 4.5.2 reported KMO value, along with Bartlett's test. The KMO value (.563) more than .05, which concluded that the sample size taken for the present study & for applying factor analysis was sufficient. If the value of KMO test found less than .05 than the null hypothesis might be rejected and the inference could be drawn that number of samples were not sufficient. Further Bartlett's test of sphericity revealed significance value (p value) .000 was significant at .05 level of significance, which concluded that the correlation matrix was not an identity matrix which ascertained the reliability of the model. Hence factor analysis might reliably be done.

Table 4.5.3 Total Variance Explained by the game skill Factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.634	54.473	54.473	1.634	54.473	54.473
2	.838	27.927	82.400			
3	.528	17.600	100.000			
Extraction Method: PCA						

The table 4.5.3 showed eigenvalues for each game skill variables, the extracted factors and the explained variance by these factors. As one can see in the table the eigenvalue for first factor was more than 1, hence only one factor was retained. It can also be seen from the table that rotation cannot be done for the model as only one factor was extracted which explained 54.473% of the total variance.

Table 4.5.4 Component Matrix: Unrotated Factor Solution

	Component
	1
Shooting in the target	.656
Balancing the ball on the stick	.834
Moving with the ball	-.713
Extraction Method: PCA	

Table 4.5.4 showed initial un-rotated factor solution for game skill variables, single factor was extracted in this model. The factor loadings for each of the variable on the extracted factor have been demonstrated in the table. Since the factor analysis results in single factor, therefore the factor solution cannot be rotated.

Figure 4.5.1 Scree Plot for game skill variables

Figure 4.5.1 below showed eigenvalues for game skill variables plotted on y-axis against the factors on x-axis. Plot showed the clear picture regarding number of variables to be retained, Single factor was retained before elbow bent as having eigenvalue more than 1. Note: the curve started flattening after factor one, the remaining two factors have eigenvalue less than one, hence were excluded from further analysis.

Table 4.5.5 Talent identification criteria based on game skill variables

S No.	Items	Loadings
1	Balancing the ball on the stick	.834
2	Moving with the ball	-.713
3	Shooting in the target	.656

Table 4.5.5 suggested the criteria to identify talent in male youth field hockey based on game skill variables. The factor analysis extracted three variables in the model, although shooting skill has the factor loading below .7, but was included in the model due to its interpretability and as it explained the construct well. Other variables showed significantly higher factor loadings. Thus Balancing the ball on the stick, Moving with the ball and Shooting in the target were most important and sufficient in explaining group characteristics based on game skill variables.

4.6 Factor analysis on the multidimensional factors

In the previous four sections from 4.2 to 4.5 talent identification criteria based on anthropometrical variables, bio motor abilities, physiological capacities and game skill variables has been presented separately. Here in this section investigator had tried to propose a multidimensional criterion for talent identification. Here all the factors anthropometrical, bio-motor, physiological and game skill factors are considered together to suggest a multidimensional model and was presented in table 4.6.1 to 4.6.13 and figure 4.6.1.

Table 4.6.1 Correlation matrix on multidimensional factors of field hockey players

	BW	SH	AL	LL	UAG	FAG	TG	CG	CHG	WD	ED	KD	AD	RPR	BF	BMI	BMR	SMM	VO2	LHGS	RHGS	SBJ	PU	FAP	LLWST	RLWST	SP	FL	AG	SIT	BBS	MWB
BW	1.000	.712	.589	.560	.803	.780	.782	.658	.846	.445	.536	.504	.391	.073	.450	.762	.945	-.279	-.148	.567	.538	.334	.110	-.145	.035	.044	-.243	-.024	-.358	.000	-.139	-.058
SH		1.000	.817	.843	.383	.435	.396	.373	.506	.361	.543	.489	.372	.102	-.066	.199	.709	.215	-.054	.468	.464	.356	.030	-.052	-.040	-.037	-.173	-.045	-.290	-.084	-.093	-.128
AL			1.000	.781	.293	.331	.293	.283	.481	.297	.518	.408	.296	.173	.037	.152	.568	.081	-.065	.289	.263	.210	-.049	-.063	-.077	-.071	-.151	-.059	-.232	-.050	-.048	-.149
LL				1.000	.233	.291	.297	.259	.379	.183	.414	.430	.189	.189	-.011	.089	.534	.170	-.003	.263	.303	.304	.061	-.001	-.065	-.052	-.171	-.151	-.368	-.064	.035	-.209
UAG					1.000	.826	.830	.645	.779	.326	.308	.309	.253	.021	.473	.758	.757	-.383	-.117	.502	.474	.183	.133	-.115	-.002	.029	-.208	-.012	-.329	.098	-.137	-.023
FAG						1.000	.754	.590	.754	.378	.334	.393	.271	-.043	.386	.652	.775	-.201	-.112	.613	.604	.368	.156	-.110	.087	.109	-.267	-.036	-.289	.055	-.083	-.052
FAG							1.000	.716	.718	.286	.220	.300	.258	.023	.505	.722	.726	-.386	-.126	.433	.454	.213	.203	-.123	-.002	.023	-.216	-.012	-.307	.148	-.099	-.116
CG								1.000	.592	.356	.319	.327	.325	.046	.335	.589	.615	-.220	-.239	.348	.355	.111	.115	-.237	.077	.132	-.207	-.033	-.229	.060	-.110	-.012
CHG									1.000	.371	.385	.427	.356	.038	.426	.726	.778	-.306	-.109	.469	.465	.286	.113	-.108	.054	.043	-.247	-.062	-.265	-.026	-.179	-.058
WD										1.000	.543	.432	.511	-.090	-.006	.310	.410	.046	-.228	.412	.332	.101	-.154	-.229	.026	-.003	.048	.067	.150	-.136	-.223	.050
ED											1.000	.453	.575	.163	.038	.279	.512	.088	-.053	.386	.271	.209	-.029	-.051	-.010	.099	-.087	.089	-.091	-.081	-.169	.059
KD												1.000	.439	.144	.106	.264	.455	.136	-.099	.202	.262	.163	-.071	-.098	.008	.068	-.080	-.057	-.024	-.095	-.177	.020
AD													1.000	.047	.017	.262	.342	.066	-.186	.342	.246	.044	-.094	-.184	-.152	-.057	.039	.044	.065	-.119	-.276	.101
RPR														1.000	.037	.027	.025	.042	-.101	-.150	-.068	-.030	-.227	-.102	-.095	-.100	.049	-.192	.057	-.102	-.164	.236
BF															1.000	.636	.372	-.776	-.116	.050	.014	.037	.125	-.116	.068	.109	-.112	-.085	-.210	.099	-.083	.099
BMI																1.000	.674	-.573	-.151	.342	.305	.144	.105	-.149	.072	.071	-.137	.033	-.204	.008	-.154	.016
BMR																	1.000	-.176	-.133	.604	.578	.360	.160	-.133	.064	.053	-.247	-.060	-.359	.001	-.117	-.083
SMM																		1.000	.061	.057	.104	.105	-.086	.059	.047	-.029	.007	-.026	.064	-.095	.086	-.098
VO2																			1.000	-.022	-.065	-.047	.291	1.000	.097	.192	.018	.129	-.091	-.072	.133	-.086
LHGS																				1.000	.835	.443	.242	-.019	.242	.168	-.307	.147	-.330	-.003	.002	-.131
RHGS																					1.000	.440	.164	-.063	.237	.114	-.318	.144	-.302	.040	.040	-.084
SBJ																						1.000	.331	-.045	.324	.235	-.541	.010	-.327	.018	.041	-.230
PU																							1.000	.292	.259	.290	-.315	.010	-.389	.051	.147	-.228
FAP																								1.000	.098	.194	.018	.130	-.092	-.072	.133	-.087
LLWST																									1.000	.685	-.362	.066	-.290	.024	.231	-.220
RLWST																										1.000	-.296	.132	-.326	.072	.213	-.137
SP																											1.000	-.001	.493	-.216	-.270	.310
FL																												1.000	.088	.058	.017	-.188
AG																													1.000	-.219	-.252	.210
SIT																														1.000	.358	-.161
BBS																															1.000	-.418
MWB																																1.000

The correlation matrix table 4.6.1 is self-explanatory; more significant conclusions could be drawn from the table regarding relationship between physiological variables.

Table 4.6.2 KMO and Bartlett's Test of sphericity when all the factors taken together

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.818
Bartlett's Test of Sphericity	Approx. Chi-Square	6623.727
	Df	496
	Sig.	0.000

Table 4.6.2 reported KMO value, along with Bartlett's test. The KMO value (.818) was found more than .05, which concluded that the sample size taken for the present study & for applying factor analysis was sufficient. . If the value of KMO test found less than .05 than the null hypothesis might be rejected and the inference could be drawn that number of samples were not sufficient. Further Bartlett's test of sphericity revealed significance value (p value) .000 was significant at .05 level of significance, which concluded that identity matrix different to that of the correlation matrix which ascertained the reliability of the model.

Table 4.6.3 Total Variance Explained by multidimensional factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.461	29.565	29.565	9.461	29.565	29.565
2	3.645	11.392	40.957	3.645	11.392	40.957
3	3.198	9.993	50.950	3.198	9.993	50.950
4	1.956	6.113	57.063	1.956	6.113	57.063
5	1.884	5.888	62.951	1.884	5.888	62.951
6	1.435	4.485	67.436	1.435	4.485	67.436
7	1.220	3.811	71.247	1.220	3.811	71.247
8	.961	3.004	74.251			
9	.894	2.794	77.045			
10	.844	2.637	79.682			
11	.750	2.344	82.026			
12	.696	2.176	84.202			
13	.621	1.941	86.143			
14	.522	1.631	87.774			
15	.516	1.612	89.386			
16	.442	1.381	90.767			
17	.406	1.268	92.035			
18	.374	1.170	93.205			
19	.336	1.049	94.254			
20	.299	.934	95.188			
21	.275	.859	96.047			
22	.218	.680	96.727			
23	.198	.617	97.344			
24	.164	.513	97.857			
25	.151	.473	98.330			
26	.131	.410	98.740			
27	.121	.378	99.118			
28	.111	.346	99.464			
29	.093	.290	99.753			
30	.059	.185	99.938			
31	.020	.062	100.000			
32	9.601E-05	.000	100.000			
Extraction Method: PCA						

The table 4.6.3 showed eigenvalues for each variable, the extracted factors and the amount variance these factors explained. As one can see in the table the eigenvalue for first seven factors was more than 1, hence seven factors were retained as their eigenvalue was more than 1. It can also be seen that after rotation the first factor explained 29.565%, second factor 11.392%, third factor 9.993%, fourth factor 6.113%, fifth factor 5.888%, sixth factor explained 4.485% and the last and seventh factor explained 3.811% of the total variance. Thus all the factors taken together explained 71.247% of the total variance.

Table 4.6.4 Component Matrix unrotated factor solution on multidimensional factors

	Component						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Body Weight	.962	-.070	-.051	.093	-.087	-.021	.032
Standing Height	.704	-.108	.561	.085	-.231	-.060	.002
Arm Length	.590	-.159	.479	.112	-.372	-.032	.185
Leg Length	.551	-.033	.544	.119	-.487	-.002	.059
Upper Arm Girth	.825	-.005	-.350	.082	.004	-.132	-.085
Fore Arm Girth	.843	.067	-.169	.000	.099	-.084	-.169
Thigh Girth	.805	.031	-.351	.054	-.076	-.164	-.037
Calf Girth	.709	-.070	-.222	-.083	.023	.025	.107
Chest Girth	.856	-.053	-.164	.112	-.030	-.003	-.026
Wrist Diameter	.500	-.356	.190	-.106	.472	-.033	.188
Elbow Diameter	.565	-.239	.372	.108	.187	.153	.303
Knee Diameter	.531	-.258	.283	.064	.052	.208	.240
Ankle Diameter	.452	-.411	.214	.000	.338	.011	.182
Resting Pulse Rate	.045	-.324	.079	.063	-.352	.467	-.032
Body Fat	.408	.031	-.705	.117	-.175	.191	.153
Body Mass Index	.722	-.053	-.530	.100	.076	.025	.076
Basal Metabolic Rate	.926	-.016	.013	.061	-.068	-.042	-.054
Skeletal Muscle Mass	-.215	-.001	.792	-.173	.110	-.022	-.159
Vo2 Max	-.178	.449	.161	.823	.091	-.061	.008
Left Hand Grip Strength	.671	.242	.202	-.107	.378	-.149	-.284
Right Hand Grip Strength	.645	.224	.207	-.170	.291	-.153	-.341
Standing Broad Jump	.422	.411	.257	-.241	.025	.200	-.293
Push Ups	.172	.610	-.056	.179	.022	.043	-.212
Fore Arm Plank	-.175	.450	.161	.823	.092	-.062	.009
Left Leg wall sit test	.110	.608	.033	-.196	.282	.480	.160
Right Leg wall sit test	.116	.579	-.003	-.029	.285	.498	.348
Speed	-.339	-.570	-.074	.309	.135	-.149	.038
Flexibility	-.016	.157	.033	.054	.473	-.355	.313
Agility	-.401	-.564	-.030	.045	.328	-.105	.056
Shooting in the target	.023	.293	-.183	-.310	-.229	-.343	.304
Balancing the ball on the stick	-.129	.559	.085	-.219	-.234	-.255	.313
Moving with the ball	-.102	-.486	-.196	.163	.132	.372	-.297
Extraction Method: PCA							

Table 4.6.4 showed loadings of the 32 variables on the extracted seven different factors. The higher the value of factor loading would be the more the factor will contributes to the variable. Here 32 variables has been divided into seven factors according to the most important variable with similar response in factor one and simultaneously into factor 2, 3,4,5,6 and seven respectively. Since it resulted from an un-rotated factor solution, consequently some of the variables showed their role exceeding one factor. This problem was sorted out using varimax rotation to get the final corrected rotated solution.

