

# The Application of physics in sports

Dr. Vishal Kumar<sup>1\*</sup>, Dr. Pradeep Kumar<sup>2</sup>

<sup>1</sup> Associate Professor, Rajkiya Mahila Snatkottar Mahavidyalaya, Kandhla (Shamli) UP

<sup>2</sup> Associate Professor, Rajkiya Mahila Snatkottar Mahavidyalaya, Kandhla (Shamli) UP

**Abstract** - The research set out to shed light on some fundamentals of physics and how they can be applied to athletics. Biomechanics refers to the study of how physical laws can be applied to athletics. You can break the term "biomechanics" down into its constituent parts by separating the prefix "bio-" and the word "mechanics," from which the term derives its name. The term "biomechanics" was coined because of the field's focus on mechanical principles as they apply to biological processes. Given its origins in the word "mechanics," it's safe to assume that biomechanics is concerned with the study of force and its consequences. According to this definition, biomechanics is the study of how mechanical forces affect biological systems. As Herbert Hatze put it in 1974, "Biomechanics is the study of the structure and function of biological systems by means of the methods of mechanics," so this is essentially what the field entails. Improvements in performance, technique, equipment, injury prevention, and rehabilitation are all targets of sport and exercise biomechanics.

**Keywords** - skating, swimming, Cycling, Physics, Sport

## INTRODUCTION

Stephen Curry surpassed Ray Allen to become the all-time leader in career three-pointers in a game between the Golden State Warriors and the New York Knicks, which the Warriors won 105-96. Have you ever pondered the secret to the success of NBA three-point shooters like Stephen Curry and Ray Allen? Perhaps the laws of physics applied to athletics are the key to their success. While there may not appear to be any obvious connection between sports and physics at first glance, there are actually many points of overlap between the two fields. Athletes can use physics to better understand and exploit certain phenomena, and physicists can help them improve their game by shedding light on how opponents' strategies work. For instance, the amount of force and direction an athlete applies to a basketball affects the parabolic arc and, in turn, the likelihood of the ball going through the net during a jump shot. [1]

The fine-tuning of these methods gives athletes distinct advantages over their rivals in competition, ultimately raising the stakes and the likelihood of a decisive victory. Some of these strategies, however, have been called into question due to the potential breach of sportsmanship and the unfair advantage they provide to the player. Deputy Senior Research Editor Yi Ting Loo of the Journal of Young Investigators addresses these debates over physics' role in sports in the current issue. [2]

Each participant, team, and league is responsible for ensuring a level playing field. The organizer has a responsibility to give all competitors a fair shot at victory. Similarly, the athlete must not engage in any conduct deemed by the competition to be unfair. If a player is allowed to use strategies or tools that give them an unfair advantage over the competition, for example, that player will inevitably win. Most sports techniques make use of at least one physical principle to make it more challenging for the opponent to receive and return the shot. The classic illustration of such tactics is the table tennis ball's sideways spin after being hit. Since they are seen as a reflection of the athlete's skill and determination to succeed, these methods are generally tolerated in the sports world. These strategies improve your odds of defeating your rival, but your challenger, armed with enough training and skill, may be able to counteract them. [3]

When using a move like the "Sidek serve," however, the opponent will have a far more difficult time returning the ball because of the laws of physics that govern it. In badminton, slicing the shuttlecock while holding it upside down is called a "Sidek serve." This makes the shuttlecock spin erratically, rendering any counterattack futile. If players were able to use the physics behind strategies like the "Sidek serve" to their advantage, it would seriously undermine the integrity of competitive sports. Because of this, many in the sports world have

voiced their disapproval, saying that such tactics violate the true meaning of sportsmanship. [4]

Sporting goods and equipment have also come under fire for allegedly giving unfair advantages to athletes. Traditionally, the goal of sportswear manufacturers has been to lessen the likelihood of injury while also increasing comfort. However, recent developments in sportswear design—based heavily on physics—may help athletes perform better than ever. The sportswear an athlete chooses to wear may have a significant impact on the outcome of a close race. Critics argue that the use of specialized sportswear gives athletes an unfair advantage in competition and conceals the athlete's true abilities on the basis of these arguments. [5]

