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ORIGINAL

BIOMECHANICAL ANALYSIS OF MOVEMENT IN HIGH IMPACT SPORTS AND ITS IMPLICATIONS FOR INJURY PREVENTION

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ABSTRACT

Sports mechanics is a detailed evaluation of sport motions that helps to decrease the risk of Injury and improve athletic performance. Sport and exercise biomechanics is the scientific study of human movement mechanics. It refers to the detailed analysis and evaluation of how individuals move when engaging in sports. Research-based on primary data analysis to determine the study used SPSS software and generated results including ANOVA test, pair sample test, etc. Mechanics is a branch of physics that studies motion and the forces that cause it. Sport biomechanics is the science that explains how and why the human body moves in the manner it functions. This phrase frequently refers to an athlete's interaction, equipment, and surroundings in sports and exercise. Biomechanics has two traditional subfields: kinematics and kinetics. Kinematics is a branch of mechanics that studies the geometry of object motion, such as acceleration, velocity, and displacement but does not consider the forces that cause the motion. Kinetics is the study of the relationships between a body's force system and the changes in motion that arise from it. In light of this, we must include skeletal, muscular, and neurological components while addressing biomechanics. Sports injuries are preventable; however, many athletes continue to suffer from them. Injuries can prohibit athletes from playing to their full potential, and in certain situations, they may be recommended not to participate. Overall, the results found that movement in high-impact sports shows negative and significant link with injury prevention. This can adversely affect the physical and psychological well-being of the athlete and their team.

KEYWORDS: Biomechanical Analysis (BMA), Sport Mechanics (SM), Sport Motion (SM), Injury Prevention (IP)

1. INTRODUCTION

The world has had tremendous success in each field of life, ranging from communication to medical science. With the advancement of medical science, a new branch of science has emerged: biochemical analysis or simply biochemistry. Further branching of this field provides an aspect called biomechanical analysis, in which mechanical applications of force related to living organisms are studied well. In this introduction, we are going to analyze how biomechanical analysis is done in high-impact sports and how it can be used and implemented to prevent injury in athletes. Athletes are more prone to injury because of the highly stressed duration of their performance and the habit of continuous exercises. Therefore, we can say that there must be better strategies for athletes to prevent any kind of possible injury. Before going into depth on this topic, we must understand high-impact sports (Zago et al., 2021). High-impact sports can be explained as high pressure, force, and continuous movement, which demand more energy as input and give more stress as output. There are various examples of high-impact sports, such as badminton, cricket, hockey, squash, tennis, aerobics, jumping sports, and others. There are a variety of movements concerned with these sports, such as jumping, running, punching, kicking, twisting, and others. All of these movements may cause Injury to athletes if not properly understood. But with the help of biomechanical Analysis, the basic science of these movements can be understood well, which may help prevent injury and improve an athlete's performance (Carrasco Páez et al., 2021; Finch et al., 2011).

The first and foremost thing that is necessary to understand in high-impact sports related to biomechanical Analysis is the aspect of force and torque. As we know, force works in linear motion and torque in circular motion, and both of these are involved in high-impact sports. When an athlete is trained well to understand the origin and impact of force and torque, he can easily perform well during high-impact sports with the output of effective performance(Thompson et al., 2017). For example, in badminton, there is an idea of which type and intensity of force can result in a foul and which type of force may result in a foul of an opponent player. The second most important aspect that must be understood in high-impact sports is the law of motion or Newton's law. These laws of motion help understand the type of movements that can take place by applying force. The first law of motion is related to the rest or motion of the body, the second law of Newton is related to acceleration produced by force, and the third law of motion is related to the action and reaction of the body. These laws should be understood well to prevent Injury and perform well during high-impact sports(Nigg, 1985). The third aspect related to biomechanical Analysis in high-impact sports is the aspect of body momentum, which is a product of mass and body velocity. The other aspects are listed as the center of gravity, balance, and biomechanics of the upper and