Figure 4.6.1 Scree Plot for multidimensional factors

Figure 4.6.1 below showed eigenvalues for multidimensional factors plotted on y-axis against the factors on x-axis. Plot showed the clear picture regarding number of variables to be retained; Single factor was retained before elbow bent as having eigenvalue more than 1. Note: curve started flattening after factor seven and also all the factors after seven having eigenvalue below one hence could not be included for the final analysis**.**

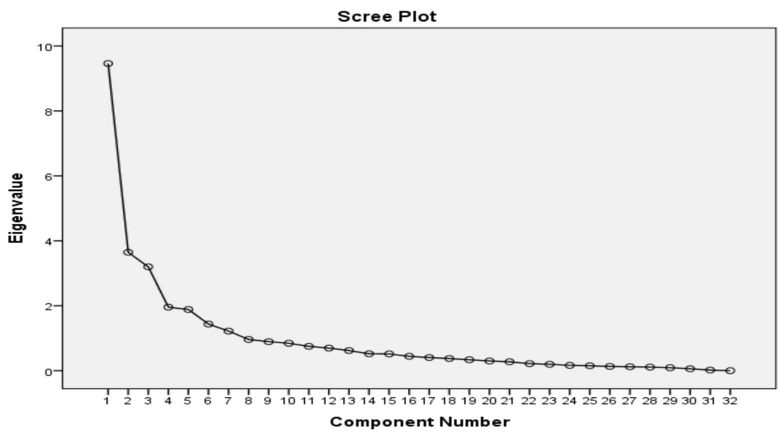

Table 4.6.5 Rotated Component Matrix for multidimensional factors

	Component						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Body Weight	.732	.565	.305	-.034	-.003	-.012	-.013
Standing Height	.138	.839	.354	.037	-.071	-.135	-.112
Arm Length	.139	.830	.096	.025	-.151	-.130	-.177
Leg Length	.065	.793	.201	.102	-.206	-.127	-.334
Upper Arm Girth	.831	.208	.301	-.020	.002	-.076	.056
Fore Arm Girth	.692	.262	.482	-.041	.028	.005	.081
Thigh Girth	.822	.210	.268	-.028	-.097	-.084	.022
Calf Girth	.641	.297	.160	-.196	-.008	.091	.067
Chest Girth	.731	.401	.279	-.012	.056	-.003	-.003
Wrist Diameter	.191	.474	.141	-.279	.270	.050	.499
Elbow Diameter	.161	.731	.046	-.048	.183	.166	.225
Knee Diameter	.194	.658	.016	-.103	.178	.139	.066
Ankle Diameter	.164	.517	.048	-.207	.299	-.009	.371
Resting Pulse Rate	-.007	.263	-.214	-.121	.285	.043	-.497
Body Fat	.803	-.124	-.217	-.021	-.007	.170	-.179
Body Mass Index	.886	.105	.069	-.062	.085	.080	.091
Basal Metabolic Rate	.652	.532	.402	-.022	-.012	-.022	-.021
Skeletal Muscle Mass	-.740	.295	.317	-.034	.025	-.035	.052
Vo2 Max	-.112	-.020	-.040	.960	.004	.072	.083
Left Hand Grip Strength	.274	.252	.759	.011	.022	.092	.288
Right Hand Grip Strength	.245	.229	.779	-.046	-.004	.042	.200
Standing Broad Jump	.047	.166	.650	-.034	-.093	.321	-.180
Push Ups	.163	-.158	.388	.416	-.173	.258	-.103
Fore Arm Plank	-.110	-.019	-.039	.961	.003	.073	.084
Left Leg wall sit test	-.011	-.065	.231	.041	-.112	.826	.028
Right Leg wall sit test	.056	.014	.042	.158	-.108	.866	.091
Speed	-.129	-.057	-.437	.049	.394	-.414	.207
Flexibility	-.023	-.023	-.011	.134	-.164	.067	.652

Agility	-.259	-.126	-.357	-.176	.406	-.280	.346
Shooting in the target	.136	-.116	-.068	-.154	-.643	-.004	.071
Balancing the ball on the stick	-.147	-.077	.007	.079	-.735	.169	.016
Moving with the ball	.054	-.121	-.144	-.100	.689	-.079	-.162
Extraction Method: PCA. Rotation Method: Varimax							

Table 4.6.5 provided final rotated solution after applying varimax rotation, which enables the variables to appear in one factor only. The variables were to be identified in seven factors on the basis of this final rotated solution obtained, in the present problem investigator has identified the variables with loadings >.8 into factor one and two, >.7 into factor three and four, >.6 into factor 5, 6 and seven respectively. BMI, TG, UAG, PBF were selected into factor one, SH and AL in factor two, LHGS and RHGS in factor three, FAP and Vo2 max in factor four, BBS, MWB and SIT in factor five, LLWS and RLWS in factor six where as one variable flexibility was selected in factor seven. Owing to the given criteria, criterion variables were grouped in each of the seven factors as shown in table 4.6.6-4.6.12**.**

Identification of variables into different extracted factors

Table 4.6.6 Factor 1: Anthropometrics

S No.	**Items**	**Loadings**
1	Body mass Index	.886
2	Thigh Girth	.822
3	Upper Arm Girth	.831
4	Body fat	.803

As presented in table 4.6.6 the variable body mass index, thigh girth, upper arm girth, Body fat were loaded on factor 1. The variables extracted on factor one were having significantly higher loading >.8, thus these variables extracted sufficient variance in explaining the factor termed as “anthropometrics”.

Table 4.6.7 Factor 2: stature

S. No.	Items	Loadings
1	Height	.839
2	Arm Length	.830

The factor 2 in the table 4.6.7, above contained variables height arm length that measure length of the body and limb, thus was named as factor "stature". All the variables loaded on factor stature showed significantly higher factor loading i.e. >.8 and thus extracts sufficient variance in explaining the factor.

Table 4. 6. 8 Factor 3: Grip strength

S No.	Items	Loadings
1	Left hand grip strength	.759
2	Right hand grip strength	.779

The factor 3 in the table 4.6.8, above contained variables grip strength (LHGS, RHGS) that measured maximum isometric Grip strength hence the factor was named as "grip strength". All the variables loaded on factor grip strength showed significantly higher factor loading i.e. >.8 and thus extracts sufficient variance in explaining the factor.

Table 4.6.9 Factor 4: Endurance

S No.	Items	Loadings
1	Fore arm plank	.961
2	Vo2 max	.960

The factor 4 in the table 4.6.9, above contained variables Fore arm plank and Vo2 max that measures core strength endurance and cardiovascular endurance/aerobic power hence the factor was termed as "endurance". Both the variables included in the factor showed significantly higher factor loadings in explaining the factor well.

Table 4.6.10 Factor 5: skill factor

S. No.	Items	Loadings
1	Balancing the ball on the stick	-.735
2	Moving with the ball	.689
3	Shooting in the target	-.643

The factor 5 in the table 4.6.10, above contained variables balancing the ball on the stick, moving with the ball and shooting in the target that measure hockey playing ability and basic skill, of hockey, hence was named as "skill factor". All the variables loaded on game skill variables showed factor loadings i.e. >.6 and thus interpreted the factor well.

Table 4.6.11 Factor 6: Leg strength

S. No.	Items	Loadings
1	Left leg wall sit test	.826
2	Right leg wall sit test	.866

The factor 6 in the table 4.6.11 above contained variables left leg wall sit test, right leg wall sit test that measures leg strength while balancing on one leg in a chair position, lifting other at the same time and thus the factor was named as "leg strength". Both the variables loaded on factor six showed factor loadings >.8 and thus extracted sufficient variance in explaining the factor.

Table 4. 6.12 Factor 7: Flexibility

S. No.	Items	Loadings
1	Flexibility	.652

The factor 7 in the table 4.6.12 above contained one variable flexibility hence was termed as "Flexibility Factor". The variable was selected into factor based on interpretability as it explained the factor well.

Table 4.6.13 Multiple variables extracted based on factor analysis

S. No.	Items	Loadings
1	Body mass Index	.886
2	Upper arm girth	.831
3	Standing Height	.839
4	Left Hand Grip strength	.759
5	Right Hand Grip strength	.779
6	Fore arm plank	.961
7	Vo2 max	.960
8	Balancing the ball on the stick	-.735
9	Moving with the ball	.689
10	Shooting in the target	-.643
11	Left leg Wall sit test	.826
12	Right Leg Wall sit test	.866
13	Flexibility	.652

Table 4.6.13 showed finally extracted thirteen different multidimensional characteristics body mass index, upper arm girth, height, LHGS, RHGS, fore arm plank, Vo2 max, Balancing the ball on the stick, Moving with the ball, Shooting in the target, Left leg Wall sit test, Right Leg Wall sit test and Flexibility are most important and sufficient in explaining group characteristics based on multidimensional factors (anthropometrical, bio motor, physiological and game skill) factors. These extracted thirteen variables explained 69.091% of the total variance in defining the latent construct talent. To further reduce the redundancy and to ensure that the results on the variables were consistent, these extracted variables were subjected to the calculation of cronbach's alpha.

4.7 Reliability analysis

Reliability analysis on extracted thirteen variables based on factor analysis, done by calculating Cronbach's Alpha, Guttman split half and Spearman brown coefficient, to ascertain whether the findings on the variables were consistent.

Table 4.7.1 Reliability analysis on Multiple variables extracted based on factor analysis

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Body mass index	371.6843	487.137	0.309	0.614
Upper arm girth	367.1907	469.191	0.496	0.596
Standing height	221.4868	381.012	0.403	0.582
Left hand grip strength	353.0071	329.063	0.71	0.49
Right hand grip strength	352.9849	333.199	0.693	0.496
Fore arm plank	388.6301	515.392	0.024	0.636
VO2 Max	328.0545	357.143	0.305	0.634
Balancing the ball on the stick	388.8806	513.805	0.045	0.635
Moving with the ball	382.0818	526.359	-0.252	0.642
Shooting in the target	384.5356	513.901	0.071	0.633
Left leg wall sit test	390.1256	513.341	0.181	0.63
Right leg wall sit test	390.2345	513.634	0.173	0.631
Flexibility	381.4438	475.597	0.099	0.646

Investigator had calculated item wise total statistics, to ascertain the influence of each variable on the alpha coefficient. Item total statistics showed that if the items marked in bold (For a arm plank, Balancing the ball on the stick, moving with the ball, Left leg wall sit test, Right leg wall sit test and flexibility) are deleted, it leads to the increase in the value of Cronbach's Alpha, which further increases reliability of the talent identification model and more consistent results among the variables could be found. Thus the results were found more consistent on final seven (Left and Right hand grip strength, standing height, vo2max, BMI, upper arm girth, shooting in the target) variables to define the latent construct talent identification in field hockey and to develop a most comprehensive and economic multidimensional talent identification model revealed alpha coefficient of .695 increased from .630.

Table 4.7.2 Spearman-brown & Guttman Coefficient

Spearman-Brown Coefficient	.733
Guttman Split-Half Coefficient	.731

Further investigator has also calculated split half reliability by dividing total variables into two groups. ‘Group a’ included body mass index, upper arm girth, standing height, left hand grip strength, whereas ‘group b’ included LHGS, RHGS, vo2 max shooting in the target.