The sports industry stands to benefit greatly from the application of physics in the future, as it will spur the creation of new and exciting techniques and products. However, athletes, sportswear companies, and other stakeholders need to work with the appropriate authorities to establish proper guidelines for the field due to the controversies surrounding the use of physics in sports. Implementing policies to ensure the fair and ethical use of physics in sports without slowing down technological progress will be a challenge. [6]

### Work and energy in pole vaulting

Work and energy are central concepts in athletics. In physics, work is defined as the distance an object is pushed or pulled by a given force. Therefore, there is a one-to-one relationship between force and work. And there's a lot of overlap between the ideas of labor and energy. Therefore, work is the transformation of energy from one location or form to another. Athletes use many different kinds of energy when they pole vault. When runners first get going, their bodies convert chemical energy into kinetic energy. The deformation of the pole is evidence that some of this kinetic energy is converted to elastic potential energy, while the remainder is converted to gravitational potential energy, which is again converted to kinetic energy as the athletes fall away from the bar. [7]

### Angular momentum in skating

An object's angular momentum—also called its rotational momentum—is equal to the product of its moment of inertia (the product of its mass and the square of its perpendicular distance from the axis of rotation) and its rate of rotation. The principle of conservation of angular momentum is also fundamental. Think of a figure skater who performs spins on the very tips of her skates. Without disturbance from without, angular momentum remains nearly constant. By drawing her arms and one leg in, a figure skater decreases the distance between her center of mass and the axis of rotation, thereby

decreasing her moment of inertia and the drag she experiences. So long as angular momentum is conserved, her rate of rotation must increase. [8]

### Friction in skating and swimming

Friction is the resistance to the movement of one surface over another and to the sliding of material elements against one another. Friction is a force that must be overcome in all sports and games; eliminating or minimizing it can help athletes perform better. The fluid layer of melted ice and skates, created by frictional heat, is what makes skating possible. The swimmers face an uphill battle against gravity and viscous friction. The coach and the swimmers work on body position and technique to overcome resistance and achieve economy of movement through the water. The swimmer's efforts are met with resistance from the water's surface, much like they would be met with air resistance on land. The swimmer's streamline position aids in this regard. [9]

### Aerodynamics in sports equipment, football and cycling

The science of reducing or eliminating the effects of air resistance is known as aerodynamics. The concept of aerodynamics is crucial to the enhancement of performance in cycling. The wind resistance is reduced by the carbon bicycle frame, the design, the clothing, and the body position of the cyclist. A bicycle coating is another method for decreasing wind resistance. Golf club heads, air rifle barrels, and various bow modules all use protective ceramic coatings for lubrication, scratch resistance, and corrosion/chemical resistance. Kayaks and paddles are given an epoxy coating to prevent damage from scratches and corrosion. [10]

### Aerodynamics in ball sports

Every sport involving a ball relies heavily on the tenets of physics. When a ball is thrown through the air, the air flows around it in different ways depending on whether or not its surface is smooth or rough. The hockey ball's dimple allows for greater precision and a slower rate of movement. [11]

### Drafting in sports

By riding in groups, or pelotons, cyclists may increase their pace significantly. What we're doing is called "drafting," and (i.e., riding closely behind one another which ultimately reduce air resistance). You may cut your energy bill by around 20%. Aerodynamics is a major factor in competitive cycling. When riding in a pack, cyclists can conserve energy by drafting, and they can also increase their overall energy output. Therefore, the outputs of the cyclists around them have a direct bearing on the outputs of any given cyclist. By interacting with one another, individuals are able to form their own cohesive

groups. An approach called "drafting" is used to lessen the force of air resistance. It is a regular sight in motorsports, as well as jogging, cycling, and swimming. Technology is utilized to aid athletes in their training and preparation. [12]

### **Why time keeper starts watch on fire or smoke rather than sound of gun**

To hear something, it must first travel to where we are. If you clap your hands, you'll make a noise. When you move your hands, the air molecules around them also move with increased vigor. The emitted sound wave travels through space and time until it reaches our ears. As opposed to light, which can travel through empty space without any problems at all, sound must have something to "settle into" in order to move from one location to another. That substance is typically just air, since it carries the vast majority of the sounds we pick up. (If you've ever submerged your head in a pool, you know that sounds can be heard even at that depth.) Light actually travels at its fastest in a vacuum, while sound cannot because there is nothing to bounce off of. And while the speed of light decreases by about 25% when transitioning from air to water, the speed of sound increases by more than a factor of four. [13]

