



P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (RJIF): 5.38
IJPESH 2022; 9(5): 130-134
© 2022 IJPESH
www.kheljournal.com
Received: 03-08-2022
Accepted: 28-09-2022

Sweety Gulia
Ph.D. Research Scholar,
Department of Physical
Education and Sports Sciences,
University of Delhi, New Delhi,
India

Dhananjay Shaw
HOD, DPESH, University of
Delhi, B-Block Vikas Puri, New
Delhi, India

Corresponding Author:
Sweety Gulia
Ph.D. Research Scholar,
Department of Physical
Education and Sports Sciences,
University of Delhi, New Delhi,
India

Two-dimensional biomechanical analysis of front kick and front toe kick of female national level taekwondo players

Sweety Gulia and Dhananjay Shaw

Abstract

Front kick and front toe kick are two of the important attacking skills in the game of taekwondo. Similar in outlook, but subtle differences exist between the two kicks, so far not reported in the literature. The primary objective of this study was to quantify the differences with the help of the kinematic variables using the methods of sports biomechanics. 2-D video graphic recording of the selected skills was performed on highly skilled female Taekwondo Players (Age:17 to 22 years; 55.5 ± 8.98 kilogram; 165.66 ± 6.43 centimeter). Subsequently, KINOVEA was used to analyze the footage after due processing such as digitizing and collaborating the videos. In the statistical analysis, descriptive statistics were calculated and furthermore, and a t-test was employed to evaluate the differences in the velocity variable between the selected kicks. The t-test revealed a significant difference in the kicking velocity between the front kick and the front toe kick. This suggests that different feedback should be given in order to develop each kicking skill. This further has implications for the training methods to be employed to develop one kick or the other.

Keywords: Front kick, front toe kick, kicking velocity, kicking kinematics, taekwondo

Introduction

Taekwondo (TKD) is a Korean martial art form that was originally taught for warfare, self-defence and physical fitness. In competition taekwondo, points are scored when contact to the torso or head produces a 'trembling shock'. With the opponent required to produce a 'trembling shock' for the acknowledgement of points, there have been many injuries caused^[1]. As a direct result of these high number of injuries chest protection and head protection are now required for participation in Kyorugi (fight)^[2].

Front Kick (ap chagi) is a very linear kick. The practitioner raises the knee to the waist, pulls the toes back and quickly extends the foot at the target. It is also known as the snap kick. The front kick is one of the first kicks learned in taekwondo; if mastered it can become one of the most powerful kick. This technique is meant to be used to push the attacker away, but can injure the opponent as well^[3].

Front Toe Kick is old-style martial arts kick was used in order to deliver a sharp narrow strike to soft vital targets such as the groin and abdomen. The toe kick is usually delivered like a front kick or roundhouse kick but with the toes as the striking surface. The toe kick is used by some traditional Karate styles and is known as Tsumasaki Geri. This type of kick is also practiced by a few other more traditional martial arts such as Kung Fu^[4].

Description and analysis of a sport technique constitute the fundamentals for the development of adequate technical training. They build on the laws and premises of biomechanics with the aim of enhancing sport performance^[5]. Such systematic use of biomechanics perspectives is of great importance in taekwondo, where a single strike might differentiate the winner from the non-winner. In taekwondo, where both explosive strength and velocity are relevant for performance, it is needed to analyse the execution technique by using reliable devices and by developing procedures that guarantee objective measurements and equal analysis of athlete's movements. Few studies have been conducted in same direction.^[6, 7, 8] Most studies have been conducting on male taekwondo players, while the kicking technique of female taekwondo players remains largely unexplored. Likewise, the objectives if this study were twofold.

Frist to describe both the techniques with the help of velocity variables. Second objective was to compare between two

dimensional front toe kick velocity and front kick velocity of national level female taekwondo players.



Fig 1: Front toe kick (A) and front kick (B)

Methodology

Data Collection

Six (6) female volunteers were randomly selected as subjects for the purpose of the study. All of them were regular participants in Taekwondo sport with at least national level games/sports participation as their achievement. The age of the subjects ranged from 17 to 22 years, the weight of the subject was 55.5 ± 8.98 kilograms and height was 165.66 ± 6.43 centimetres at least each participant was with of three years' experience of taekwondo practice. Each subject had performed technique namely front kick and front toe kick for ten repetitions each, which was recorded with a video camera using two dimensional methods independently.

Video Recording Protocol

The distance between subject and camera was 330 centimetres. The camera was placed 70 centimetres above the ground for recording the techniques.

Protocol of 2D Analysis

For analysing the videos KINOVEA 0.8.21 was used. Total time taken to perform each repetition was taken in seconds.

Separate time was taken for each repetition in different internal clocks of KINOVEA [9].