The value of split-half reliability for Spearman-brown and Guttman coefficient was above .7 revealed high reliability of the talent identification model when (For a arm plank, Balancing the ball on the stick, moving with the ball, Left leg wall sit test, Right leg wall sit test and flexibility) variables were deleted, following seven variables were retained after testing the consistency of results on each variables.

4.8 Talent Identification Model Based on Multidimensional factors

Table 4.8.1 Talent Identification Model

S. No.	Items
1	Body mass Index
2	Upper arm girth
3	Height
4	Left Hand Grip strength
5	Right Hand Grip strength
6	Vo2 max
7	Shooting in the target

Table 4.8.1 above showed the criteria to identify talent in early age in field hockey. It was evident from the model that the criteria for talent identification must based on multidimensional characteristics ranges from anthropometrical, bio-motor, physiological to skill factors. The subjects showed much consistent results on the variables given in the model. At last factor analysis was administered on the finally selected seven variables given in the above table 4.8.1 to test the extent to which the selected variables/factors define the latent construct talent in field hockey.

Table-4.8.2 Factor analysis on Talent Identification Model in field hockey

Factor-1 Physical Factor	Factor-2 Anthropometric	Factor-3 Skill Factor
Left Hand Grip strength = .832	BMI= .923	Shooting in the target=.916
Right Hand Grip strength= .827	Upper Arm Girth= .852	
Standing Height= .709		
Vo2 Max= .571		
Variability= 33.645	**Variability= 26.094**	**Variability= 15.675**
Total Variance explained by seven variable model=75.414%		

Factor analysis was again conducted on finally selected seven variables and was presented in above table 4.8.2 revealed that the developed talent identification model explained 75.414% of the total variance in defining the talent in field hockey, which meant if an individual is selected to field hockey considering above model of talent identification there is 75.414% probability that individual will rightly be selected as talented, showed validity of the model in defining the talent in field hockey. The model suggested that three factors physical (LHGS, RHGS, standing height and vo2max) 33.645%, anthropometric (Body mass index & upper arm girth) 26.094 and skill factor shooting in the target 15.675 extracts sufficient variance in defining talent in field hockey and hence should be considered while identifying talent in field hockey. It was clearly evident after a comprehensive statistical analysis of 32 different anthropometric, bio-motor, physiological and game skill variables, that the variables can be reduced to a minimum of seven variables extracted into three different physical, anthropometric and game skill factors. Thus were defining the latent construct talent in field hockey and suggested that these seven variables to be focused rather than studying to many redundant and insignificant variables.

Norms 4.9

Obtained raw data, first was converted into standard Z-score using formula (X-µ/Sd.), where ‘X’ is obtained score, ‘µ’ is the population mean, ‘Sd’ is the population standard deviation. The Z-score than converted into transformed standard score (T-score) using formula (Z x 10) +50, where ‘Z’ represents standard Z-score, ‘10’ is standard deviation and ‘50’ is the population mean, to negate the effect of sign and further for simplification of the interpretation, but to make any inference on the basis of T-score individual should be well aware about different statistical testing techniques. At last percentile scale norms was prepared based on these transformed standard score as percentile norms are easily interpretable and easy to use, these type of norms directly indicated the excellence or weakness of the performer in percentage of the subject studied, anyone can easily compare the obtained score on the variable of interest and got to know about their status in the population using percentile scale norms.

Norms table has described percentile rank and percentile scores, percentile rank ranges from 0-100 defines the score point in the unit of measurement above or below which a specified percentage of score fall, whereas centile point can have any value in the unit of measurement.

In the present study for the purpose of preparing percentile scale norms investigator had calculated p3, p10, p25, p50, p75, p90, p97 percentile, here subjects were not assigned exact percentile rank, but only a range that the individual will lies below 3rd percentile, between 3rd to 10th, between 10th and 25th, between 25th and 50th, between 50th and 75th, between 75th and 90th, between 90th and 97th Kansal (2008).

Table 4.9.1 Percentile norms on Standardized T-Score

		Standing height	Upper Arm Girth	Body Mass index	Vo2 Max	LHGS score	RHGS score	Shooting in Target	Composite
Percentiles	**3**	27.22	31.36	28.83	32.54	29.60	30.32	32.23	265.90
	10	35.21	38.21	38.24	36.07	38.81	38.72	40.50	299.11
	25	43.20	42.92	44.58	45.32	43.82	43.76	40.50	320.78
	50	50.39	50.00	49.46	51.34	50.50	50.32	48.76	353.78
	75	57.59	57.08	56.78	56.89	57.18	57.21	57.02	380.08
	90	63.18	61.79	63.75	61.52	64.82	63.93	65.29	405.92
	97	65.58	68.87	66.43	64.30	67.20	68.57	65.29	417.49

Table 4.9.1 above presented percentile scale norms on the variables, which were extracted after the final analysis in the model to identify talent in field hockey. These norms can be used to know the status of an individual in the population.

Standing Height

P^3 for standing height was 27.22, which indicated that around 3% of youth hockey players had the standing height score below 27.22; one could also say that 97% of the subjects had scored above 27.22 and having longer stature.

P^{10} for standing height was 35.21, which indicated that around 10% of male youth hockey players had the standing height score below 35.21, one could also say that 90% of the subjects had scored above 35.21 or the score lies between p^3 and p^{10}.

P^{25} for standing height was 43.20, which indicated that around 25% of youth hockey players had the standing height score below 43.20, one could also say that 75% of the subjects had scored above 43.20 or the score lies between p^{10} and p^{25}.

P^{50} for standing height was 50.39, which indicated that around 50% of youth hockey players had the standing height score above or below 50.39.

P^{75} for standing height was 57.59, which indicated that around 75% of youth hockey players had the standing height score below 57.59, one could also say that 25% of the subjects had scored above 57.59 or the score lies between p^{50} and p^{75}.

P^{90} for standing height was 63.18, which indicated that around 90% of youth hockey players had the standing height score below 63.18; one also can say that 10% of the subjects had scored more than 63.18 or the score lies between p^{75} and p^{90}.

P^{97} for standing height was 65.58, which indicated that around 97% of youth hockey players had the standing height score below 65.58; one could also say that 3% of the subjects had scored more than 65.58 or the score lies between p^{90} and p^{97}.

Upper arm Circumference

P^3 for upper arm girth was 31.36, which indicated that around 3% of youth hockey players had the biceps circumference below 31.36, one could also say that 97% of the subjects had wider biceps circumference than 31.36.

P^{10} for upper arm girth was 38.21, which indicated that around 10% of youth hockey players had biceps circumference below 38.21, one could also say that 90% of the subjects had wider biceps circumference than 38.21 or the score lies between p^3 and p^{10}.

P^{25} for upper arm girth was 42.92, which indicated that around 25% of youth hockey players had biceps circumference below 42.92, one could also say that 75% of the subjects had wider biceps circumference than 42.92 or the score lies between p^{10} and p^{25}.

P^{50} for upper arm girth was 50, which indicated that around 50% of youth hockey players had biceps circumference below 50, one could also say that 50% of the subjects had biceps circumference below and above 50.

P^{75} for upper arm girth was 57.08, which indicated that around75% of youth hockey players had biceps circumference below 57.08, one could also say that 25% of the subjects had wider biceps circumference than 57.08 or the score lies between p^{50} and p^{75}.

P^{90} for upper arm girth was 61.79, which indicated that around 90% of youth hockey players had biceps circumference below 61.79, one could also say that 10% of the subjects had wider biceps circumference than 61.79 or the score lies between p^{75} and p^{90}.

P^{97} for upper arm girth was 68.87, which indicated that around 97% of youth hockey players had biceps circumference below 68.87, one could also say that 3% of the subjects had wider biceps circumference than 68.87 or the score lies between p^{90} and p^{97}.

Body Mass Index

P^{3} for body mass index was 28.83, which indicated that around 3% of youth hockey players, had BMI below 28.83, hence could be categorized as very lean, one, could also say that 97% of the subjects had higher BMI score than 28.83.

P^{10} for body mass index was 38.24, which indicated that around 10% of youth hockey players, had BMI below 38.24, one, could also say that 90% of the subjects had higher BMI score than 38.24. Or the score lies between p^{3} and p^{10}.

P^{25} for body mass index was 44.58, which indicated that around 25% of youth hockey players, had BMI below 44.58, one, could also say that 75% of the subjects had higher BMI score than 44.58 or the score lies between p^{10} and p^{25}.

P^{50} for body mass index was 49.46, which indicated that around 50% of youth hockey players, had BMI below 49.46, one, could also say that 50% of the subjects had higher BMI score than 49.46. Or 50% of BMI score lies below and above 49.46.

P^{75} for body mass index was 56.78, which indicated that around 75% of youth hockey players, had BMI below 56.78, one, could also say that 25% of the subjects had higher BMI score than 56.78. Or the score lies between p^{50} and p^{75}.

P^{90} for body mass index was 63.75, which indicated that around 90% of youth hockey players, had BMI below 63.75, one, could also say that 10% of the subjects had higher BMI score than 63.75 or the score lies between p^{75} and p^{90}.

P^{97} for body mass index was 66.43, which indicated that around 97% of youth hockey players, had BMI below 66.43, one, could also say that 3% of the subjects had higher BMI score than 66.43 or the score lies between p^{90} and p^{97}.

Aerobic power score

P^{3} for Vo2 max was 32.54, which indicated that around 3% of youth hockey players had the aerobic power score below 32.54; one could also say that 97% of the subjects might have better aerobic power score than 32.54.

P^{10} for Vo2 max was 36.07, which indicated that around 10% of youth hockey players had the aerobic power score below 36.07; one could also say that 90% of the subjects might have better aerobic power score than 36.07 or the score lies between p^{3} and p^{10}.

P^{25} for Vo2 max was 45.32, which indicated that around 25% of youth hockey players had the aerobic power score below 45.32; one could also say that 75% of the subjects might have better aerobic power score than 45.32. Or the score lies between p^{10} and p^{25}.

P^{50} for Vo2 max was 51.34, which indicated that around 50% of youth hockey players had the aerobic power score below 51.34; one could also say that 50% of the subjects had aerobic power score below and above 51.34.

P^{75} for Vo2 max was 56.89, which indicated that around75% of youth hockey players had the aerobic power score below 56.89; one could also say that 25% of the subjects might have better aerobic power score than 56.89 or the score lies between p^{50} and p^{75}.

P^{90} for Vo2 max was 61.52, which indicated that around 90% of youth hockey players had the aerobic power score below 61.52; one could also say that 10% of the subjects might have better aerobic power score than 61.52 or the score lies between p^{75} and p^{90}.

P^{97} for Vo2 max was 64.30, which indicated that around 97% of youth hockey players had aerobic power score below 64.30; one could also say that only 3% of the subjects might have better aerobic power score than 64.30 or the score lies between p^{90} and p^{97}.

Left hand grip strength score

P^{3} for LHGS score was 29.60, which indicated that around 3% of youth hockey players had the grip strength below 29.60; one could also say that 97% of the subjects were having left hand grip strength score more than 29.60.

P^{10} for left hand grip strength score was 38.81, which indicated that around 10% of youth hockey players had the grip strength below 38.81; one could also say that 90% of the subjects were having left hand grip strength score more than 38.81 or the score lies between p^{3} and p^{10}.

P^{25} for left hand grip strength score was 43.82, which indicated that around 25% of youth hockey players had the grip strength below 43.82; one could also say that 75% of the subjects were having left hand grip strength score more than 43.82 or the score lies between p^{10} and p^{25}.

P^{50} for left hand grip strength score was 50.50, which indicated that around 50% of youth hockey players had the grip strength below or above 50.50.

P^{75} for left hand grip strength score was 57.18, which indicated that around75% of youth hockey players had the grip strength below 57.18; one could also say that 25% of the subjects were having left hand grip strength score more than 57.18. Or the score lies between p^{50} and p^{75}.

P^{90} for left hand grip strength score was 64.82, which indicated that around 90% of youth hockey players had the grip strength below 64.82; one could also say that 25% of the subjects were having left hand grip strength score more than 64.82 or the score lies between p^{75} and p^{90}.

P^{97} for left hand grip strength score was 67.20, which indicated that around 97% of youth hockey players had the grip strength below 67.20; one could also say that 25% of the subjects were having left hand grip strength score more than 67.20 or the score lies between p^{90} and p^{97}.