### **Physics in playing surface area**

Even when using the same surface, the speed and bounce of the ball might vary depending on its design and construction. A single ball may have a wide range of responses to various substances. Tennis can be played on a variety of surfaces, including grass, clay, or synthetic, each of which has a distinct impact on the ball's speed and bounce. Softer clay, for example, absorbs more of the ball's energy, while a grass court actually increases its velocity. [14]

### **Magnus effect on the flying object**

Athletes in various ball sports, including cricket, football, handball, and even discus throw, spin the ball or discus to improve their control and balance when throwing. To perform a curved kick in football, for example, the player needs an understanding of physics to control the trajectory of the ball in midair. Science explains why spinning balls deflect; this is known as the Magnus effect. When a ball spins, it alters the flow of air around it, increasing the speed of the air on one side and slowing it down on the other. Cricket balls that have been polished on one side and other balls with seams cause the air to be more turbulent on the side the ball is flying away from, causing the ball to curve through the air as it flies. [15]

### **Combat Games**

A combat sport or game is one in which participants engage in physical conflict on an individual basis in a competitive setting. Depending on the practitioner's degree of training, the benefits of combat sports for

developing strength, stamina, and mental stability also extend to improved eye-hand coordination, foot balance, and reflex action. The rise in popularity of combat sports has prompted a corresponding rise in interest in the intellectual development of combat sports format development. Here, the victor is determined by who of two or more rivals accumulates the most points. Mixed martial arts, such as judo, boxing, wrestling, kickboxing, etc., are all instances of combat sports. Athletes often face off against one another in one-on-one situations, and each combat sport has its own unique set of rules, maneuvers, and skill requirements. Combat sports are beneficial for people of all ages because they improve physical fitness and mental fortitude. Combat sports teach participants how to handle the highs and lows of life, helping them develop emotionally and spiritually. Wrestling is a combat sport that has been shown to decrease or eliminate tension and improve coordination in the arms, legs, and brain. The advantages of competitive fighting may be boiled down to four main points: 1. increased mental and physical attention 2. Involvement in fantastic, beneficial physical activity 3. Strengthens the Capacity for Self-Defense 4. Enhances communicative abilities As a last point, one of the main advantages of combat sports is the discipline it imparts to the athletes on and off the court. The benefits of self-discipline are far-reaching, from allowing you to deal with your personal difficulties more effectively to allowing you to live a more relaxed, serene existence. Karate, like other combat sports, teaches its practitioners the value of maintaining composure under stress by providing them with a framework within which to organize their thoughts. Additionally, the need to collaborate with your opponents is what sets combat sports apart from others. As a result, there is an increase in team spirit and competitiveness. Respect for oneself and for others is yet another gain from participating in combat sports. When you have self-assurance, an active lifestyle, and a clearer mind, you feel great and gain a greater appreciation for life.

### **Women In Combat Sports**

Women's participation in combat sports has increased dramatically during the last two decades. Boxing, according to studies, is growing in popularity, with more and more women taking an interest in the sport each year. Female champion boxers say that in addition to helping with self-assurance and confidence, boxing is a great method to get the physique of your dreams by actively exercising many different muscle groups. Women may benefit from this activity by learning to take charge, learn to regulate their emotions, and learn to put their energy to good use. When it comes to your body, it strengthens your heart and lungs and tones your biceps, triceps, abs, legs, and glutes. However, there are obstacles that women confront that are far more difficult than those faced by their male competitors. The fight for gender equality in combat sports has a long way to go in terms of equal pay and media

coverage. However, modern culture views female athletes with less prejudice than ever before.

### Development Of Sports In India

People used to participate in sports for fun back in the stone age. Sports were mostly played for amusement's sake. The ancient Greeks are often regarded as the pioneers of modern physical education and sports, having made athletics an essential aspect of their nation's educational and political framework. The sports have evolved from being played for fun into serious competition. International tournaments like the Olympic Games, the Asian Games, the Commonwealth Games, the SAIF Games, the Afro-Asian Games, etc., are more commonplace.