Analysis of the Data

Keeping in view the objectives of the study, feasibility, and natures of the selected variables the statistical techniques employed were mean, standard deviation and t-test. The hypothesis was tested at 0.5 level of significance.

Results

Table 1: Repetition Wise Front Kick Velocity (FKV)

S.no	Subject	Velocity (m/s) of each Repetitions										SD
		1	2	3	4	5	6	7	8	9	10	
1	Sub 1	5.33	4.81	4.93	4.83	4.81	4.3	4.6	4.96	4.38	4.1	0.37
2	Sub 2	6.21	5.37	5.05	5.8	5.67	4.71	5.08	5.04	5.09	5.52	0.45
3	Sub 3	3.96	4.31	5.44	5.23	4.47	4.86	6.05	4.84	4.81	4.32	0.62
4	Sub 4	5.22	5.65	5.3	5.35	5.75	4.57	4.82	5.07	5.65	4.9	0.4
5	Sub 5	6.09	4.38	4.79	5.08	5.08	4.98	3.96	5.07	4.45	4.6	0.58
6	Sub 6	4.95	4.73	4.69	4.66	4.63	4.58	4.07	4.5	4.14	4.12	0.3

N = 6; Repetitions = 10

Table 2: Descriptive statistics of front kick

Repetitions	N	Velocity (m/s) Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum
					Lower Bound	Upper Bound	
One	6	5.3	0.83	0.34	4.44	6.16	3.96
Two	6	4.88	0.54	0.22	4.32	5.44	4.31
Three	6	5.04	0.3	0.12	4.73	5.34	4.69
Four	6	5.16	0.41	0.17	4.74	5.59	4.66
Five	6	5.07	0.54	0.22	4.51	5.64	4.47
Six	6	4.67	0.25	0.1	4.42	4.92	4.3
Seven	6	4.77	0.77	0.32	3.97	5.57	3.96
Eight	6	4.92	0.23	0.1	4.69	5.15	4.5
Nine	6	4.76	0.56	0.23	4.18	5.34	4.14
Ten	6	4.6	0.55	0.23	4.02	5.17	4.1
Total	60	4.92	0.54	0.07	4.78	5.05	3.96

Rounded to two digits after the decimal

Table 2 shows the descriptive statistics of the front kick for each repetition of kicking including all the selected

participants.

Table 3: Comparison among the repetitions of front kick velocity

	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	2.734	9	0.304	1.088(NS)	0.388
Within Groups	13.964	50	0.279	-	-
Total	16.697	59	-	-	-

DF = degree of freedom, F = F-ratio, NS = Not significant

According to table – III, the comparison among the repetitions of front kick velocity was insignificant, F (9,59)=1.088,

$p = .05$.

Table 4: Repetition wise front toe kick velocity (FTKV)

S. No	Subject name	Repetition wise front toe kick velocity (FTKV)									
		1	2	3	4	5	6	7	8	9	10
	Sub 1	6.96	8.42	8.45	7.79	6.7	7.35	7.05	7.23	7.07	7.26
1	Sub 2	6.45	6.38	7.62	8.39	7.26	7.27	7.05	7.47	7.42	7.4
2	Sub 3	8.87	8.23	8.14	7.11	7.25	8.37	8.41	7.35	8.02	7.68
3	Sub 4	6.382	8.1	8.76	8.53	7.52	6.97	5.04	7.14	6.59	6.64
4	Sub 5	6.36	7.36	6.68	6.8	7.22	6.97	5.04	7.14	6.59	6.64
5	Sub 6	6.36	7.36	6.68	6.8	7.22	6.97	5.04	7.14	6.59	6.64
6	Sub 7	6.52	6.67	5.18	6.45	6.32	6.41	5.66	6.9	6.02	5.93

N =6; Repetitions = 10, m/s = meter per second

Table 5: Descriptive statistics front toe kick

Repetitions	N	Velocity (m/s) Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
One	6	7	0.95	0.39	6.01	7.99
Two	6	7.53	0.86	0.36	6.63	8.43
Three	6	7.48	1.34	0.55	6.07	8.88
Four	6	7.52	0.86	0.36	6.62	8.42
Five	6	7.05	0.45	0.19	6.58	7.52
Six	6	7.24	0.65	0.27	6.56	7.92
Seven	6	6.85	1.29	0.53	5.5	8.19
Eight	6	7.44	0.57	0.24	6.84	8.04
Nine	6	7.15	0.75	0.31	6.37	7.94
Ten	6	7.05	0.65	0.27	6.37	7.72
Total	60	7.23	0.85	0.11	7.01	7.45

N = number of samples, m/s= meter per second; Rounded to two digits after the decimal

Table 6: Comparison among the Repetitions of Front Toe Kick Velocity

	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	3.293	9	0.366	.474(NS)	0.885
Within Groups	38.598	50	0.772	-	-
Total	41.891	59	-	-	-

DF= degree of freedom, F = F-ratio, NS= non-significant at 0.5 level

According to table – VI, the comparison among the repetitions of front toe kick velocity was non-significant

(F=.474) at 0.5 level of significance.