Right hand grip strength score

P^3 for RHGS score was 30.32, which indicated that around 3% of youth hockey players had the grip strength below 30.32; one could also say that 97% of the subjects were having right hand grip strength score more than 30.32.

P^{10} for right hand grip strength score was 38.72, which indicated that around 10% of youth hockey players had the grip strength below 38.72; one could also say that 90% of the subjects were having right hand grip strength score more than 38.72 or the score lies between p^3 and p^{10}.

P^{25} for right hand grip strength score was 43.76, which indicated that around 25% of youth hockey players had the grip strength below 43.76; one could also say that 75% of the subjects were having right hand grip strength score more than 43.76 or the score lies between p^{10} and p^{25}.

P^{50} for right hand grip strength score was 50.32, which indicated that around 50% of youth hockey players had the grip strength below or above 50.32.

P^{75} for right hand grip strength score was 57.21, which indicated that around75% of youth hockey players had the grip strength below 57.21; one could also say that 25% of the subjects were having right hand grip strength score more than 57.21 or the score lies between p^{50} and p^{75}.

P^{90} for right hand grip strength score was 63.93, which indicated that around 90% of youth hockey players had the grip strength below 63.93 one could also say that 25% of the subjects were having right hand grip strength score more than 63.93 or the score lies between p^{75} and p^{90}.

P^{97} for right hand grip strength score was 68.57, which indicated that around 97% of youth hockey players had the grip strength below 68.57; one could also say that 25% of the subjects were having right hand grip strength score more than 68.57 or the score lies between p^{90} and p^{97}.

Shooting in the target

P^3 for shooting in the target was 32.23, which indicated that around 3% of youth hockey players had shooting ability score below 32.23.

P^{10} for shooting in the target was 40.50, which indicated that around 10% of youth hockey players had shooting ability score below 40.50.

P^{25} for shooting in the target was 40.50, which indicated that around 25% of youth hockey players had shooting ability score below 40.50.

P^{50} for shooting in the target was 48.76, which indicated that around 50% of youth hockey players had shooting ability score below 48.76.

P^{75} for shooting in the target was 57.02, which indicated that around 75% of youth hockey players had shooting ability score below 57.02.

P^{90} for shooting in the target was 65.29, which indicated that around 90% of youth hockey players had shooting ability score below 65.29.

P^{97} for shooting in the target was 65.29, which indicated that around 97% of youth hockey players had shooting ability score below 65.29.

Composite Norms

Composite norms had been prepared; one could use these composite norms in order to holistically evaluate a player based on multidimensional talent indicators instead of using separate norms for each variable.

Composite norms indicated that P^{3} to compare obtained raw score when converted into transformed standard score was 265.90, which meant that 97% of the individuals might score more than 265.90, hence could not be selected as talented.

Composite norms indicated that P^{10} to compare obtained raw score when converted into transformed standard score was 299.11, which meant that 90% of the individuals might score more than 299.11, hence could not be selected as talented.

Composite norms indicated that P^{25} to compare obtained raw score when converted into transformed standard score was 320.78, which meant that 75% of the individuals might score more than 320.78, hence could not be selected as talented.

Composite norms indicated that P^{50} to compare obtained raw score when converted into transformed standard score was 353.78, which meant that 50% of the individuals might score more than 353.78, hence may be selected as talented.

Composite norms indicated that P^{75} to compare obtained raw score when converted into transformed standard score was 380.08, which meant that 25% of the individuals might score more than 380.08, hence may be selected as talented.

Composite norms indicated that P^{90} to compare obtained raw score when converted into transformed standard score was 405.92, which meant that 10% of the individuals might score more than 405.92, hence may be selected as talented.

Composite norms indicated that P^{97} to compare obtained raw score when converted into transformed standard score was 417.49, which meant that 3% of the individuals might score more than 417.49, hence may be selected as talented.

4.9 Interpretation of obtained raw score and comparison with Norms

Interpretation of the obtained raw score to that with the norms, required population mean and standard deviation, followed by following steps:-

Step 1:- convert the obtained raw score into standard Z-score using formula =X-μ/SD.

Step 2:- convert standard Z-score to the transformed standard score using formula = 50+ (10xZ).

Step 3:- Add all calculated T-scores to find final composite score.

Compare the calculated composite score with the norms given above in the table 4.9.1.

Example

Calculate Z-score, T-score and compare with established Norms. If on testing an individual on all extracted variables, one found standing height=170, Upper arm girth= 20, BMI= 21, VO2 MAX=59, LHGS= 41, shooting ability=6 and RHGS= 29.

Standing Height

Raw Score = 170

Use following mean and standard deviation

Mean 'μ' = 170.21

Standard Deviation = 6.27

Z-Score= X-μ/SD = 170-170.21/6.27 = -0.03

T-Score = 50+ (10xZ) = 50+(10 x -0.03) = 49.66

Upper Arm Girth

Raw Score = 20

Use following mean and standard deviation

Mean 'μ'	= 24.50		
Standard Deviation	= 2.12		
Z-Score=	X-μ/SD	= 20-24.50/2.12	= -2.12
T-Score =	50+ (10xZ)	= 50+ (10 x -2.12)	= 28.77

Body mass index

Raw Score = 21

Use following mean and standard deviation

Mean 'μ'	= 20.01		
Standard Deviation	= 2.05		
Z-Score=	X-μ/SD	= 21-20.01/2.05	= 0.48
T-Score =	50+ (10xZ)	= 50+ (10 x 0.48)	= 54.82

VO2 MAX

Raw Score = 59

Use following mean and standard deviation

Mean 'μ'	= 64.74		
Standard Deviation	= 9.50		
Z-Score=	X-μ/SD	= 59-64.74/9.50	= -0.60
T-Score =	50+ (10xZ)	= 50+ (10 x -0.60)	= 43.96

Left hand grip strength

Raw Score = 41

Use following mean and standard deviation

Mean 'μ'	= 38.69		
Standard Deviation	= 5.99		
Z-Score=	X-μ/SD	= 41-38.69/5.99	= 0.39
T-Score =	50+ (10xZ)	= 50+ (10 x 0.39)	= 53.86

Shooting in the target

Raw Score = 6

Use following mean and standard deviation

Mean ‘μ’ = 7.16

Standard Deviation = 1.21

Z-Score=	X-μ/SD	= 6-7.16/1.21	= -0.96
T-Score =	50+ (10xZ)	= 50+ (10 x -0.96)	= 40.41

Right hand grip strength

Raw Score = 29

Use following mean and standard deviation

Mean ‘μ’ = 38.71

Standard Deviation = 5.95

Z-Score=	X-μ/SD	= 29-38.71	= -1.63
T-Score =	50+ (10xZ)	= 50+ (10 x -1.63)	= 33.68

Composite Score

T-Score (Standing height) + T-Score (Upper Arm Girth) +T-Score (BMI) +T-Score (VO2MAX) +T-Score (LHGS) +T-Score (Shooting in the target) +T-Score (RHGS)

=49.66+28.77+54.82+43.96+53.86+40.41+33.68=305.16

The overall composite score of an individual with standing height=170, Upper arm girth= 20, BMI= 21, VO2 MAX=59, LHGS= 41, shooting ability=6 and RHGS= 29, was 305.16 which on comparing with the developed norms found that the score lies between 10^{th} -25^{th} percentile and 75% of the individuals can score more than this, thus an individual may not be selected as talented.

4.10 Discussion on the findings

Identification of talented individual in every discipline whether it is in, management, business, science and technology etc. is detrimental for the professional development. Nations, organizations, physical educationists and sports scientists are making enduring efforts for searching most talented following different approaches and methodologies and are making persistent efforts to suggest most objective scientific criteria to address talent identification in early childhood in different sports, with the probability that the individual will serve their organization, profession and nation in the coming future, sports is not exception to this, talent selection (selecting the player with the probability of win in the competition) and identification (means identifying the most promising child who have perceived potential, talent and inherited natural ability to excel at highest level) is always been the part and parcel of sports. With the increasing competitiveness among the countries, clubs, and broad scale commercialization of sports, it becomes necessary to identify the talented individual at youngest possible age and then providing the suitable learning/training environment to nurture the acquired talent. Present research endeavor was focused on developing an objective, most parsimonious and multidimensional talent identification criteria in field hockey. The process is truly multi-factorial, thus future success cannot be predicted based on single factor (Bar-or, 1996). Hugo (2004) suggested multiple factors should always be considered while attempting to identify talent. Elferink-Gemser (2005) stress a great need for knowledge and understanding of how talent can be best identified. Although there was no evidence of any similar research study in male field hockey on talent identification, but the present study was having its roots in and was in line with the studies conducted by Asteya 2015; Ahamad 2015; Dachen 2012; Matthys et al., 2011; Amir & Navid 2011; Singh 2011; Vaeyens et al., 2008; Pearson et al., 2006; Singh 2006; Abbott & Collins, 2004; Gogia 2002; Reilly et al., 2000; Williams & Reilly 2000; Hoare & Warr 2000; Williams & Frank, 1998 and Bompa, 1985 etc. revealed identifying talent, developing a multidimensional talent identification criteria is crucial to athletic success and for the development sports profile in the country. The result of the present study was in line with the study of Asteya (2015) a talent identification model to identify talent in squash and revealed anthropometric variables calf circumference, arm length and hip width, bio-motor variables back strength and flexibility and physiological variable body fat percentage were important to identify squash talent, Dachen (2012) developed a model for screening archery talent on the basis of physical (arm & shoulder strength), physiological (resting pulse rate, respiration rate and vital capacity), Singh (2006) developed a test battery to identify talent in soccer and found except personality factor, all the other factors game skill, physical and physiological factors were important to predict playing ability, Gogia (2002) screened out swimming talent based on anthropometric, physical and physiological parameters, while identifying talent morphological, physiological and bio-motor factor should be given utmost importance (Bompa 1985; Williams & Frank 1998). Nieuwenhuis, & Spencer (2002) revealed physical, physiological and anthropometrical variables were important to discriminate successful and less successful hockey players. Emmanuel (2012) revealed agility and speed should be used to predict talent in field hockey. Suthamathi, & Suganthi 2014 suggested speed, agility, 30 meter run and 2.4km run may be considered for talent identification in field hockey. Elite field hockey players were characterized by higher hand grip strength superior leg explosive power and poor flexibility (Scott, 1991).

Present study was focused on developing evidence based multidimensional talent identification criteria for identifying talent in field hockey. The talent identification model was developed by considering key multidimensional factors i.e. anthropometrical, bio motor, physiological and game skill factor (Nieuwenhuis et al., 2002; Koley et al., 2012; Wither and Robert 1981; Bale et al., 1986; Scott, 1991; Mokha and Sidhu 1987). Nature of the data taken on these multidimensional factors, have been analyzed by applying mean and median (for asymmetrical data) as a measure of central tendencies, standard deviation as a measure of absolute variability and coefficient of variance as a measure of relative variability to understand variability in distribution freeing from unit of measurement, skewness for symmetricity and distribution was tested using kurtosis. Standard error of mean has ascertained that the samples were true representative of the population. Skewness statistics for analyzing symmetricity of the distribution on the data of different variables ascertained that the distribution of the data on agility (.572), forearm plank (.896), vo2max (-1.441) and moving with the ball (.455) was departed from symmetricity. Because the data on agility, moving with the ball and forearm plank was positively skewed and revealed that most of the subjects in sampling distribution has the agility and moving with the ball score smaller than average, meant they perform better than average, but due to the poor performance of few subjects the distribution was appeared to be skewed, as the least score indicated better performance. Same was the case with the data on forearm plank, but most of the subjects had scored poorer than the average, but due to few extraordinary performances the data was skewed positively. The distribution of the data on vo2 max was negatively skewed, because most of the data has scored better than average, thus the data was skewed to the negative direction due to few poor performers. The statistical analysis of kurtosis showed the distribution for the data on knee and ankle diameter (1.760, 1.594), speed (.941), Body mass index (2.003), vo2 max (4.541), resting pulse rate (.731) and moving with the ball (1.237) was leptokurtic, meant the data on these variables was more clustered around average (peaked curve) observed less fluctuation in the data set. Whereas the distribution for data set on flexibility (-.896), agility (-.897) and balancing the ball on the stick (-1.261) showed negative value, because the distribution was platykurtic and the data was more scattered (flatted curve) revealed high level of data fluctuation. Skewness and kurtosis was calculated to get the general in-depth understanding of the distribution of the data and this does not has any influence on the final outcome of the present study. The descriptive statistical analysis showed the data was appropriate to conduct factor analysis for developing talent identification model to identify talent in field hockey.