Sports are now widely recognized as crucial to a person's overall growth and development. When a country's athletes achieve success on the global stage, it boosts national pride and morale. The government has instituted projects to foster sporting performance in order to meet the rising demands of the modern era, both at home and abroad. Back in 1982, before it was renamed the Ministry of Youth Affairs and Sports, it was known as the Department of Sports. For the occasion of International Youth Year 1985, the department's name was changed to the Department of Youth Affairs and Sports. On May 27, 2000, it was officially designated as a Ministry. As of 30th April, 2008, the Ministry's responsibilities were split between the Department of Youth Affairs and the Department of Sports. The marketing of sports is generally the purview of separate national governing bodies for each sport. The government's job is to construct the facilities and support the training of athletes so that they may compete successfully at the highest levels of sport on both the national and international stages. These goals are the driving force behind any plan. The increasing importance of sports has elevated the value of both taking part in and excelling at competitive sports. As a result, many governments have established national training academies and specialized centers of sports excellence, where exceptionally talented children can spend years honing their skills with the help of professional coaches and cutting-edge training equipment.

### Sports In Modern Era

Some of the earliest organized activities and sports in India date back to the late 19th century and were brought to the country by the British. These include tennis, polo, cricket, football, hockey, rifle shooting, and even pen and paper competitions. The government, the public, and the private corporation, as well as the industrial/business organization, have all paid much more attention to games and sports in the country since independence. A higher proportion of the population is now influenced by gaming and sports as a consequence. During the period of segregation,

games and sports were mostly reserved for the upper class. Sixty years ago, a service scheme was introduced to bring sports to the masses in the hopes of improving the country's international performance. Since then, funding has increased from Rs. 13 crores in the sixth five-year plan to Rs. 200 crores in the seventh. In independent India, people have been able to participate in dozens of sports and activities that didn't exist here before 1947. Many universities and colleges now offer Bachelor's, Master's, M.Phil., and Ph.D. programs in Physical Education, and the number of colleges offering such programs has increased dramatically.

### REVIEW OF LITERATURE

**Cappella and Weinstein (2006)** aimed to prove a theory-based program to reduce girls' social aggression and increase constructive supervision between peers; it was the first systematic attempt of its kind. Girls in fifth grade from six different public schools were split up into reading clubs and the Social Aggression Avoidance Program (SAPP) at random. The SAPP is a school-based small group program that has been shown to have a positive impact on students across the board in terms of their ability to assist with community problem solving. Teachers saw encouraging improvements in the practical conduct of SAPP members with regard to students' larger baseline community concerns. Members of the analytic reading club also improved their reading proficiency at a greater pace than those in the SAPP program. Incorporating female students into a program that seeks to address community issues from a variety of perspectives has the potential to have far-reaching, systemic benefits in the fight against aggression and promotion of leadership in educational institutions. [16]

**Filaire et al (2009)** investigated the correlation between the emotional and physical states of 16 tennis players (eight males and eight females) on the first day of a tournament. Athletes collected saliva for Cortisol analysis on multiple occasions, including a day of rest (baseline values), the day of the first match, and the day of the second match. They also completed the Competitive State Anxiety Inventory-2, which includes both intensity and direction subscales. Predictive increases in Cortisol were seen as a result of exposure to competitive situations. Although cortisol levels were significantly higher in females on the day of the competition, the pattern of responses was the same in both sexes. The results showed that, with the exception of the evening, there were always statistically significant differences between the winners' and losers' Cortisol concentrations. One way to investigate the link between anxiety and performance is to measure cortisol at the same time as self-reported psychological indicators. [17]

**Gill and Kaur (2010)** examined the differences between rural and urban female Punjab University students in terms of their fitness levels. We have

made an effort in this study to evaluate the differences in speed, strength, endurance, agility, and flexibility between female students from rural and urban areas. Statistical methods such as the mean, standard deviation, standard error of the mean, and the T-test were used to examine and compare the data. Female students in rural areas were found to have higher abilities in strength, endurance, speed, and agility, whereas urban female students were found to have superior abilities in flexibility. [18]