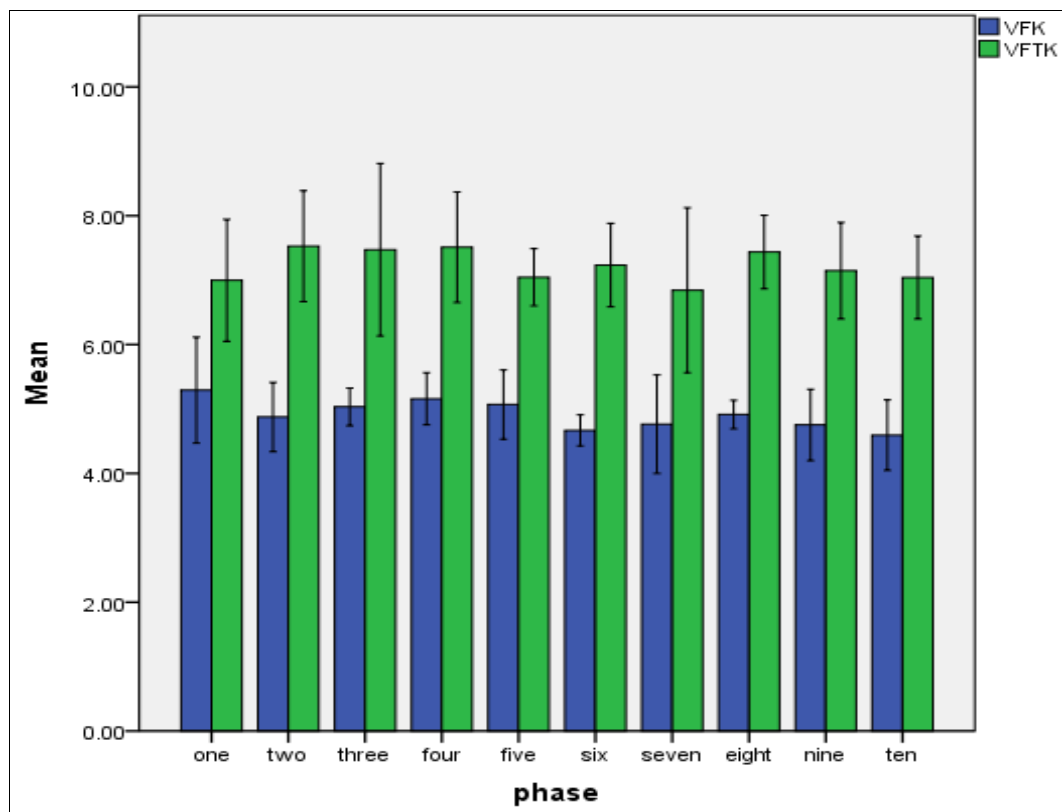


Fig 2: Comparison between means of front kick velocity and front toe kick velocity

Table 7: Comparison between Front Kick Velocity and Front Toe Kick Velocity

Repetition	Independent Samples Test								
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	DF	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
One	0.246	0.631	-7.103*	10	.000	-2.449	0.345	-3.217	-1.681
Two	0.639	0.443	-6.302*	10	.000	-2.394	0.38	-3.24	-1.548
Three	1.584	0.237	-10.117*	10	.000	-2.524	0.25	-3.08	-1.968
Four	1.76	0.214	-3.417*	10	0.007	-2.08	0.609	-3.437	-0.724
Five	1.701	0.221	-9.104*	10	.000	-2.567	0.282	-3.195	-1.939
Six	0.306	0.592	-6.941*	10	.000	-1.977	0.285	-2.612	-1.343
Seven	6.746	0.027	-6.078*	10	.000	-2.354	0.388	-3.216	-1.491
Eight	6.986	0.025	-4.359*	10	0.001	-2.439	0.56	-3.685	-1.192
Nine	2.939	0.117	-6.410*	10	.000	-2.652	0.414	-3.574	-1.731
Ten	0.015	0.906	-3.330*	10	0.008	-1.704	0.512	-2.844	-0.564
Total	8.199	0.005	-17.983*	118	.000	-2.314	0.129	-2.569	-2.059

F= frequency, DF= Degree of freedom, *= significance at 0.05 level; Rounded to three digits after the decimal

According to table VII, there was a non-significance difference between front kick and front toe kick velocity in repetition one ($t = -7.103$), between front kick and front toe kick in repetition two ($t = -6.302$), between front kick and front toe kick in repetition three ($t = -10.117$), between front kick and front toe kick in repetition four ($t = -3.417$), between front kick and front toe kick in repetition five ($t = -9.104$), between front kick and front toe kick in repetition six ($t = -6.941$), between front kick and front toe kick in repetition seven ($t = -6.078$), between front kick and front toe kick in repetition eight ($t = -4.359$), between front kick and front toe kick in repetition nine ($t = -6.410$), between front kick and front toe kick in repetition ten ($t = -3.330$), between front kick and front toe kick in total ($t = -17.983$), at 0.05 level of significance.