lower limbs. The center of gravity of any body is the point within the body at which the weight of the body acts downward. So if support is provided to that point, the whole weight of the body can be balanced well. This aspect also helps to keep the balance that helps prevent Injury in an athlete's body. Understanding the biomechanics related to specific sports is also necessary(Trasolini et al., 2022). Biomechanics is the combination of bio and mechanics, which means the study of movements in living organisms. The correct understanding of upper and lower limb biomechanics can help understand the movement of upper and lower body parts, which is the basic training for performing well in high-impact sports. The second part of the introduction states that biomechanical analysis can help prevent athlete injury. There are different ways in which biomechanical analysis can be used to prevent injury in athletes(Fox, 2018). The first way biomechanical analysis can be used in injury prevention is by identifying faulty biomechanics. When there is no proper understanding and training of athletes in the aspect of biomechanics, it may lead to less or poor balance of the body, which may result in falling, twisting, or any other kind of Injury in athletes. Still, by correct understanding of biomechanics, such Injury can be prevented well. The other way of using biomechanical Analysis injury prevention by ying the potential risk of Injury. Injury comprehending the basic roles of biomechanics, any athlete may understand the wrong procedure or poor technique which may keep him at high risk of Injury(Lim et al., 2009). So with the help of biomechanical Analysis, such analysis risk of injuries is identified. The other benefit of biomechanics in injury prevention is the personalized training programs for athletes. When an athlete easily understands the roles and applications of biomechanics, he can provide himself with personal training, which may enhance the athlete's performance and reduce the risk of possible injury during high-impact sports. The other major benefit of biomechanical analysis is that it may help reduce the rehabilitation period of athletes after injury. With the assistance of biomechanics, the intensity and type of Injury can be understood, and then a few specific types of movements are suggested, which may increase the chance of rehabilitation of the athlete after the Injury(Navarro et al., 2021). The other benefit of biomechanics is that it may increase the endurance level of the body of athletes and make it easy for athletes to bear minor injuries. By reviewing all of these studies, we can conclude that biomechanical Analysis is the better and more effective step for increasing the potential, endurance, and Performance level of an athlete and at the same, it can be used to prevent and heal injuries related to high-impact sports. This aspect of biomechanical Analysis will be very helpful shortly in high-impact sports (Lopes et al., 2018; Sugimoto et al., 2015; Trejo Trejo et al., 2020).

1.1 Research objective

The main objective of this research is to discuss how biomechanical

Analysis can be used in high-impact sports and prevention of sports-related injuries in athletes. This study has vividly explained the importance of biomechanical Analysis for enhancing the performance of athletes and preventing sports-related Injury. The research determines the impact of sports on injury prevention. The research paper is divided into five sections first portion represents the introduction related to sports and injury prevention. This section also describes the objective of the research. The second component represents a literature review, while the third section describes methodology, including tools and procedures. The fourth chapter describes the results and their descriptions, while the last section summarizes the total research study and presents recommendations for sport and injury prevention.

2. Literature Review

There are major types of difference between the life of an athlete and the life of a layman. An athlete has to undergo different stress conditions and sometimes undergo an injury or something like an injury(Viano et al., 2007). In this, review we ar going, mechanical Analysis can be proved helpful in high-impact sports and how it can be used and implemented to prevent Injury in athletes. This emerging field of science has benefited athletes in different ways. This field of science is mainly concerned with the study of motions in living organisms and human beings(Olvey et al., 2004). This field is not only concerned with the locomotion of human beings but also related to movements in the human body, such as the motion of joints, the working of skeletal muscles, and others. As we know, athletes are more prone to injuries; thus, they should be provided with knowledge that is helpful for them in preventing possible Injuries during performance in high-impact sports(Portus et al., 2011). We can define high-impact sports as sports that demand high energy. These sports may have a risk of higher athlete injury in-depth knowledge and learning from biomechanical Analysis, athletes get proper knowledge of how to work well in high-impact sports(Simms, 2018). Recent studies have shown that a few points are kept in mind to prevent injury and maximize the performance of athletes. The first thing that is necessary to prevent Injury during high-impact sports is the mental willingness to participate in high-impact sports(Hewett et al., 2012). When an athlete is mentally satisfied to participate in sports, the risk of Injury decreases automatically. The second point that has been made by biomechanical Analysis is the ability to understand the types and actions of forces(Pappas et al., 2013).

