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A Comparative Study Of Kinematic Analysis Of The Tomoe Nage Of Judo Technique

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ABSTRACT

Jigoro Kano created judo in the early 1900s to enhance both mental and physical strength. Judo involves tough training and includes various techniques for combat. Kano primarily emphasized throwing techniques, which he believed were essential for physical and spiritual education. Each throwing technique has three parts: kuzushi (unbalancing), tsukuri (positioning), and kake (throwing). Kuzushi is crucial because it helps save energy, putting the opponent in a weak position for easier throwing.Judo techniques follow the laws of physics, with five key elements influencing performance: motion, support base, center of gravity, and levers. Timing, stability, and other factors are vital to success. Biomechanical analysis categories judo movements into two main divisions, showing the complexity of gestures used in the sport. Though speed and velocity are often confused, they differ in biomechanics. Velocity includes both direction and speed, while speed only measures the amount. Biomechanical concepts like velocity, center of mass, kinetics, and kinematics are useful for assessing judo performance.

Six elite Indian male judokas, aged 18 to 25, were chosen based on their competition performance to participate in a study. Each judoka practiced the tomoe nage technique, receiving guidance and having two chances to perform it naturally. Their technique was recorded using a digital video camera set at 500 frames per second, and motion capture was employed for analysis. Kinovea software was used to analyze the recorded footage. The study applied Karl Pearson's correlation coefficient to examine the relationship between kinematical variables and the performance of the judokas, with a significance level set at 0.05.

he study examined the connection between kinematic factors and male judo performance using Pearson's correlation coefficient. It found a strong correlation for Kuzushi, a moderate one for Tsukuri, and a weak one for Kake. The results highlighted the significance of analyzing horizontal velocity in Tomoe Nage to enhance judo performance.

INTRODUCTION

Jigoro Kano invented judo in the early 1900s as amethod to build mental and physical strength. Judo frequently involves rigorous training sessions, demonstrating its importance to physical growth. As a sport, there are a variety of techniques that enable players to participate in combat in various ways. Kano has focused mostly on throwing techniques since he thought they were the most beneficial for spiritual and physical education. (Kano,1994)Kuzushi, tsukuri, and kake, which are simply defined as unbalancing, contact, and throw execution, respectively, are the different stages into which each of these throwing

techniques is further subdivided. Kano emphasized the important role of kuzushi, which usually happens first among the three phases, as a requirement to save strength and energy effectively. As a result, this phase has received a lot of attention. According to Kano's judo philosophy, the main idea behind using kuzushi is to put the opponent in a compromised position so the attacker can throw with little effort. Although the fundamental mechanics of kuzushi have not yet been thoroughly elucidated, their significance has been emphasized.

Judo is a sport that combines various grappling and throwing techniques that follow fundamental natural laws. According to the rules of physics, five primary elements significantly affect judo performance: the laws of motion, the base of support, the center of gravity and the concept of levers. Timing, stability, body anthropometry, equilibrium, leverage, inertia, speed and acceleration are all essential for success in judo.Sports can be categorized biomechanically based on technical and athletic gestures. There are innumerable permutations of the gestures and actions used in judo to describe a fighting method and the phases of battle. A generalization of movements and their division into two primary divisions is the outcome of the biomechanical analysis of approaches.

In everyday speech, speed and velocity are sometimes used interchangeably, although in biomechanical terminology, they have distinct meanings. The rate at which an object's position changes over time is called its velocity. Speed, being a scalar quantity, only accounts for magnitude, but velocity, being a measure of displacement, is a vector quantity, meaning it must consider both direction and magnitude. An object's velocity will be positive if it is travelling in an arrow-like direction. But if the object is travelling in the opposite direction (velocity), the velocity will likewise be negative. A shift in a body's velocity may indicate a change in its speed, direction of motion, or even both
It is possible to use biomechanical analyses across the duration of a particular throwing technique. Like other sports, biomechanical variables related to the human body or measures of these principles can be used to study performance. Velocity is one of the frequently measured variables in the context of performance.

- Velocity: Rate of change of position (Winter, 2005)
- Centre of mass: Point in the body where all of body’s mass is equally distributed (Floyd, 2014)
- Kinetics Study of the relationship between body and forces acting upon the body (Winter, 2005)
- Kinematics Description of motion independent of forces that cause movement (Winter, 2005)
- Kuzushi: Initial phase of a throw involving the unbalancing of the opponent (Kano, 1994)
- Tsukuri Phase, following kuzushi that the attacker assumes a position to execute a throw (Kano, 1994)
- Kake Final phase which the attacker executes the throw (Kano, 1994)

METHOD AND PROCEDURE

SELECTION OF SUBJECTS

Six judokas were selected as a sample: Indian elite male judokas who had represented the university at the All-India competition level were selected based on their performance in the preceding competition. The ages of all the subjects ranged from 18 to 25.