Model one, the thorough application of factor analysis revealed that different anthropometrical variables could be grouped into as many as three factors i.e. circumference, length and skeletal diameter factors. PCA (Principal components analysis) was used to extract related variables into different factors. The extracted factor one (circumference factor) contained variables upper arm girth, thigh girth, body mass index, fore arm girth and chest girth. PCA clubbed highly correlated variables into one factor, it was clearly evident from the correlation matrix table 4.2.1, that the relationship between UAG and TG (r = .830), UAG and BMI (r= 0.76), UAG and FAG (r = .830), UAG and CHG (r = .779), TG and BMI (r= 0.72), TG and FAG (r = .754), TG and CHG (r = .718), BMI and FAG (r= 0.65), BMI and CHG (r= 0.59) and the correlation between FAG and CHG (r = .754) was relatively high and significant at .01 level of significance. The variables can be selected into the factor based on their factor loadings on the factor and correlation among the variables, variables explaining maximum variance in explaining the factor one must be selected first. It can be seen in the table 4.2.6 that upper arm girth explained .913%, thigh girth .896%, body mass index .866, fore arm girth .833% and chest girth explained .80% of the total variance in explaining the ‘circumference factor’. Factor two the ‘length factor’ table 4.2.7 included the variables leg length, arm length and standing height. Correlation matrix table 4.2.1 revealed that these variables were highly correlated to each other as the correlation between leg length and arm length was (r = .781), leg length and standing height was (r = .843) and between arm length and standing height was (r = .817) significant at .01 level of significance, thus were rightly clubbed into length factor, further these variables extracted quit sufficient variance >.8 in explaining the length factor evident from the loading of these variables on the length factor. Extracted third factor was 'skeletal diameter' single variable ankle diameter with loading .825 was extracted into this factor, showed the variable extracted sufficient variance in explaining the "skeletal diameter" factor. The variables body weight, calf girth, elbow diameter, wrist diameter and knee diameter were not extracted into any of the factor because of the criteria set by the investigator for extracting variables into the factor, as only those variables were extracted having factor loading more than >.8 in explaining the factor. Finally, five anthropometrical variables upper arm girth, thigh girth, leg length, standing height (Schimdt & Toes 1970; Koley et al., 2012) and body mass index were suggested to identify talent using anthropometrical variables. These five variables based suggested criteria for talent identification in field hockey explained 88.460% of the total variance in explaining talent identification in field hockey based on anthropometrics.

Factor analysis on bio-motor variables found out that, the variables could be reduced and grouped to a minimum of four factors which could sufficiently explained the group characteristics based on bio motor variables. The four extracted factors were named as grip strength factor, quickness, leg strength endurance and core strength endurance factor. Further factor one (grip strength) included RHGS and LHGS as these variables were correlated to each other (r = .835) significant at .01 level of significance, meant they might measure the same construct, but the variables could be selected into the grip strength factor only on the basis of ability of these variables in explaining grip strength factor. Thus it could be seen from the table 4.3.5 the final solution so obtained after rotating the factors using varimax rotation revealed that LHGS and RHGS showed significantly higher factor loading >.9 in explaining the factor. Factor two 'quickness' included agility and speed (r = .49) significant at .01 level of significance, were clubbed into a single factor 'quickness'. The variables agility and speed showed factor loading >.6 in explaining the quickness factor. Although pushups (-.603) too showed factor loading >.6, but was not selected into the factor based on its interpretability. Left leg wall sit test and right leg wall sit test while holding squat position on one leg alternatively left and right leg assisted by a wall showed high correlation (r = .685) significant at .01 level of significance, thus could be clubbed into a single factor named as ‘leg strength endurance’, further both the variables showed significantly higher factor loading >.8 in explaining the factor. A single variable fore-arm plank was selected into factor four, as it was having factor loading above >.8 (.882) sufficient in explaining the factor named as ‘core strength endurance’. Thus the model suggested six variables to identify talent based on bio-motor variables. The suggested model included left and right hand grip strength from factor one (Nieuwenhuis et al., 2002; Koley et al., 2012; Wither and Robert 1981; Bale et al., 1986; Scott, 1991; Mokha and Sidhu 1987), agility from factor two (Bril 1980; Volkov and Filin 1983; Koley et al., 2012), left and right leg wall sit test from the factor three and forearm plank from factor four (Nieuwenhuis et al., 2002; Koley et al., 2012; Wither and Robert 1981; Bale et al., 1986; Scott, 1991; Mokha & Sidhu 1987). Flexibility, standing broad jump and pushups were not selected into any of the explained factor and into the suggested model for talent identification based on bio motor variables because of their lower factor loading <.6 and too these variables were not correlated to any other variable to the expected level. This suggested criteria for talent identification in field hockey based on bio-motor variables explained a variability of 64.534% in defining the talent. This criterion showed average variability in defining talent. So, it was suggested to follow multidimensional talent identification model.

It was too evident after a thorough factor analysis on physiological variables resting pulse rate, percent body fat, basal metabolic rate, skeletal muscle mass and vo2 max from table 4.4.5 that the variables can be clubbed into two separate factors named as factor-one ‘body composition’ and factor two ‘aerobic power’ which sufficiently explained group characteristics based on physiological variables. As it was evident from the table that two variables body fat and skeletal muscle mass were highly correlated at 0.01 level of significance, thus they might measure same construct and could be clubbed into single factor “body composition”, these variables too showed higher factor loading >.8 in explaining the factor body composition. Factor two ‘aerobic power’ extracted sufficient variance for its explanation from vo2 max and resting pulse rate. Thus the physiological model for identifying talent in field hockey should include body fat, skeletal muscle mass, vo2max and resting pulse rate (Bril 1980; Volkov & Filin 1983; Koley, Ayra-Petyan 1991; Bishop et al., 2016; Koley et al., 2012), selected from two different extracted factors based on factor loading and interpretability of the construct. The final criteria, suggested to identify talent in field hockey based on (body fat, skeletal muscle mass, vo2max and resting pulse rate) extracted sufficient (variability= 76.210%) in defining talent in field hockey based on physiological variables. Factor analysis done on selected game skill variables revealed three variables shooting in the target, balancing the ball on stick and moving with the ball were highly correlated i.e. the correlation between shooting in the target and balancing the ball on the stick was (r = .358), balancing the ball on stick and moving with the ball was (r = .413) significant at .01 level of significance, whereas shooting in the target was correlated with moving with the ball at .05 level of significance (r = .164), further these variables showed significantly higher factor loading >.6 in explaining the game skill factor. This suggested criteria for talent identification in field hockey based on game skill variables explained a variability of 54.473% in defining the talent based on skill factors, this criteria showed average variability in defining talent. So, it was suggested to include more significant game skill variables, if one wishes to identify talent based exclusively on game skill variables along with the application of bio-motor, anthropometrics and physiological variables individually and separately, otherwise it was suggested to follow multidimensional talent identification model.

The readers had the option to identify talent in field hockey based on extracted anthropometrical, bio motor, physiological and game skill variables separately, if wishes so, but for this all the factors must be administered thoroughly and separately and it may be time consuming and redundancy may still occur, as focusing on unidimensional factor does not solve the purpose. The major objective was to develop a multidimensional (considering all the factors together) talent identification model for identifying talent in field hockey. In order to develop a most parsimonious, multi-factorial talent identification model the thorough statistical analysis was done on the variables taken in the study altogether.

Step one, all the variables were subjected to factor analysis and found that, the variables could be loaded onto seven different factors based on factor loading of the variables on the factor, correlation matrix among the variables and explainability of the factor in mind. In factor one, four variables body mass index, thigh girth, upper arm girth and body fat have been retained as these variables showed factor loading of

>.8 in explaining 'anthropometric factor'. The same was also ascertained by looking at the value of correlation coefficient among extracted variables as the coefficient between BMI & TG was (r=.72), BMI & UAG (r=.76), BMI & BF (r=.64), TG & UAG (r=.85), TG & PBF (r=.50) and the correlation coefficient between UAG & PBF (r=.47) presented in table 4.6.1 significant at .01 level of significance. Two variables standing height and arm length were clubbed into single factor named as 'stature' based on factor loading of >.8 both the variables were also correlated to each other at .01 level of significance (r=.82). Two variables LHGS and RHGS were retained in factor three, as the variables showed factor loading of .7 in explaining 'grip strength factor' same was also ascertained by the value of correlation coefficient among these extracted variables (r=.83) significant at.01 level of significance. Fore arm plank and vo2 max were clubbed into factor four named as 'endurance factor' because of their loading on the factor was >.9 thus satisfactorily explained the factor. Game skill variables clubbed into a factor named as 'skill factor' balancing the ball on stick, moving with the ball and shooting in the target were extracted based on their ability to interpret the factor, further these variables showed loading >.6 and were correlated to each other at .01 level of significance, except the relationship between shooting in the target and moving with the ball was insignificant. Left leg wall sit test and right leg wall sit test which measured leg strength of left and right leg respectively were extracted into sixth factor named as 'leg strength' both the variables were correlated at 0.01 level of significance and showed significantly higher factor loading of >.8. Flexibility with loading of .652 was extracted into seventh factor named as 'flexibility'.

Step two, a total of thirteen variable body mass index, upper arm girth, standing height, LHGS, RHGS, forearm plank, vo2 max, balancing the ball on stick, moving with the ball, shooting in the target, left leg strength endurance, right leg strength endurance and flexibility were selected from seven different extracted factors based on their factor loadings, interpretability of the factor, correlation and explanation of the latent construct i.e. identifying talent in field hockey. These extracted thirteen variables explained 69.091% of the total variance in explaining the construct, meant that approximately 70% of the times the extracted variables will define the talent in field hockey accurately.

Step three, Investigator had calculated internal consistency on finally extracted thirteen variables to ascertain that the obtained results were consistent across different variables for an individual. This determines if an individual is good at one variable, then must be good at another, meant if one shows potential on one variable must show potential on another and revealed seven variables body mass index, upper arm girth, standing height (Koley et al., 2012; Schmidt & Loews 1970), LHGS, RHGS as (Strok, T. 2016; Mcdonanghand & Davies 1984; Astrand & Rodhal 1986; Nieuwenhuis et al., 2002; Koley et al., 2012; Wither and Robert 1981; Bale et al., 1986; Scott, 1991; Mokha and Sidhu 1987) revealed that higher grip strength of hands ensure and is an marker of overall muscle strength and fitness, further is critical to health and well-being, vo2 max (Bril 1980; Volkov and Filin 1983; Koley, Ayra-Petyan 1991; Bishop et al., 2016; Koley et al., 2012) and shooting in the target were most consistent and reliable in identifying talent.

Step four; finally investigator had suggested criteria for talent identification in field hockey based on seven multidimensional characteristics. Thus the talent identification model constructed to identify talent in field hockey explained quite high i.e. 75.414% of the total variance in explaining the latent construct, intended to explain talent identification in field hockey. This meant that out of 100 times, there is probability that the developed model will accurately define talent 75 times. In other words one can also say that 75% of the times the individual will rightly be selected or rejected as being talented. The developed multidimensional talent identification model is in consensus with the studies of (Asteya 2015; Ahamad et al., 2015; Dachen 2012; Yadava 2012; Matthys et al., 2011; Amir & Navid 2011; Gray 2010; Hadavi & Zarifi 2009; Vaeyens et al., 2008; Pearson et al., 2006; Singh 2006; Abbott & Collins 2004; Elferink-Gemser et al., 2004; Gogia 2002; Reilly et al., 2000; Williams, & Reilly 2000; Hoare, & Warr 2000; Elferink-Gemser et al., 2006; Williams & Frank, 1998; Bompa, 1985; Gimbel, 1976 and Toohey, Beaton, & Auld n. d.) who suggested all the stakeholders who are entrusted with the responsibility of talent identification should always considered multidimensional talent predictors.

