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The Application of physics in sports

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Abstract

When we think sports the other words that come in minds are fitness, competition, endurance, exercise and recreation; Physical Education and sports is very scientific. It has strong roots in science. Modern sports are not only demonstration of skills, strength and techniques but it is also shown scientific performance. It is equally powerful demonstration of science. From bicycle to tennis rackets and from high jump to long jump, it involves science. You may surprise to see sprinter who run 100 m in less than 10 sec. It is not only strength and speed that enable to run but it is also science that helps to run in such high speed. Why the shape of Helmet in cycling is having long tail? Why discus throwers spin the discus in air? There are thousand questions and all answers lies in science.

The purpose of the study was to illuminate various principles of physics and their implication in sports. The application of physics principles in sports know as biomechanics. The word biomechanics can be divided into two parts: the prefix bio- and the root word mechanics. The prefix bio- indicates that biomechanics has something to do with living or biological systems. The root word mechanics indicates that biomechanics has something to do with the analysis of forces and their effects. So it appears that biomechanics is the study of forces and their effects on living systems. This comes very close to the definition of biomechanics presented by Herbert Hatze in 1974: "Biomechanics is the study of the structure and function of biological systems by means of the methods of mechanics". The goals of sport and exercise biomechanics are performance improvement, technique improvement, equipment improvement, injury prevention and rehabilitation

Keywords: Biomechanics, Physics, Performance

Introduction

In 1968, there was drastically change in the high jump technique. Dick Fosbury an American athlete uses a peculiar technique known as Fosbury Flop. This technique improves the high jump performance to great extend. After 1968 Fosbury flop techniques become popular among high jumpers. This techniques have advantages over the straddle technique were its faster approach run and its ease of learning. Athletes strive hard many years in high intensity training, develops fitness and mental toughness. Knowledge of levers, forces and influences all ambits of sports. It helps the athlete to develop greater strength, move faster, to preventing injuries, planning more efficient trainings, and developing aerodynamic equipment and clothing. Physics and sports are two faces of same coin. This is because every sport's discipline depends on the ability of an athlete to exercise a force, and a force is one of the key elements of Newton's laws of motion and other elementary physics concepts.

Work and energy in pole vaulting

The concepts of work and energy plays pivotal role in sports. In physics, work is explained as the result of a force moving an object a definite distance. Thus, force and work are directly proportional to each other. Moreover, the concepts of work and energy are closely related. Hence, work transfers energy from one place to another or one form to another. While performing a pole vault by athletes, various kinds of energies are engaged. First, the athletes convert chemical energy into kinetic energy of their body while running. Part of this kinetic energy becomes elastic potential energy, as observed by the deformation of the pole; the rest of energy becomes gravitational potential energy, which again it is transformed into kinetic energy while the athletes fall away from the bar. (Schade, F *et al.*; 2012 and Dillman, C.J, *et al.*; 1968)^[7, 8].

Angular momentum in skating

Angular momentum is also defined as rotational momentum—is the product of the moment of inertia (i.e., the product of the mass of the object and square of its perpendicular distance from the axis of rotation) and rotational velocity. Conservation of angular momentum is another important concept. For instance, consider a figure skater who turns on the tip of her skates. In the absence of external forces, the angular momentum is almost constant. When a figure skater draws her arms and a leg inward, she reduces the distance between the axis of rotation and some of her mass, therefore reducing the moment of inertia and her friction with the air. Since angular momentum is conserved, her rotational velocity must increase to compensate

Friction in skating and swimming

The force of friction is the force resisting the displacement of one surface over another and material elements sliding against each other. In every games and sports, friction act as resistance force that required being tackle; by reducing the effect of these force, the athletes can improve their performance. The melted fluid layer in between ice and skate caused by the heat due to friction that make possible skating. (Berre Le; *et al.*, 2015 and Koning De *et al.*; 1992)^[1, 2]. Gravity and viscous friction act against the swimmers. In order to achieve economy of movements through the water, the coach and swimmers work on the correct body position and technique to overcome resistance. Resistance can be reduces by reducing the surface area, which acts as against the efforts of the swimmer like air resistance outside the water. Streamline position of swimmer helps in this regards. (Minetti *et al.*; 2009)^[3].

Aerodynamics in sports equipment, football and cycling

Aerodynamics is a term of physics that describes the ability of an object to overcome air resistance. In cycling the concept of aerodynamics play important role in the improvement of the performance. Carbon bicycle frame, design, clothing, and body position of the cyclist help to overcome the effect of the wind resistance. A coating of bicycle also helps to reduce resistance. In addition, protective ceramic coatings are also used for golf club heads, air rifle barrels, and in various bow modules used in archery to provide surface lubrication as well as impact, scratch, and corrosion/chemical protection. Finally, epoxy coatings are used on kayaks and on paddles to enhance their scratch and corrosion protection. (YU *et al.*, 2016)^[4].

Aerodynamics in ball sports

The role of the principles of physics is vital in every ball related sports. The air flow around a ball thrown through the air differs greatly depending on whether it has a smooth surface or a rough surface. The dimple in the hockey helps to control and reduce the speed of the ball. (Dupeux *et al.* 2011)^[6].

Drafting in sports

The speed of cyclists improves considerably by riding in pelotons. The technique is known as drafting (i.e., riding closely behind one another which ultimate reduce air resistance). About 20% energy save by doing this. In cycling, aerodynamics plays an important role in cycling races. Drafting save the energy of cyclists and energy expenditures also increase. This means that each cyclist's output is directly affected by the outputs of their nearest neighbors. This

interactivity produces self-organized collective behavior. Drafting is tactics which helps to reduce the impact of air resistance. It is commonly seen in car racing, running, cycling and swimming. Technology is used that can help athletes to prepare and train more effectively and efficiently. (Trenchard *et al.*; 2014, 2015 and Crouch *et al.*; 2016)^[5, 9, 10].

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

Sound must also travel to us if we are to hear it. Clap your hands together and you hear a sound. Some of the energy in the motion of your hands is transferred to an energetic motion of the air molecules around your hands. The sound wave produced eventually reaches us and transfers some of its energy to our ears. Unlike light, which travels quite well in an empty vacuum, sound needs a substance through which to travel. That substance, for most of the sounds we hear, is air. (If you have ever had your head underwater in a swimming pool, you have probably heard sounds there, too.) Light in fact achieves its greatest speed in a vacuum, whereas sound cannot travel at all in a vacuum, because there is no supporting substance. And whereas light speed drops by about 25% when passing from air to water, sound speed actually increases, by more than a factor of four, when it moves from air to water. (Je Goff; 2010)^[11].

Physics in playing surface area

Ball sports are played on different surfaces and the velocity and the bounce of ball depends upon the designed and material of ball even on the same surface. Same ball can react differently on different stuff. The grass, clay or synthetic surfaces are used in the tennis; each of these affects the speed and bounce of the ball in a drastically different way, the absorption of the ball's energy is more in softer clay whereas, grass surface increase the speed of the ball.

Magnus effect on the flying object

In many ball sports such as cricket, football, handball even in discus throw the athlete spin the ball or discus which helps the athlete to balance the ball in the air and also ball move in more precision. The knowledge of physics helps the athlete to change the direction of the ball in the air like curved kick in football. Spinning balls bend because of science—usually through something called the Magnus effect: as a ball spins, it changes the way air moves around it, speeding it up on one side and stopping it on the other, producing a force that pushes the ball in an unexpected direction. Balls with seams and cricket balls that have been polished on one side curve through as they fly because they make the air more turbulent on one side than the other.

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.

The current study is not comprehensive more studies are required to improve the body of knowledge.

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