**Kumar (2011)** conducted research on male adolescent risk-taking behavior and found that more aggressive boys took greater risks in the areas of hills (A), sea (C), police and intelligence services (E), and fire (F) than their less aggressive counterparts. Also, there was little to no significant variation in the aggressiveness of male adolescents taking risks in the areas of space travel (B), commercial trading (D), professional trading (G), and military service (H). He also saw that there were significant individual differences in the male adolescents' levels of aggression and risk-taking. When compared to typically aggressive teenage boys, highly aggressive boys engage in significantly more risky behavior across the board.[19]

**Sood (2012)** concluded that senior high school girls were more aggressive than boys. There were no significant differences in aggression among high school seniors based on family background, educational background, or socioeconomic status. There were also significant differences in aggressive behavior between students with high and low levels of optimism and pessimism in their senior year of high school. [20]

**Ioana Oproiu (2013)** Aggression is a person's defining trait; it's a situation that can be managed swiftly or methodically, and it can take many forms. When one's primary motivation is to win, intense competition provides the necessary compass points of existence. As more and more violent incidents occur on and around the sports field, we begin to wonder what constitutes acceptable behavior. An improved understanding of the profound psychological implications of such actions is also necessary. The first part of this study is an examination of the most influential theories of aggression that have developed over time. We also identified some of the most pertinent studies on the topic of aggression in sports. The research is predicated on Albert Bandura's theory of social cognition. It was proposed as a comparative study of the results obtained from 106 football athletes who completed a specific questionnaire for assessing conflict. Athletes between the ages of 14 and 15 show a very different pattern of anger expression than those between the ages of 17 and 18. [21]

**Singh (2015)** analyzed the variance between Volleyball and Handball players on the selected Physical fitness and Physiological variables. Thirty handball and volleyball players, aged 17 to 28, were

chosen as subjects because they competed for their university in the Inter University tournament in the 2011-2012 session in the Patiala district. Physical fitness and physiological variables were measured, including those related to flexibility, endurance, agility, explosive strength, heart rate, vital capacity, and cardiovascular endurance, among others, in this experimental study. The data were analyzed using the t-test to look for statistically significant differences between the groups. However, there was no statistically significant difference between the two physical variables of endurance and agility, while there were significant differences between the physical variables of flexibility and explosive strength and physiology. We conclude that there is a significant difference in some selected physical & physiological variables, including flexibility, explosive strength & endurance, and agility, and that further research into this topic is warranted, ideally involving a larger sample size and a wider range of players of both sexes and of varying ages. [22]

**Bashir, Kumari and Kumar (2016)** A comparison of sportsmen and non-sportsmen was made to determine their aggression and sense of self-worth. All of the male students enrolled in the secondary schools of the districts in Jammu and Kashmir State participated as data for the study. Sixty sportsmen and sixty non-sportsmen were randomly selected from six secondary schools across Jammu and Kashmir State to participate in the current study. The current study found that athletes were more likely to exhibit physical, aggressive, and indirect aggression than their non-athletic counterparts. In contrast, sportspeople tend to be more reserved and reserved in their expressions of emotion than non-sportspeople. When compared to non-athletes, athletes exhibited higher levels of positive self-concept across the board, including in the areas of physical, social, temperamental, and moral health. The non-athletes had a higher academic and mental Selfconcept. The scholar concluded that there were significant differences between the aggressive and self-concept traits of athletes and those of non-athletes, and that these traits were crucial to success on and off the field. A higher degree of self-concept was found among athletes compared to non-athletes on measures of physical, social, temperamental, and moral self-concept (mean score of .75). The average scores of the non-athletes on the educational and intellectual dimensions of the Self Concept showed that they had a higher level of Selfconcept than the athletes. We found that the physical, social, temperamental, and moral dimensions of athletes' self-concepts were more positively impacted than those of non-athletes. The educational and mental aspects of non-athletes' self-concepts improved more than those of athletes'. [23]

**Kumar and Singh (2017)** Two of the most influential psychological factors on one's character are one's level of adjustment and one's sense of one's own self-worth. What makes up an individual's sense of who they are and what they can accomplish in the

world is what psychologists call their "Self-concept." A other method of looking at one's Self-concept is via one's sense of self-worth. Self-concepts are either positive or negative; those with high self-esteem go toward the former. Improvements in one's social, emotional, intellectual, physical, and occupational functioning can all be attributed to a healthy self-concept and a steady state of adjustment. It examines how one conforms to the needs of his surroundings. The researcher probes the student's sense of self and the challenges they're facing in making sense of their own gender and educational setting. We used a non-probabilistic selection strategy to choose 100 students from the urban regions of Banda District as our sample. No significant differences between girls and boys were found in the measures of self-concept or adjustment. [24]