The developed model for identifying talent in field hockey, suggested three factors physical, anthropometrics and skill factor are distinguishing factor to identify talent in field hockey, which was in line with the findings and suggestion of Singh (2006); Asteya (2005); Dachen (2012); Bompa (1985); Williams and frank (1998) suggested physical, anthropometric and skill variables should always be considered while developing a talent identification criteria in field hockey. Successful and less successful field hockey players differ in physical, anthropometrics and physiological determinant for success Nieuwenhuis et al., (2002). Factor one, “physical factor” is most important and included four variables LHGS, RHGS, standing height and vo2max, these variables jointly explained 33.645% of the total variance. Hare, (1983); Havelick et al., (1982) considered children’s with all-round athletic ability more specifically the variables having strong and stable genetical influence such as standing height, hand grip strength and vo2 max should always be considered while attempting to identify talent. Further Scott, (1991) suggested elite field hockey players were characterized by higher hand grip strength. International tennis coaches were also of the same opinion and suggested that standing height and vo2 max should be considered Limoochi (2013). Reilly, & Borrie (1992) observed a vo2 max of above 60ml/kg/min. is required for playing field hockey at elite level. Body mass index and upper arm girth were retained in factor two, named as “anthropometrics” and explained 26.094% of the total variance. Rana (2016) field hockey players tend to be taller, heavier and healthier whereas Hanjabam & Jyotsna (2017) revealed limb length, body mass index, body fat, body weight, fate free mass determine an individual strength, speed, endurance, flexibility and further leads to performance improvement in field hockey. Sharma, Tripathi, & Koley et al., (2012) revealed that anthropometrical measurement such as standing height predicts weight, hand grip strength, leg power and playing ability. Natarajan (2010) negatively predicted percentage body fat, dribbling ability whereas body weight was positively correlated to percentage body fat, hand grip strength and leg power, further %body fat and body mass index predicts vo2 max (Lemos et al., 2017). Bakhtiyari et al., (2015) suggested maintaining anthropometrical variables at optimal is necessary in any performance domain, as anthropometrical variables having strong genetical influence (stature, leg length, arm length, and bi-epicondylar femur width) and having a larger role to play in whole talent identification process (Reilly 2009; Mohamed 2009; Suthamathi, & Suganthi 2014; Lauren 2007; Pramanick 2002), whereas BMI should also be considered while addressing to identify talent in field hockey (Scott 1991; Sahu 2015; Sidhu 2012). Anthropometrical variables has a detrimental effect on individuals performance in field hockey evident from senior national team of Pakistan and India, on comparing both the teams it has been found that Pakistani field hockey players were having significantly higher upper arm length, bi-hummers diameter and Indians had lesser body fat percentage Singh et al., (2009), further anthropometrical variables (humerus diameter, femurs diameter, height, weight and BMI) significantly differentiate between successful and less successful field hockey players and revealed that successful and senior players were significantly taller, heavier, better BMI, higher humerus and femurs diameter (Nieuwenhuis et al., 2002; Manna et al., 2011). Manna et al., (2010) revealed senior field hockey players were significantly better in body mass index, anaerobic power, lesser percentage body fat, whereas the players in U/19 age group were having higher vo2 max. Scott (1991) elite international field hockey players were too having lesser percentage body fat and it significantly predicts hockey performance (Singh et al., 2009). Whereas percentage low body fat and BMI should also be considered while addressing to identify talent in field hockey (Scott 1991; Sahu 2015; Sidhu 2012). However the findings were controversial as (Bakhtiyari et al., 2015; Sidhu 2012) observed none of the physical fitness variables (36 meter shuttle run, semo test, standing broad jump, bending forward, 1600 meter, sit and reach and zig-zag jump test) was significant whereas (Burr et al., 2008; Wassmer & Mookerjee 2002) revealed standing broad jump and power can predict overall hockey playing potential. Elite players differs significantly from their sub-elite counterparts in handgrip strength, speed, flexibility and agility (Matthys et al., 2011; Amir & Navid 2011), but not differ in psychological variables Singh (2011). Further Williams & Reilly (2000) revealed no characteristics from among anthropometrical, physiological, psychological and sociological variables can be isolated with confidence but suggested that they can play a role in talent identification process. Reilly et al., (2000) slow sprinters are likely to be higher performers. Least important in the model was “skill factor” which explained 15.675% of the total variance in defining talent in field hockey. The findings of the investigation was in line the way many major sporting Nations such as Germany, China, Cuba, USSR, Australia and Soviet Union attempt to identify talent at different stages. They select talent on the basis of physical, physiological, anthropometrical variables Abbott et al., (2005); Du Randt et al., (1992); Rizak (1986). Alias (2018) and Gabbett (2000) suggested physical variables should always be considered while identifying talent in field hockey. (Lemos et al., 2017; Singh 2006) observed agility, speed, core muscle endurance, muscular strength endurance determine performance in field hockey. (Suthamathi & Suganthi 2014; Emmanuel 2012; Nieuwenhuis & Spsmer 2002; Natarajan 2010; Mohamed 2009;

Pramanick 2002) observed standing broad jump, speed, agility and 30 meter run predicts playing potential and significantly discriminate between successful and less-successful athletes. The value of Cronbach alpha .695, spearman brown coefficient .733 and Guttman split half reliability coefficient .731 ascertained the findings were consistent and the reliability of the model was quiet high in identifying talent in field hockey.

Lastly, it is always of concern for evaluator that whom to select or reject as being talented. So, in order to assess performance, ascertain status quo of an individual in comparison to others and to further select or reject an individual as talented or not talented, percentile scale norms were developed. To develop percentile norms raw data was first converted into standard Z-score, so that all the variables measured on different units of measurement could be converted into a single unit i.e. standard deviation units above or below the mean. The Z-score than converted into transformed standard score (T-score) to negate the effect of sign and further for simplification of the interpretation, but to make any inference on the basis of T-score individual should be well aware about different statistical testing techniques. At last percentile scale norms p3, p10, p25, p50, p75, p90, p97 percentile was calculated based on these transformed standard score as percentile norms are easily interpretable and easy to use, these type of norms directly indicated the excellence or weakness of the performer in percentage of the subject studied, anyone can easily compare the obtained score on the variable of interest and got to know about their status in the population using percentile scale norms. here subjects were not assigned exact percentile rank, but only a range that the individual will lies below 3rd percentile, between 3rd to 10th, between 10th and 25th, between 25th and 50th, between 50th and 75th, between 75th and 90th, between 90th and 97th Norms were developed for each variable separately, so that an individual or coach could assess weakness and strength by focusing on individual variables, but for comprehensive assessment of an individual composite norm should be followed. The percentile composite scores was ranged from as low as p^3 = 265.90 to as high as p^{97} =417.49. Investigator had suggested p^{50}= 353.78 as the point to make the decision about selection or rejection. So, anyone scored below 50th percentile could be rejected as talented and subsequently an individual having higher centile point or percentile score than p^{50}= 353.78 could be selected as talented. The p^{50} was suggested because it is neither appropriate nor wise to exclude too many children's at the initial stage. The children's scoring p^{50} and above might be selected and then must put into talent development pools for continuous deliberate practice, than only the children's can further be reduced considering several factors such as, consequent testing on several dimensions, receptivity to training, rate of development etc.

4.11 Discussion on Hypothesis

The investigator had hypothesized that the developed multidimensional talent identification model will significantly define the latent construct "talent identification" and significantly helps in identifying talent in field hockey. The developed talent identification model significantly explained the latent construct "talent identification" in field hockey as an individual with healthy body mass index, higher upper arm girth, longer stature, firm hand grip strength, exceptional aerobic power and higher shooting accuracy, evident from the variability of 75.414% of the total variance in defining the construct, which meant if an individual is selected to field hockey considering the present model of talent identification there is 75.414% probability that individual will rightly be selected or rejected as talented, showed validity of the model in defining the talent in field hockey.

4.12 Terminologies used

Mean: mean is a most reliable measure to measure central tendency which represents a score that describes the aggregate of the data set, should be used for symmetrical data which is measured on interval and ratio scale.

Standard error of mean: measures whether the subjects were true representative of the population, the larger the sample size lesser will be the standard error. If we take 'n' number of samples from identical population their mean may not same, this difference in mean from sample to sample is termed as standard error of mean.

Median: median is one of the best descriptive statistical technique to measure central tendency for asymmetrical (skewed) data, measured on interval and ratio scale. It is the middle most score in the set of distribution least affected by the outlier/extreme scores.

Variability: refers to the extent or degree to which the score in the given distribution diverges from one another, tells how the scores were distributed.

Standard deviation: it is the positive square root of the average deviation of all the scores in the data set around their mean value. It measures absolute variability and takes in account all the scores in the distribution.

Coefficient of variance: a measure of relative variability, and is free from units. It explained variability in the data set in terms of percentage, so that on the basis of this only we can say which distribution of the data was having maximum variability in relation to other.

Symmetricity: The data is said to be symmetrical distributed, when minimum outliers are present in the data and most the data in the distribution was centered around mean.

Skewness: it is a measure of symmetricity of the data.

Negative skewness: the data was said to be negatively skewed, when most of the scorers in the distribution was above average.

Positive skewness: the data was said to be positively skewed, when most of the scorers in the distribution was below average.

Kurtosis: it deals with the measurement of the extent to which the data was clustered around the mean value, measure hightdness, peakness and flatness of the observation.

Platykurtic: the curve was said to be platykurtic, when the value of kurtosis was negative, makes the curve to flatten and the data has larger variance.

Mesokurtic: the curve was said to mesokurtic, when the value of kurtosis was zero and the data was normally distributed.

Leptokurtic: represents higher level of data fluctuation meant observation clustered more around mean, reflected by a positive value of kurtosis.

Talent: In the present study talent is defined as the individual's ability or potential to perform at highest level.

Talent Selection: Is the scientific process of selecting the players for immediate competition.

Correlation coefficient: is defined as the degree of relationship between two are more independent variables.

Correlation matrix: is the arrangement of correlations between different criterion variables in rows and columns.

Percentile scale: most widely used scale for norms preparation in physical education, represents excellence or weakness of an individual in term of percentage.

Factor analysis: is a multivariate parametric statistical procedure used to measure latent/ unobservable constructs by considering large number of related independent variables.

KMO (Kiaser Meyer Olkin) test: is a test of multivariate normality used to measure whether the sample size taken in the study was adequate or not.

Bartlett's test of sphericity: used to measure whether correlation matrix was an identity matrix.

Identity matrix: indicated strength of relationship among the variables, where all diagonal elements are one and off diagonal elements are close to zero.

Communality: indicated reliability of the variable taken in the study and is defined as the amount of variance each variable shared with other variable.

Eigenvalues: eigenvalue of the factor is defined as the variance explained by the factor out of the total. Sum of eigenvalues is same as number of variables studied.

Extraction sums of squared loadings: it is defined as the amount of variance can be attributed to each factor after extraction.

Rotation sums of squared loadings: it is defined as the amount of variance can be attributed to each factor after rotation.

Talent Identification: In games and sports, talent identification means identifying the promising individual/child who have perceived potential, talent and inherited natural ability to excel at highest level and who is currently involved in sports with maximum probability of getting medals at highest level.

Talent Development: Talent development is the process of nurturing an individual through different stages of development from fundamental to higher performance training stage through deliberate practice put on for several years.

Talent Emergence: Is defined as an individual who is talented will emerge itself without giving special consideration.

PCA: it is the technique to extract the factor explaining maximum variance first and then start searching greatest variance for the second factor after eliminating the variance explained by the first factor and so on.

Varimax rotation: it is a commonly used factor rotation technique to achieve the simple structure i.e. higher factor loading on one variable and low on others.

Scree plot: it is the graphical illustration of the eigenvalues against the factors, helps in identifying the point where significant factor stops and insignificant starts.

Rotated factor solution: is the final solution obtained after the factors have been rotated using varimax rotation.

Factor loadings: is defined as the coefficient of relationship between the factors to the variable, factor loadings explained variance shown by each variable on factor. Factor loading of .7 and above is sufficient, means the factor extracting sufficient variance from the variable.

Communality: indicated reliability of the variable taken in the study and is defined as the amount of variance each variable shared with other variable.

Multicollinearity: is a linear association between two or more explanatory variables i.e. the variables are highly correlated means one can linearly be predicted from other.