An athlete must have in-depth knowledge of force and torque because the whole scenario of high-impact sports is dependent upon force and torque. For example in hockey, an athlete must be aware of what type of force can help win and what force can result in failure(Guskiewicz & Mihalik, 2011). In the game of cricket, the whole success or failure is dependent upon correct

understanding and usage of force and such understanding can only be provided by biomechanical Analysis(Steele & Sheppard, 2015). The biomechanical Analysis also suggests that not only understanding of forces and torque is enough but some other points must be followed for preventing Injury. Recent studies have shown that proper balance of the body is the backbone of high-impact sports. For the proper balance of the body, the balance of the upper and lower limbs must be understood(Sinclair et al., 2010). These types of balance help to maintain body posture, thus preventing any possible risk of falling. By correct and accurate understanding and learning of body balance, the chances of winning in high-impact sports increase(Daly et al., 2001). The field of biomechanical Analysis also provides information about stress on different types of joints that which joint can bear stress and which joint must not undergo any stress. For example, there are two types of joints in the body, hinge joint and ball and socket joints(Chen et al., 2017). The hinge joints can only be moved in one plane but ball and socket joints can be moved in all directions. The biomechanical Analysis provides information that stress should be applied to joints according to their nature(Malisoux et al., 2017). When an athlete knows the types of joints, he may perform well and also the risk of Injury can be prevented. The other important point that has helped in athlete's performance with the help of biomechanical Analysis is the correct understanding of laws of motion(Murayama et al., 2013). These laws of motion help to understand the origin, action, and reaction of force. By understanding these laws, the performance of athletes can be enhanced, and Injury can be prevented(Sasaki et al., 2021). The next important aspect brought into light with the help of biomechanical Analysis is the aspect of momentum which is also helpful for preventing Injury during performance(Irmischer et al., 2004). The emerging and very crucial aspect of biomechanical Analysis is that it gives information about such movements and exercises that are quite helpful in eliminating the factor of stress and anxiety. At the same time, these exercises bring mental Peace and calmness to athletes, which is a prerequisite for performing well during high-impact sports(Brown et al., 2009). Modern studies brought to light that not only physical health is necessary for performing well in high-impact sports but the factor of mental health is also decisive for enhancing the performance of athletes(Lopes et al., 2018). These are modern aspects of athlete performance that have been brought into light with the knowledge of biomechanical Analysis(Whyte et al., 2019). Today we are living in the modern world where technology has also been invented and devised for athletes such as different wearable technologies, improved training, different congenital therapies, maintenance of physical and mental health, and others(Tomescu et al., 2018). The knowledge of biomechanical Analysis is also proof of the importance of science and technology in the life of athletes. In recent years, many efforts have been made to focus on improving the lifestyles of athletes to enhance their performance during high-impact sports(Spech et al., 2022). As we all know,

despite having all of these resources, there is always a risk of Injury to athletes(Kristianslund et al., 2012). After the Injury, the main problem and concern is the rehabilitation of athletes in a short period. Usually, most of the care is required in the rehabilitation period but some important aspects must be understood to lessen the rehabilitation period for fast and quick recovery of athletes(Gittoes & Irwin, 2012). These important aspects are brought into light because of biomechanical Analysis and these aspects are related to different therapies that may galvanize the process of healing from Injury(Bradshaw & Hume, 2012). A few types of specific movements are suggested by knowledge of biomechanical Analysis that helps in quick recovery. These types of movements are also suggested in daily exercises for athletes and also for the common man to maintain a healthy lifestyle(Kristianslund et al., 2013). In the present world of time, we can never deny the importance of biomechanical Analysis for improving the performance of athletes and preventing Injury(Nagano et al., 2021). It is the most important evidence of the importance of medical science in our daily lives. Such fields of medical science can help maintain a better lifestyle for athletes as well as the health of a layman(Hume et al., 2013).

3. Methodology

The research study determine that biomechanical analysis related to the movement in high effect of sport on injury prevention. The research based on primary data analysis for collecting the data develop different research questions related to variable. the high sport is main independent variable and injury prevention is dependent variable for determine the research study used SPSS software and generate informative result included descriptive statistic, the one-way ANOVA test and regression analysis.