Discussion

The front toe kick is one of the kicks that taekwondo players use from their repertoire of skills to deal a soft blow to the opponent. This technique uses one leg as support and other leg as support while the other leg is free to probe the opponent when the opportunity presents. The motion begins when flexing the hip and knee in chorus. Through the way the knee is extended as you reach the opponent with the toe.

Since the participants of this study were highly skilled, least differences were noted the inter-subject and intra-subject standard deviation was minimal. Approving that since the participants of this study were highly skilled taekwondo players there was also a minimal difference in their kicking velocity. The average velocity of participants for the front kick was 4.91 m/s, while the average velocity of the participants was found to be 7.23 m/s for toe kick velocity. The velocity of female taekwondo players in one study was higher than our athletes at 8.51 m/s, this could be attributed to increased level of training of the participants in their study^[10]. Also it is clear that gender differences exist in kicking velocity of taekwondo players as a number of studies demonstrated higher kicking velocity of men compared to females^[8, 10].

In order to compare between the front kick and front toe kick a t-test was employed. T-test showed significant difference across all the repetitions in the variable namely velocity of kicking (refer to table VII). The two kicking techniques although similar in outlook are very different when it comes to the velocity of kicking. It is quite evident that the velocity

of front toe kick is significantly higher than the front kick (see figure 1), however front kick is a more powerful kicking technique which can deal damage to the opponent while the front toe kick is a soft strike at the opponent to push him/away and out of reach to make a counteroffensive. No studies have compared the two kicks so far to the best of our knowledge so there is no comparable literature in this regard. It is therefore suggested similar studies be carried out in this regard with higher sample size to quantify the kinematics of kicking velocity of female taekwondo players possibly with high resolution camera system.

In addition, studies have shown that the velocity of the kick can change depending upon the environment a player is in, such as when you are aiming at a target, or aiming at a dummy which can change the nature of the kicking technique in terms of kinematics [11]. It is suggested that kicking techniques should be captured in a more realistic setting so that the true nature of kicking in taekwondo is unfolded.

Conclusions

- Front kick and front toe kick has been sufficiently described in term of velocity.
- Front kick and front toe kick technique are significantly different in velocity in each repetition and as a whole.
- The front toe kick was found to have higher velocity in each repetition and as a whole than that of front kick.

References

1. Zemper ED, Pieter W. Injury rates during the 1988 U.S. Olympic team trials for Taekwondo. International Institute for Sport and Human Performance, University of Oregon; c1989.
2. Kazemi M, Chudolinski A, Turgeon M, Simon A, Ho E, Coombe L. Nine year longitudinal retrospective study of Taekwondo injuries. J Can Chiropr Assoc. 2009;53(4):272-281.
https://en.wikipedia.org/wiki/List_of_Taekwondo_techniques#Kicks_.28Chagi.29
<http://www.blackbeltwiki.com/toe-kick>
3. Shaw D, Mechanical Basis of Biomechanics, Sports Publication; c2007.
4. Gavagan, Colin J, Mark GL Sayers. A biomechanical analysis of the roundhouse kicking technique of expert practitioners: A comparison between the martial arts disciplines of Muay Thai, Karate, and Taekwondo. PloS one. 2017 Aug 25;12(8):e0182645.

doi:10.1371/journal.pone.0182645

5. Estevan I, Alvarez O, Falco C, Molina-García J, Castillo I. Impact force and time analysis influenced by execution distance in a roundhouse kick to the head in taekwondo. *J Strength Cond Res.* 2011;25(10):2851-2856. doi:10.1519/JSC.0b013e318207ef72
6. Kim YK, Kim YH, Im SJ. Inter-joint coordination in producing kicking velocity of taekwondo kicks. *J Sports Sci Med.* 2011;10(1):31-38. Published 2011 Mar 1. <https://www.kinovea.org/>
7. Wasik J, Ortenburger D, Gora T. Studies of kicking of three targets – does sex differentiate the velocity of the taekwondo front kick? *Baltic Journal of Health and Physical Activity,* 2022, 11(1). doi:10.29359/BJHPA.11.1.08
8. Wąsik Jacek, Tomasz Góra. Impact of target selection on front kick kinematics in taekwondo – pilot study; c2016.