SELECTION OF VARIABLES

A sample of the university's top six Indian male judokas was selected. Every participant who was selected was requested to perform the tomoe nage as accurately and fully as possible. The judokas were prepared for the study, well-informed, and under good guidance. Each judoka was given two chances. As they performed, they received directions to do the tomoe nage naturally. The subjects were found to have an acceptable level of technique. As needed, players were filmed using a methodical filming technique. In this study, motion capture was used. A professional photographer utilized a digital video camera set to 250 frames per second to

capture the judokas doing the move. A digital video camera was positioned perpendicularly at a distance of 4 meters.

FILMING PROTOCOL

In this study, motion capture was used. A professional photographer used a digital video camera (500 frames per second) to capture the judokas performing the tomoe nage. After the recorded video was collected, Kinovea software version 0.9.4 was used for analysis. The Sony RX10 MK 4 camera was used to digitize the first video. The video data was calibrated during the digitization process. We get the results through makers and the stroboscopic effect from the calibrated video.

STATISTICAL TECHNIQUES

A statistical method known as Karl Pearson's product-moment correlation coefficient was used to compare the performance of male judokas with a few chosen kinematical characteristics. The significance level was set at 0.05 to verify the significance.

TABLE-1

Descriptive Statistics of horizontal velocity at tomoe nage of three steps.

SI.No.	Horizontal Velocity	Mean	SD
1.	Kuzushi	.665	.148
2.	Tsukuri	4.37	1.87
3.	Kake	5.80	2.95

The values of mean and standard deviation for all variables are shown in Table 1. These values may be used for further analysis in the study.

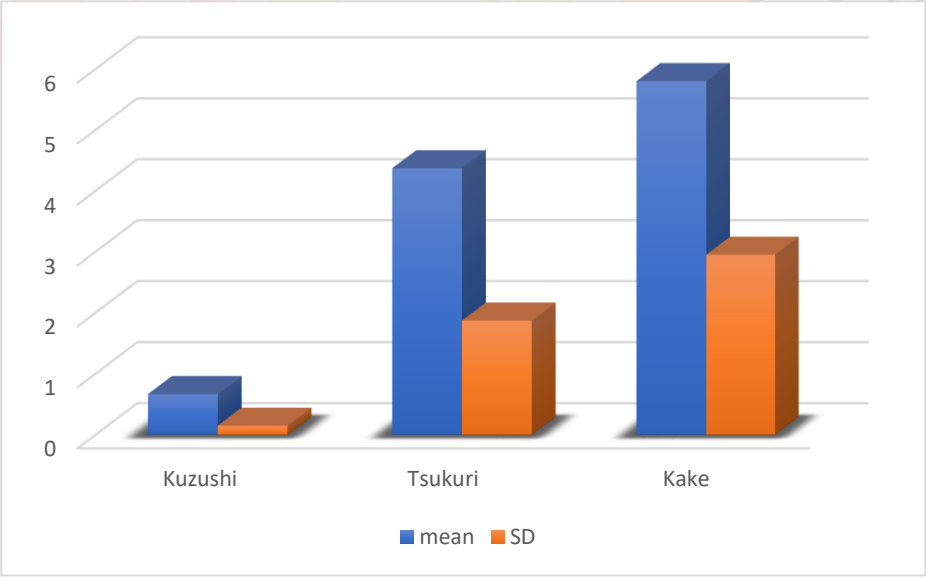

Figure 1: Graphical Presentation Shows the Mean and Standard Deviation of the Kinematic Variable at Tomoe Nage

TABLE-2

Correlation Coefficient of kinematic analysis of Horizontal Velocity at steps of Tomoe Nage with the performance of judokas

SI.No.	Horizontal Velocity	Mean	SD	Coefficients of correlation	r
1.	Kuzushi	.665	.148	1.00	1
2.	Tsukuri	4.37	1.87	.467	.808
3.	Kake	5.80	2.95	.200	.310

r’0.05(2) = 1
Significant at .05 level of significance

The r value was 1 The data does suggest that there is a significant relationship between Horizontal velocity of kake of tomoe nage with performance.

RESULT

The study used Karl Pearson’s product-moment correlation coefficient to investigate the link between certain kinematical variables and the performance of male judokas. The level of significance was set at 0. 05 for a thorough analysis of the correlation coefficients related to the horizontal velocity during different steps of Tomoe Nage. The descriptive statistics provided valuable insights for future research. The analysis showed a perfect positive correlation (1.00) for Kuzushi, a moderate correlation (.467) for Tsukuri, and a weak correlation (.200) for Kake, showing different levels of association with judokas' performance. The results confirmed a significant relationship at the 0. 05 level, especially between horizontal velocity of Kake in Tomoe Nage and judokas’ performance, emphasising the importance of kinematic analysis in improving performance in judo.

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