Figure 1: Sport Injury Prevention

High-impact sports are not like ordinary sports. These are types of sports that need more force and power and thus give more pressure and stress as

output. There are a variety of analyses that are used to improve movement in high-impact sports. One of those analyses is biochemical Analysis, which has gained importance in recent times as well. Biochemical Analysis is related to studying and analyzing the motion of living organisms. There are a variety of benefits of studying biochemical Analysis of movement related to high-impact sports(Hewett et al., 2010). There are many important implications of biochemical Analysis which are discussed below:

3.1 To improve performance in high-impact sports

To perform well in high-impact sports is quite difficult because these sports demand more energy and strength. There is a need to understand the important aspects of high-impact sports to give an effective performance. The biochemical Analysis mainly focuses on understanding the basics of high-impact sports. There are a few important aspects of movements in high-impact sports such as force, torque, momentum, displacement, circular motion, laws of motion, and others(Myer et al., 2005). If a person understands all these basic aspects, there will be betterment in performance as well. If we define these aspects, we can define force as the basic entity to do any work in the body. The torque can be described well in terms of the product of force and moment arm. The momentum can be defined as the product of mass and velocity(Kristianslund et al., 2012). The displacement can be defined as movement from the original position. The circular motion also follows the roles of linear motion but in different ways. If we talk about laws of motion there are three laws of motion the first law is related to inertia, the second law is related to acceleration in body, and third law is related to action and reaction of force. These are important aspects that are to be studied in biochemical Analysis related to movements in high-impact sports. For example in cricket, when a player has an idea of all of these factors he can perform well by keeping in view all these factors(Zebis et al., 2016). In this way, we can say that biochemical Analysis helps to improve the performance level of athletes in high-impact sports. This is one of the important implications of biochemical Analysis of movement related to high-impact sports.

3.2 To improve physical and mental health:

The other benefit of biochemical Analysis of movement related to high-impact sports is that it indirectly helps to maintain health in terms of physical and mental health. We know that there are some important types of movements suggested in biochemical Analysis, so these movements are related to health in different ways(Weerapong et al., 2005). For example, the proper movement of forelimbs helps to maintain cardiovascular function which in turn helps maintain the health of the heart. There are few movements of the forelimbs and heart that help to increase blood flow in the upper area of the body such as the

head, and shoulders. There are some movements suggested y biochemical Analysis that help to prevent fatigue and stress in the body after performance in high-impact sports. All the benefits of biochemical Analysis are based upon exercises that are suggested in this biochemical Analysis. All these exercises help to maintain the physical health of the body in a better way. If we talk about mental health's importance, we can never deny the importance of the mental health of athletes to perform well in any sport including high-impact sports(Whiting & Zernicke, 2008). The present scientific studies have brought us to the fact that the effective performance of athletes needs both physical and mental health as well. The importance of biochemical Analysis can be proved by the fact that biochemical Analysis helps to improve the condition of mental health as well(Hewett et al., 2013). We cannot deny the fact that the rate of mental health issues in athletes is more than the mental health issues of the common man, therefore in this way, biochemical Analysis can be proved an effective way to maintain the physical as well as mental health of athletes.

3.3 To prevent risk of Injury in athletes:

There is a high risk of Injury in athletes as compared to the layman because athletes are more prone to high pressure, force, and stress. Especially in high-impact sports, there is a need for power, tolerance, and endurance of the body to perform well as well as to prevent Injury. The Injury can be prevented only if there is proper knowledge about actions and reactions during sports. For example during the high-impact sport of cricket, if an athlete does not have a sense of dealing with force and its reaction, it can be resulted in disastrous consequences in terms of Injury as well(Roi & Bianchedi, 2008). The same is the case of badminton, if an athlete does not have an idea of how to maintain a posture of body in balance, it can cause severe Injury to the athlete as well. Secondly, it has also been that some joints are more prone to Injury as compared to other joints of the body. This is because of more stress applied to those joints. For example, the ankle, the knee, and the elbow joints are more prone to suffer from stress because of the high pressure on them in case of high-impact sports(Bartlett, 2002). But by a correct and accurate understanding of biochemical Analysis, an athlete may have pre-knowledge of this aspect that what type of force can cause what type of Injury as well. This is the most important implication of biochemical Analysis that it not only prevents Injury but also helps in treating Injury soon by reducing the rehabilitation period of the athlete. A few important types of physical exercises are suggested for specific injuries so that these exercises help to regain health in a short time. If there is no proper exercise activity in athletes in case of Injury, there will be very little recovery, and will also take much time in rehabilitation. These important implications of biochemical Analysis made it a prerequisite to be added in the training of athletes for better performance and preventing major types of injuries as well(Nigg et al., 2000).