CHAPTER-V

SUMMARY & CONCLUSION

5.1 Summary

Sports the most exciting modern phenomenon, (Kobierecki 2013) involves rigorous physical effort or the use of relatively complex physical skills by the participants, who are motivated by personal satisfaction and extrinsic rewards. A sport is defined as an institutionalized competitive activity, for any activity to be classified as sports; it must have to accomplish three major criteria's. First activity must involve physical exertion and skill prowess, second activity must be institutionalized and competitive and third activity must be motivated by a combination of intrinsic and extrinsic motivation. In other words, sports is a physical activity, that involves competition conducted under formal and organized condition i.e. the activity which is governed by standardized pattern or set of behavior, where standardized rules are enforced. Sports participation can eternally benefits everyone irrespective of age, gender, caste, creed, race, ethnicity, socioeconomic status in multidimensional aspects for an individual and the Nation as well. Although professional sports is a modern phenomenon, but evidence showed that, it was there in ancient time too, for example gymnastics have been popular in China as early as in 2000 BC, Iranian martial art, polo, jousting and swimming, fishing was played in ancient Egypt, however for different reasons such as pastime, recreation and preparation for war etc. At present the evolutionary process of identifying talent in sports is one of the most debated topic, among the national government, professional bodies, sports fraternity and sports enthusiasts, which was too evident from the recent initiative 'Khelo-India' initiated by the government of India, with the main objective was early talent identification in wide range of sporting activities and reviving sports culture. Swasth Bachche, Swasth Bhart an initiative, in order to imbibe seven core values of Olympics and Paralympics i.e. Olympics (respect, friendship and excellence), Paralympics (determination, courage, equality and inspiration) including identification of talent and development of motor skills given green signal by Kendriya Vidyalaya Sangathan, New Delhi. Talent identification is as old as the existence of human beings on earth and universe itself. But due the competitive nature and ever increasing professionalism, in sports at stake, it was of supreme importance to address this issue. The major aim of talent identification is to find the individuals who are promising and have required prerequisite's to succeed in future. Pienaar et al., (1998), highlight the importance of talent detection, when they said, talent identification is a priority for modern sports, sporting bodies, associations and for elite programs. The present study will provide authentic and objective Indian criteria of identifying the talent in field hockey for male. The study will significantly help to make the approach to talent identification more scientific and increase the horizon of knowledge in the field of hockey, as in general the children's were selected to the sports to which they are physically, physiologically unsuited, thus the participation in unsuited sports, leads to dropout and lose the sense of fun in sports (Molinero et al., 2006), and can increase a huge amount of frustration (Bompa 1985, Pletola 1992 and Ghita 1994). The present study helps to a greater extent in reducing the frustration caused due to participation in unsuited sports. In recent Williams and franks (1998); Gimbel (1996); Regnier et al., (1993); Elferink (2011), some sports specific talent identification models Asteya (2015); Dachen (2012); Gogia (2002); Singh (2006); Nieuwenhuis (2002); Suthamathi & Suganthi (2014) etc. address the issue of talent identification in sports from different perspectives. These studies had numerous limitations such as they didn't give precedence to any particular variable. There was no standardized test to measure the variables given in the model (Williams et al., 1998, 2000). No explanation of how the variables were selected, moreover most of them were conceptual and reviewable, further some studies were conducted to know the coaches perspective in identifying most talented without considering child, whereas focusing only on one aspect as Harre (1982) stated that only through training it would be possible to ascertain whether an individual has required attribute to succeed, some of them were sports specific and couldn't applicable to other sports. There was no unanimous acceptance about the variable's selected by the researchers that they would discriminate between elite and non-elite, no attempt has been made to standardize these models which always remained highly debatable and there was no theoretical framework which could be universally accepted. In summing all these researchers and sports scientists stressed demand on more specific and scientific criteria for talent identification which could be different from sports to sports as each sports is unique itself. The performance as well as talent is a multidimensional concept, which cannot be sorted out unidimensionally. So, the present study was stated as "Development of talent identification Model for Hockey", which would be more comprehensive and scientific in approach and focused on the developing a talent identification model in field hockey. While fulfilling sub-objectives to find out anthropometric, bio-motor, physiological and game skill variables for the development of TID in field hockey, percentile norms were also given. The study was conducted on 207 Indian youth male field hockey players of mean age 15.87±1.31 years and 4.61±1.56 years of playing experience, selected from different renowned sports academies of the country (North India). Investigation was delimited to Anthropometrical factors (Body weight, Standing height, Body mass index, Arm length, Leg length, Upper arm Girth, Forearm Girth, Thigh Girth, Calf Girth, Chest Girth, Wrist diameter, Humerus Bi Condyle diameter, Femur epicondyle diameter, Ankle diameter) Bio-motor factors (Left and Right hand Grip strength, Arm & Shoulder Strength, Core Strength, Leg Strength, Standing Broad Jump, Speed, Flexibility, Agility), Physiological factors (Resting heart rate, Percent body fat, Basal metabolic rate, Skeletal muscle mass, Aerobic power), Game skill factors (Shooting in the target, Balancing the ball on the stick, Moving with the ball). The data on selected variables was collected using valid and reliable tests/tools. The central tendency (standard error of mean), dispersion, symmetricity and distribution have been calculated for the data obtained on different anthropometric, bio-motor, physiological and game skill factors and presented in table (4.1.1-4.1.4), which assisted in initial cleaning and for further calculations. The parametric data collected on interval and ratio scale was described using central tendency, dispersion was measured using standard deviation, however median to measure central tendency and quartile deviation as dispersion was reported for asymmetrical data, symmetricity was measured using skewness, whereas kurtosis was used to understand distribution of the data. To accomplish the main objective of the study i.e. to develop a model to identify the talent in field Hockey, factor analysis was applied. Assumptions for applying parametric statistics like factor analysis on the metric data to yield reliable results were fulfilled. PCA an extraction technique to extract and retain the variables into the factors was used. The developed model was tested for reliability using Cronbach's alpha, Spearman brown coefficient and Guttman split half reliability coefficient, further percentile norms were prepared. Before accomplishing major objective of developing a multidimensional talent identification model, investigator had thoroughly analyzed five sub-objectives differently i.e. to find out the anthropometrical, bio-motor, physiological and game skill factors for developing a talent identification model in field hockey and further suggested percentile scale norms for interpretations of the raw data.

Application of factor analysis on different anthropometrical variables and as evident from scree plot in figure 4.2.1 revealed that three factors were having eigenvalue more than one, after which the curve started flattening sharply. So, only three factors could be extracted namely circumference, length, and skeletal diameter factor, based on correlation among the variables, explain ability of the factor and the loadings of the variable on the factor, after obtaining rotated component matrix solution by applying varimax rotational technique. Five variables upper arm girth .913, thigh girth .896, body mass index .866, fore arm girth .833 and chest girth .803 (Table 4.2.6), were having higher factor loadings ≥.8 in explaining the factor one, hence were clubbed into the "circumference factor". Further three variables leg length .932, arm length .872 and standing height .869 (Table 4.2.7), were having higher factor loadings ≥.8 in explaining the factor two, hence were clubbed into the "length factor". Single variable ankle diameter .825 was extracted into factor three named as "skeletal diameter" (Table 4.2.8), were clubbed into "skeletal diameter factor", as were having eigenvalue ≥.7 and further explain the factor satisfactorily. Finally talent identification criteria based exclusively on anthropometric variables has been suggested, five variables upper arm girth .913, thigh girth .896, standing height .869, leg length .932 and body mass index .866 (Table 4.2.9), were selected from different factors i.e. circumference, length and skeletal diameter factor, based on loading of ≥.8 and were sufficient in explaining the group characteristics based on anthropometrical variables. Hence instead of studying too many redundant variables, it was suggested to use these four extracted variables for talent identification in field hockey, when considering anthropometrical variables.

Different bio-motor variables were too subjected to the factor analysis and revealed that four factors were having eigenvalue more than one, evident from figure 4.3.1 So, four factors grip strength, quickness, leg strength endurance and core strength endurance, based on correlation among the variables, explain ability of the factor and the loadings of the variable on the factor, after obtaining rotated component matrix solution by applying varimax rotational technique. Two variables RHGS .914 and LHGS .900 were having a loading of ≥.9 (Table 4.3.6), in explaining the factor grip strength, hence were clubbed into "grip strength factor". Agility .697 and speed .602 were selected into factor two "quickness", as having a factor loading of ≥.6 (Table 4.3.7) in explaining factor satisfactorily. Two variables right leg wall sit test .885 and left leg wall sit test .871 measured leg strength endurance were clubbed into the factor three “leg strength endurance”, as they were having higher loading ≥.8 in explaining the factor satisfactorily. Single variable, forearm plank .882 (Table 4.3.8) was extracted into the factor four, namely “core strength endurance”. At last talent identification criteria considering bio-motor variables was suggested (Table 4.3.10), revealed six variables RHGS .914, LHGS .900, agility .697, right leg wall sit test .885, left leg wall sit test .871 and fore-arm plank .882 were sufficient in explaining group characteristics based on bio-motor variables. Hence instead of studying too many variables, these six variables may be focused for talent identification in field hockey based exclusively on bio-motor variables.

Application of factor analysis, on physiological parameters and as evident from scree plot in figure 4.4.1, revealed that two factors could be extracted namely body composition and aerobic power, as they were having eigenvalue more than one and on the basis of correlation among the variables, explainability of the factor and loading of the variables on the factor. Two variables percent body fat .937 and skeletal muscle mass -.815 were selected into factor one named as “body composition”, based on factor loading of ≥.8 in explaining the factor (Table 4.4.6). Two variables Vo2 max .839 and resting pulse rate -.697 were extracted into factor 2 named as “aerobic power” based on loading of ≥.8 in explaining the factor (Table 4.4.7). Finally talent identification criteria based exclusively on physiological parameters was suggested, four variables percent body fat .937, skeletal muscle mass -.815, vo2 max .839 and resting pulse rate -.697 (Table 4.4.8), were selected from two different factors body composition and aerobic power. Hence investigator had suggested that instead of studying too many variables, these four variables may be focused for talent identification in field hockey based on physiological parameters.

At last talent identification in field hockey following game skill variables was suggested. The thorough application of factor analysis suggested that all the three variables, balancing the ball on the stick .834, moving with the ball .713 and shooting in the target .636 (Table 4.5.5), should be focused as they satisfactorily explain group characteristics based on skill variables.

The major objective of the study was to develop a talent identification criteria in field hockey considering multidimensional (anthropometric, bio-motor, physiological and game skill factor) aspects of both the performance and talent. Application of factor analysis to 32 multidimensional indicators of talent, substantiate that 32 variables could be reduced to seven factors, based on eigenvalue more than one evident from figure 4.6.12. So, seven factors named as anthropometrics, stature, grip strength, endurance, game skill, leg strength and flexibility could be extracted based correlation coefficient among the variables, explainbility of the factor and loading of the variables on specific factor, after obtaining the rotated component matrix solution by applying varimax rotational technique. Four variables BMI .886, upper arm girth .831, thigh girth .822, and percent body fat .803 were clubbed into factor one, "anthropometrics" as they were having higher loading ≥.8 (Table 4.6.6) in explaining the factor satisfactorily. Two variables standing height .839 and arm length .830 were identified in factor two, named as "stature", as having a loading of ≥.8 (Table 4.6.7) in explaining the factor satisfactorily. Two variables RHGS .779 and LHGS .759 were rightly clubbed into factor three, named as "grip strength factor" with having a loading of ≥.7 (Table 4.6.8) in explaining the factor satisfactorily. Factor four "endurance" consisted of forearm plank .961 and Vo2 max .960 as they were having a loading ≥.9 (Table 4.6.9), in explaining the extracted factor satisfactorily. Three variables balancing the ball on the stick -.735, moving with the ball .689, shooting in the target -.643 were rightly clubbed into factor five, named as "skill factor" (Table 4.6.10). Two variables right leg strength endurance .866 and left leg strength endurance .826 were clubbed into factor six, named as "leg strength" as they were having a loading of ≥.8 (Table 4.6.11) in explaining the factor satisfactorily. Single variable flexibility .652 (Table 4.6.13) was a lone variable in factor seven, named as "flexibility". At last thirteen variables body mass Index .886, upper arm girth .831, standing height .839, LHGS .759, RHGS .779, fore arm plank .961, Vo2 max. .960, balancing the ball on the stick -.735, moving with the ball .689, shooting in the target -.643, left leg strength .826, right Leg strength .866 and flexibility .652 (Table 4.6.12), were extracted to show that the performance and talent is truly a multidimensional construct. But before suggesting a final criterion to identify talent considering multidimensional aspects of performance and talent, it was of utmost importance to ensure that the most parsimonious variables were extracted, no redundancy exists and that the performance of the subjects was consistent among the variables. To ensure this investigator had further calculated internal consistency, using Cronbach's alpha coefficient, which helps in most consistent and parsimonious selection of the variables in suggesting a talent identification criterion in field hockey. The reliability of the remained extracted variables was ensured using Spearman-Brown coefficient and Guttman split-half reliability coefficient. Application of Cronbach's alpha on 13 extracted variables revealed that after eliminating forearm plank, balancing the ball on the stick, moving with the ball, left leg strength endurance, right leg strength endurance and flexibility, the most authentic, parsimonious criteria to identify talent could be developed. Thus finally suggested 7 variables multidimensional talent identification criteria in field hockey and were consisted of body mass index, upper arm girth, standing height, LHGS, RHGS, vo2 max and shooting in the target. This seven variables model can be used for talent identification in field hockey.