**Mohan KB, .et, al. (2013)** The research aims to provide an anthropogenic empirical formula that may be used as a measure of body fatness within a certain occupational group. There were a total of 159 participants, 77 of whom were male. Careful clinical examination was followed by the taking of anthropometric and anatomical analytical measures. A body composition analyzer was utilized to determine the subject's body fat percentage and provide supporting evidence for the usage of the anthropogenic empirical indicator (AEE). Analysis based on the genders independently confirmed the AEI's nominal correctness. Community specific mean body fat for an average weight of 66.05 .4 13.46 (kg) 23.15 7 8.47 (kg) indicated having more than 35% of body fat. The BMI cutoff of 42.25.56 (4.66 (kg / m (2)) does not account for this proportion of body fat. There is a statistically significant correlation between AEI and body fat in the high-risk group, but not in the control group defined by BMI. Using a person's body mass index (BMI), AEI can better pinpoint which neighborhoods or occupational groups may be affected by obesity. [25]

**Wioleta Dudzinska, et.al. (2015).** Antiagent activities of enzyme, lipid profiles, and anatomical changes in overweight individuals were studied after they underwent a six-month physical exercise program, with the results showing that the program had twice the impact on whole-body weeping stimulation over the course of 20 sessions. Serum samples were collected before to the program, after the exercise regimen for a month, before and after the first WBC treatment, again after the second WBC treatment, and at least 1 month and 45 days after the interference. Body mass, percentage of lean body mass, leptin, circulating adiponectin, and resistance concentrations were not affected by moderate aerobic mixed with white blood cell exercise over the course of 6 months. With just a little rise in HDL concentration, low density-lipoprotein levels dropped dramatically in response to triglycerides and interference. Variation in the anti-oxidant enzymes' altered activity pattern was of several origins. A substantial decrease in super-oxide dismutase, glutathione reductase activity, and

catalysis was seen after a month of increased physical activities. Subsequent rounds of whole-body weeping stimulation led to a significant elevation in SOD activity. Over time, its activity was shown to decrease noticeably as a result of catalysis. [26]

**Christopher Bismarck Eke.et.al. (2018)** Child participants in these cross-sectional studies ranged in age from 10 to 18, and were nominated using a multi-stage sampling process. Fasting serum lipid levels were measured by enzyme assay, and body mass index and percentage were calculated. Three hundred and fifty-five participants, all between the ages of 10 and 18, were surveyed and their data was analyzed using SPSS version 20.0, with a threshold of P 0.05 used to evaluate statistical significance. Only 2.6% of the population was considered normal weight, whereas 10% were overweight. Hypertriglyceridemia (13.5%), high-density lipoprotein (HDL) 48 cholesterol (9.5%), hypercholesterolemia (6.2%), and low low-density lipoprotein (LDL) cholesterol (6.2%) were the most common abnormal lipid profiles. In each case, 5.3% An rise in BMI was associated with an increase in hypercholesterolemia, hypertriglyceridemia, and LDL-C. [27]

## CONCLUSION

The literature provides strong evidence that the principles of physics have pivotal role in sports performance. In current sports era the athlete should be biomechanical strong. His or her techniques should be corrected by using motion-analysis software. The application of principles of physics not only improves sports performance but also reduce the chance of injuries. The sports equipments industry must produce sports equipments while taking the consideration of principles of physics. The equipments should ensure safety of sports person, more aerodynamics, improve performance and durability. The coaches and athletes must work to improves skills which are biomechanically strong. Enhancing the knowledge of biomechanics is imperative in modern sports.

## REFERENCES

1. Adair, R. K. (2002). The physics of baseball. New York: Harper Perennial.
2. Cross, R. (2011). Physics of baseball and softball. New York: Springer.
3. Denny, M. (2011). Gliding for gold. The physics of winter sports. Baltimore: The Johns Hopkins Univ. Press.
4. Fontanella, J. J. (2006). The physics of basketball. Baltimore: Johns Hopkins Univ. Press.