4. Result and descriptions

Table 1: Result of Bayesian Estimates of Coefficients[a,b,c,d]

BAYESIAN ESTIMATES OF COEFFICIENTS[a,b,c,d]					
PARAMETER	**POSTERIOR**			**95% CREDIBLE INTERVAL**	
	Mode	Mean	Variance	Lower Bound	Upper Bound
HIGH-IMPACT SPORTS = STRONGLY AGREE	1.289	1.289	.009	1.103	1.475
HIGH-IMPACT SPORTS = AGREE	1.545	1.545	.015	1.301	1.790
HIGH-IMPACT SPORTS = NEUTRAL	1.000	1.000	.113	.338	1.662

The above result of table 1 describe the Bayesian estimated of coefficient analysis the result also describes variance level, the lower bound and upper bound related to the 95% credible interval of each parameter. The first parameter is high impact sports its shows that mode value is 1.289 the posterior mean value is 1.289 the variance rate is 0.009 shows that 9% variance level. The lower bound represent the positive level its rate is 1.103 the upper bound level is 1.475 respectively. According to the table-1 the second parameter is high impact sports according to the result its mode level is 1.545 the variance rate is 0.015 shows 15% variance level. The lower bound and upper bound shows 1.301 and 1.790 respectively.

Table 2: Result of Paired Samples Statistics

PAIRED SAMPLES STATISTICS					
		MEAN	**N**	**STD. DEVIATION**	**STD. ERROR MEAN**
PAIR 1	Movement	1.2600	50	.52722	.07456
	High-Impact Sports	1.3800	50	.53031	.07500
PAIR 2	Movement	1.4400	50	.57711	.08162
	High-Impact Sports	1.4200	50	.57463	.08127
PAIR 3	High-Impact Sports	1.3800	50	.53031	.07500
	Injury Prevention	1.4200	50	.53795	.07608
PAIR 4	High-Impact Sports	1.5600	50	.54060	.07645
	Injury Prevention	1.5400	50	.54248	.07672

The above result of table 2 describe that paired sample statistical analysis result represent that mean values, standard deviation rate also that standard error of the mean value. According to the result the first pair is movement and high impact sports its mean value is 1.2600 and 1.3800 the standard deviation rate is 0.52 and 0.53 shows that 52% and 53% deviate from mean. The standard error of the mean value is 0.0745 and 0.07500 its shows that 74% and 75% error of the estimated rate between them the second pair is movement and high impact sports result represent that standard deviation rate is 57% deviate from mean value. The standard error of the mean value is 81% between them the pair 3 is high impact sports and injury prevention according to the result its mean value is 1.3800 and 1.4200 the standard deviation rate is 53% in between high impact sports and injury prevention. The pair 4 represent that positive deviation rate its value is 54% the standard error of the estimated value is 76% respectively.

4.1 Pair sample analysis

Table 3: Result of Paired Samples Test

PAIRED SAMPLES TEST									
		PAIRED DIFFERENCES					T	DF	SIG. (2-TAILED)
		MEAN	STD. DEVIATION	STD. ERROR MEAN	95% CONFIDENCE INTERVAL OF THE DIFFERENCE				
					LOWER	UPPER			
PAIR 1	Movement - High-Impact Sports	-.12000	.62727	.08871	-.29827	.05827	-1.353	49	.182
PAIR 2	Movement - High-Impact Sports	.02000	.42809	.06054	-.10166	.14166	.330	49	.743
PAIR 3	High-Impact Sports - Injury Prevention	-.04000	.69869	.09881	-.23856	.15856	-.405	49	.687
PAIR 4	High-Impact Sports - Injury Prevention	.02000	.42809	.06054	-.10166	.14166	.330	49	.743

The above result of table 3 demonstrates that pair sample test analysis result describes that paired sample test analysis included mean values, standard deviation, the 95% confidence interval included lower and upper level the result also describes the t statistic and significant level between them. the first pair is movement and high impact sports its mean value is -0.1200 the standard deviation rate is 0.62 shows that 62% deviate from mean. According to table-3 the t statistic value is -1.353 the significant level is 0.182 shows that 18% significant level between them. the third pair is high impact sports and injury prevention result represent that mean value is -0.0400 the standard deviation rate is 69% the t statistic value is -0.405 also that its significant level is 0.687 shows 68% significantly level between them. the high-impact sport and injury prevention also that shows 74% significantly level and t statistic level is 33% respectively.