Application of factor analysis on finally selected seven variables and was presented in table 4.8.2 revealed that the developed talent identification model explained 75.414% of the total variance in defining the talent in field hockey, which meant if an individual is selected to field hockey considering above model of talent identification there is 75.414% probability that individual will rightly be selected as talented, showed validity of the model in defining the talent in field hockey. The model suggested that three factors physical (LHGS, RHGS, standing height and vo2max) 33.645%, anthropometric (Body mass index & upper arm girth) 26.094 and skill factor shooting in the target 15.675 extracts sufficient variance in defining talent in field hockey and hence should be considered while identifying talent in field hockey. Thus were defining the latent construct talent in field hockey and suggested that these seven variables to be focused rather than studying to many redundant and insignificant variables.

It is necessary for a coach and evaluator to have some standard norms to follow in order to select or reject an individual as talented. Percentile norms p3, p10, p25, p50, p75, p90 & p97 were prepared following standard procedure, here subjects were not assigned exact percentile rank, but only a range that the individual would lie below 3rd percentile, between 3rd to 10th, between 10th and 25th, between 25th and 50th, between 50th and 75th, between 75th and 90th, between 90th and 97th.

P^{3} is the score in the given distribution which was more than the score of 3% of the subjects or 3% of the subjects have lower score than the given score, in other word the score was less than 97% of the subjects.

P^{10} is the score in the given distribution which was more than the score of 10% of the subjects or 10% of the subjects have lower score than the given score, in other word the score was less than 90% of the subjects.

P^{25} is the score in the given distribution which was more than the score of 25% of the subjects or 25% of the subjects have lower score than the given score, in other word the score was less than 75% of the subjects.

P^{50} is the score in the given distribution which was more than the score of 50% of the subjects or 50% of the subjects have lower score than the given score, in other word the score was the center i.e. above or below which 50% of the observations' lies.

P^{75} is the score in the given distribution which was more than the score of 75% of the subjects or 75% of the subjects have lower score than the given score, in other word the score was less than 25% of the subjects.

P^{90} is the score in the given distribution which was more than the score of 90% of the subjects or 90% of the subjects have lower score than the given score, in other word the score was less than 10% of the subjects.

P^{97} is the score in the given distribution which was more than the score of 97% of the subjects or 97% of the subjects have lower score than the given score, in other word the score was less than 3% of the subjects.

Interpretation of the obtained raw score to that with the norms, required population mean and standard deviation, After getting the measurement on above given seven variables, the tester has to use the mean and standard deviation of each variable respectively, given in the present study to find out the individuals score and further to make any decision regarding selection or rejection, than following steps to be followed:-

Step 1:- convert the obtained raw score into standard Z-score using formula =X-μ/SD.

Step 2:- convert standard Z-score to the transformed standard score using formula = 50+ (10xZ).

Step 3:- Add all calculated T-scores to find final composite score.

Composite score= T-Score (Standing height) + T-Score (Upper Arm Girth) +T-Score (BMI) +T-Score (VO2MAX) +T-Score (LHGS) +T-Score (Shooting in the target) +T-Score (RHGS)

Compare the score with the Norms and make the decision.

The findings will help the coaches in knowing the athlete holistically and in dealing with false negative (erroneously overlooked the talented) or false positive (erroneously identified as talented) effectively. India had made steady progress in sports in recent years and there is need to showcase this tremendous potential at global stage.

5.2 Conclusions

The findings of the present scientific investigation conceptualized that the talent can be fairly defined, selected and identified based on the selected physical, anthropometric, and skill factors. Further on the basis of the findings following conclusions could be drawn:

According to the results, talent in field hockey may defined as an individual with healthy body mass index, higher upper arm girth, longer stature, firm hand grip strength, exceptional aerobic power and higher shooting accuracy.

It has been concluded that the talent can be identified on the basis of physical (body mass index, vo2 max/aerobic power/cardio respiratory endurance, left hand grip strength, right hand grip strength), anthropometric (upper arm girth, standing height) and skill factors (shooting in the target).

5.3 Suggestions

1. Similar kind of research study can be conducted on female field hockey players in the Indian context.
2. Depending upon the feasibility of the samples, a longitudinal study can be conducted.
3. Similar kind of study can be conducted in any other sports both for male and female.
4. The focus should be increased on promoting educational values of sports in educational institutions.

5. Government should develop a long term sports development plans and there should be centrally controlled talent identification scheme, the way Australians did before Sydney Olympics.
6. There should have separate talent development pools for different age, gender and proficiency stage wise from toddling, to higher performance training stage and eventually higher performance. Every stage should have certain set objectives to be focused thorough scientific training.
7. Studying motor behavior and focusing on motor learning and motor development during Kindergarten and Primary schooling phase is of supreme importance for the overall sporting development of any nation, consequently improves health and prosperity of a nation.
8. Curriculum for physical education teachers, coach's education should comprehensively include a subject on motor learning, motor development and study of motor behavior.
9. Need to educate different stakeholders responsible for children's development about various stages of talent identification.
10. Investigators interested to study talent should search factors in an individual's that are listed effected by the environment and natural developmental process.
11. Similar kind of study can be conducted on any other zone of the country or on full country keeping feasibility of the time in mind.
12. Future research attempting to identify talent should consider psychological, sociological and various supporting factors.
13. Psychological questionnaires measuring sports specific cognitive, meta-cognitive aspects, self-efficiency, anxiety, self-confidence, state and trait anxiety, motivation, achievement motivation, personality inventory, intelligence in group, sports achievement motivation, team cohesion, commitment, task & ego Orientation, ability to handle pressure, concentration ability, attraction to group task, group integration task, attraction to group, group integration social, Mental toughness, concentration ability, pressure tolerance, motivation level, confidence level, rebound ability, resilience should be constructed focused at talent identification in early childhood at 11-15 years of age.
14. A method to measure productive thinking (talent to generate unusual ideas and finding interesting solution), decision making (talent to take most appropriate

decision after comprehensively analyzing situation), ability to plan (talent to prepare strategy for the execution of an idea), forecast (talent to understand cause and effect and make possible predictions), communication (talent to express emotions, ideas in different verbal and non-verbal ways) and academic talent (talent to gain multidisciplinary knowledge) considering early talent identification in sports should be developed.

5.4 Application/Recommendation of the Research

1. The findings of the study can be of immense help to the coaches, physical education teachers, clubs, associations and Nation to identify talent in field hockey at early age.
2. The findings of the study can be used by the stakeholders, who are responsible for individual development i.e. trainers, exercise and conditioning staff and coaches in monitoring players development.
3. The findings has an application in addressing individual weaknesses and strength, thereby ensures which area to be focused more.
4. The study has highlighted the issues related to early and late mature individual while talent identification, coaches could use the guidelines to handle false negative (erroneously overlook the talent) and false positive (erroneously selected as talent).
5. To catch up with the developed sporting countries, talent development pools, excellence centers at every nook of the country or scientific sporting infrastructure in educational institutions from grass root level should be developed, where a child after being identified as talented could train generally to specifically to higher performance training stage.
6. Most important issue in the development of sports in the country is coach’s education. Coaches should have fund of scientific knowledge and equipped with modern principles of sports training and talent identification.
7. Curriculum for physical education teachers, coach’s education should comprehensively include a subject on motor learning, motor development and study of motor behavior.
8. The study will help the PETs, coaches, clubs, and associations to get cognizant with the drawbacks of early specialization and in tackling the issue effectively.

9. The monitoring of a child during Kindergarten, pre-Primary and primary schooling should be left to the Physical education teachers or motor development specialists.
10. For realization of talent fully specialized training in sports should only be started after comprehensive multilateral development has been achieved, followed it by rigorous deliberate training spread for several years based on ever evolving scientific principles and with the unison efforts of teachers, coaches, parents, sports organizations and educational institutions.
11. Government owned talent identification scheme and centrally controlled talent development pools on the basis of stages of motor development or general developmental stages should be set in.
12. The study will help the coaches and Physical education professionals in preparing training schedule specifically for field hockey players.
13. Independent organizations or NGO with the fixed accountability should be set in to monitor the process of talent identification and development in sports.

APPENDICES

Appendix I- Score Card

Please fill the below information, If any problem asks the tester…

Name:	Contact Number (Optional):
Date of Birth:	Vegetarian/Non-Vegetarian:
Category:	Type of school:
Religion:	Class:
Name of sports:	Level of participation:
Playing position:	Experience of Playing:

Family Nuclear/Joint:	Parents Sport/Level of Participation:
Parents Monthly Income:	Urban/Rural:

Anthropometrics and Physiological variables		
VARIABLES	Scores	
	T1	T2
Resting Heart Rate		
Standing Height		
Arm Length		
Leg Length		
Upper Arm Circ.		
Fore Arm Circ.		
Thigh Circ.		
Calf Circ.		
Chest Circ.		
Wrist		
Elbow Diameter		
Knee Diameter		
Ankle Diameter		
Body Weight		
Percent Body Fat		
Visceral Fat		
BMI		
Subcutaneous Fat		
Physiological Age		
BMR		
Skeletal Muscle Mass		
Aerobic Power		

Bio-motor Variables		
VARIABLES	Scores	
	T1	T2
Left hand grip strength		
Right hand Grip strength		
Standing broad Jump		
Push-ups		
Forearm Plank		
Wall Sit test	L	R
Speed		
Flexibility		
Agility		

Game skill variables		
VARIABLES	Scores	
	T1	T2
1) Shooting in the target		
2) Balancing the ball on the stick		
3) Moving with ball		

Appendix II Communalities

Communalities (Bio-motor variables)

	Initial	Extraction
Left Hand Grip Strength	1.000	.842
Right Hand Grip Strength	1.000	.853
Fore Arm Plank	1.000	.786
Left Leg wall sit test	1.000	.806
Right Leg wall sit test	1.000	.827
Agility	1.000	.600
Standing Broad Jump	1.000	.574
Push Ups	1.000	.660
Speed	1.000	.590
Flexibility	1.000	.669

Extraction Method: Principal Component Analysis.

Communalities (Physiological variables)

	Initial	Extraction
Resting Pulse Rate	1.000	.486
Body Fat	1.000	.890
Basal Metabolic Rate	1.000	.392
Skeletal Muscle Mass	1.000	.776
Vo2 Max	1.000	.706

Extraction Method: Principal Component Analysis.

Communalities (Anthropometric variables)		
	Initial	Extraction
Body Weight	1.000	.935
Standing Height	1.000	.900
Arm Length	1.000	.837
Leg Length	1.000	.892
Upper Arm Girth	1.000	.866
Fore Arm Girth	1.000	.768
Thigh Girth	1.000	.835
Calf Girth	1.000	.604
Chest Girth	1.000	.793
Wrist Diameter	1.000	.675
Elbow Diameter	1.000	.703
Knee Diameter	1.000	.504
Ankle Diameter	1.000	.709
Body Mass Index	1.000	.786

Extraction Method: Principal Component Analysis.

Communalities (Game skill variables)		
	Initial	Extraction
Shooting in the target	1.000	.430
Balancing the ball on the stick	1.000	.696
Moving with the ball	1.000	.508

Extraction Method: Principal Component Analysis.

Communalities (on thirteen extracted variables)		
	Initial	Extraction
BODY MASS INDEX	1.000	.793
UPPER ARM GIRTH	1.000	.819
STANDING HEIGHT	1.000	.622
LEFT HAND GRIP STRENGTH	1.000	.792
RIGHT HAND GRIP STRENGTH	1.000	.747
FORE ARM PLANK	1.000	.501
VO2 MAX	1.000	.441
BALANCING THE BALL ON THE STICK	1.000	.699
MOVING WITH THE BALL	1.000	.478
SHOOTING IN THE TARGET	1.000	.664
LEFT LEG WALL SIT TEST	1.000	.850
RIGHT LEG WALL SIT TEST	1.000	.793
FLEXIBILITY	1.000	.783

Extraction Method: Principal Component Analysis.

Communalities (on the factors selected in talent identification model)		
	Initial	Extraction
BODY MASS INDEX	1.000	.865
UPPER ARM GIRTH	1.000	.862
STANDING HEIGHT	1.000	.553
LEFT HAND GRIP STRENGTH	1.000	.789
RIGHT HAND GRIP STRENGTH	1.000	.765
VO2 MAX	1.000	.582
SHOOTING IN THE TARGET	1.000	.863

Extraction Method: Principal Component Analysis.