5. Guttersrud, O. (2008). Mathematical modelling in upper secondary education [Dissertation thesis]. Oslo: Univ. Oslo ISSN, 1501–7710.
6. Haake, S. (2012). Material advantage. *Physics World*, July 2012, 26–26.
7. Kimball, J. (2010). *The physics of sailing*. Boca Raton: CRC Press.
8. Mathelitsch, L. & Thaller, S. (2012). Olympische Rekorde. *Physik in unserer Zeit*, 43(4), 186–189.
9. Spathopoulos, V. (2013). *An introduction to the physics of sports*. CreateSpace Independent Pub.
10. Thaller, S. (2003). Hochsprung auf dem Mond. *Physik in unserer Zeit*, 34(9), 87–89.
11. Nara, K., (2017). A study of physical fitness between basketball and football players of Haryana. *International Journal of Physiology, Nutrition and Physical Education*, (1), 01-04.
12. Poonam. (2018). A comparative study on selected physical fitness components between kabaddi and kho-kho players. *International Journal of Yoga, Physiotherapy and Physical Education*, 3 (1), 154-156. Online available at: <http://www.sportsjournal.in/archives/2018/vol3/issue1/3-1-59>
13. Ruhil, M., (2016). A Comparison of Selected Physical Fitness Parameters and Physiological Parameters between Individual Sports Athletes and Team Sports Athletes. *International Educational E-Journal*, 5(4), 1-10.
14. Sahrawat, M., et al. (2016). Comparison of self-concept, stress and social adjustment between sports women and non-sports women. *International Journal of Management and Applied Science*, 2(6) 10-13.
15. Zhang, H., (2013). Research on Emotional Adjustment Effect of Sports Game on the Primary and Middle School Students. *International Workshop on Computer Science in Sports*, 3(2), 99-102.
16. Cappella, E., & Weinstein, R., (2006). The prevention of social aggression among girls. *Social Development*, 15(3), 434-462. <https://doi.org/10.1111/j.1467-9507.2006.00350.x>
17. Filaire, E., et al. (2009). Psychophysiological stress in tennis players during the first single match of a tournament. *Psychoneuroendocrinology*. 34(1), 150-7.
18. Gill, M., & Kaur, R., (2010). Comparative Study of Physical Fitness Components of Rural and Urban Female Students of Punjabi University, Patiala. *Journal The Anthropologist*, 12(1), 17-21.
19. Kumar, A., & Malik, S., C., (2011). Performance Analysis of a Computer System with Imperfect Fault Detection of Hardware, *Precedia Computer Science*, 45(2), 602-610.
20. Sood (2012) A comparative study of motor fitness components between inter- collegiate volleyball and basketball players of Punjabi University Patiala. *International Educational E-Journal*, 6 (3),78-80.
21. Ioana, O., (2013). A Study on the Relationship Between Sports and Aggression, *Sports Science*, 22 (1-2), 33-48.
22. Singh, H., (2015). Comparative Study on Selected Physical Fitness and Physiological Variables Between Volleyball and Handball Players. *European Journal of Physical Education and Sport*, 10(4), 206-211
23. Bashir, M., Kumari, S., & Kumar, S. (2016). Aggression and self-concept among sports men and non-sports men: A comparative study, 5(2), 1-8.
24. Kumar, S., & Singh, N., (2017). A Comparative Study On 'Adjustment' and 'self Concept' of the College Students. *International Journal of Technical Research and Applications*, 5 (4), 23-26.
25. Mohan KB, .et, al. (2013) "Effects of dietary lipid, Carnation and exercise on lipid profile in rat blood, liver and muscle." Mysore 57011, India.
26. Wioleta Dudzinska, et.al. (2015). The athletes heart syndrome study related to food 13.5-69% trained athlete's performance disease to practice 80- 90%. 3509-575
27. Christopher Bismarck Eke.et.al. (2018) Effects of weight loss on serum lipoprotein (a) concentrations in an obese population clin, chem, 37:1191-1195.

---

#### Corresponding Author

**Dr. Vishal Kumar\***

Associate Professor, Rajkiya Mahila Snatkottar Mahavidyalaya, Kandhla (Shamli) UP