Table 4: Result of Model Summary

MODEL SUMMARY				
MODEL	**R**	**R SQUARE**	**ADJUSTED R SQUARE**	**STD. ERROR OF THE ESTIMATE**
1	.591[a]	.349	.275	.45790
a. Predictors: (Constant), High-Impact Sports , Movement, Movement, High-Impact Sports , High-Impact Sports				

The above result of table 4 describe that model summary result shows that R value, R square value, the adjusted R square also that standard of estimated rate of model 1. The R rate is 59%, the R square rate is 27% the standard error of the estimated value is 45% respectively.

Table 5: Result of ANOVA[a]

ANOVA[a]						
MODEL		**SUM OF SQUARES**	**DF**	**MEAN SQUARE**	**F**	**SIG.**
1	Regression	4.954	5	.991	4.726	.002[b]
	Residual	9.226	44	.210		
	Total	14.180	49			
a. Dependent Variable: Injury Prevention						
b. Predictors: (Constant), High-Impact Sports , Movement, Movement, High-Impact Sports , High-Impact Sports						

The above result of table 5 describe that ANOVA test analysis result describe that sum of square value, the mean square value, F statistic also that significant level between them. the regression shows that sum of square rate is 4.954 the mean square rate is 99% the significantly level is 0.002 shows 2% significantly level between them. the residual value present that 9.226 the mean square value is 0.210 shows that 21% average square rate between them. according to the result total value is 14.180 respectively shows that positive total value between them.

Table 6: Result of Coefficients

COEFFICIENTS						
MODEL		**UNSTANDARDIZED COEFFICIENTS**		**STANDARDIZED COEFFICIENTS**	**T**	**SIG.**
		B	**STD. ERROR**	**BETA**		
1	(Constant)	1.403	.338		4.155	.000
	Movement	-.248	.134	-.243	-1.852	.071
	Movement	.233	.167	.250	1.395	.170
	High-Impact Sports	.162	.133	.160	1.215	.231
	High-Impact Sports	.181	.171	.194	1.063	.294
	High-Impact Sports	-.312	.128	-.314	-2.446	.019
a. Dependent Variable: Injury Prevention						

The above result of table 6 describes that linear regression analysis result represent that unstandardized coefficient value, included beta and standard error the result also represents the t statistic value and significant value of each independent variable. the first is movement consider as independent variable according to the result its beta value is -0.248, 0.233 the standard error value is 0.134 and 0.167 the t statistic value is -1.852 and 1.395 also that its significant value is 0.071 and 0.170 shows that 7% and 17% significantly level between them. the high impact sports show that 1.215, 1.063

and -2.446 the significant level is 0.231, 0.294 and 0.019 shows that 23% and 29% also that 19% significantly level between them.

5. Conclusion

This study has effectively explained the importance and implications of biochemical Analysis of movement related to high-impact sports in athletes for enhancing performance and preventing Injury. The principles of mechanics are applied to human movement in sports biomechanics to better understand athletic performance and prevent sports-related injuries. The research based on primary data analysis for measuring the research used SPSS software and generate result included paired sample test. The overall research concluded that negative but its significant link between them. It focuses on applying mechanical physics concepts to science in order to comprehend human movement and the functioning of sporting equipment like hockey sticks, cricket bats, and javelins, among other things.

Sports biomechanics frequently makes use of techniques from mechanical engineering, electrical engineering, computer science (including numerical methods), gait analysis, and clinical neurophysiology. The muscle, joint, and skeletal movements of the body during the performance of a certain activity, skill, or technique are referred to as biomechanics in sports. The biggest effects of having a proper grasp of biomechanics in relation to sports skill are on sport mastery, rehabilitation, and injury prevention.

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