

## Forces Impulse of Body Parts as Function for Prediction of Total Impulse and Performance Point of Ippon Seoi Nage Skill in Judo

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**Abstract:** The research aims to recognize contribution percentage of forces impulse of body parts in total impulse for center of gravity (CG.) and performance point to Ippon Seoi Nage (I.S.G.) skill, research sample was selected purposely, it included 7 players of 17- 20 years, the researcher used (3D) video recording system using two Panasonic video cameras of light resource with frequency of 25 field/sec. dynamic analysis using Win analyze system and Jury arbitration, of the most important results gained by the researcher was contribution percentage of selected variables in total impulse for of (CG.) and performance point of the skill under discussion, the most important conclusions was that contribution rate at Kuzushi phase is the resultant of trunk impulse and the resultant of right thigh impulse and at Tsukuri phase, the resultant of trunk and thighs impulse was the highest contribution rate in the resultant of total impulse for (CG.), while performance time and the resultant of left thigh impulse were the highest contribution percentage at Kake phase, the resultant of right and left thighs impulse at Tsukuri phase and both the resultant of trunk and right thigh impulse during the Kuzushi phase had the highest contribution percentage in performance point of (I.S.G.) skill, performance point could be predicted by the following equation: Performance point of (I.S.G.) skill = (7.32) - 2.38 (skill performance time) - 0.06 (the resultant of right thigh impulse during the Kuzushi phase) + 0.056 (the resultant of trunk impulse during the Kuzushi phase) + 0.08 (the resultant of left thigh impulse during the Tsukuri phase) - 0.43 (the resultant of right thigh impulse during the Tsukuri phase) + 0.138 (the resultant of trunk impulse during the Tsukuri phase).

**Keys words:** Impulse • Centre of gravity of the body • Judo • Ippon Seoi Nage

### INTRODUCTION

CG. of body mass is the point of effectiveness of the resultant of gravity forces affecting all body parts [1-3]. In order to determine (CG.) it is necessary to identify the resultant of moments of forces of body parts by the following equations:  $T_{seg} = F_{seg} \times d_{seg}$   $\Sigma T_{seg} = \Sigma (F_{seg} \times d_{seg})$   $TCG = FR \times dCG$

As:  $T_{seg}$  is the moment of force of the bodily part,  $F_{seg}$  is the weight of bodily part,  $d_{seg}$  is the farness of bodily part off the axis and  $FR$  is body weight [4].

Al-Sumaida'ie [5] mentioned that if several forces had an impact simultaneously, it is important to identify impulse of these forces in order to understand muscular work circumstance completely, as it express mechanical value of forces impact on the body in a specific time and the resultant of these forces impulse

equals the resultant of these forces at the time of its impact, as:  $I = f \times t$ ,  $\Sigma I = \Sigma (f \times t)$ .

$I$  is forces impulse,  $F$  is force and  $T$  is time of force impact.

Judo sport is one of the sports that require accurate technical performance that needs special dynamic potentials and requirements that depend on scientific principles and bases, with which it requires dynamic harmonious responses gradually acquired until it shows in a dynamic conduct that is characterized by harmony and agility with husbanding effort and time necessary for performance [6].

I.S.G. skill is one of the hand skills (Te Waza), as through a questionnaire that was conducted by Shoukry [7], this skill attained the highest proportional importance of hand skills for judo beginners, as it's of the basic skills on which the coach depend in Judo sport. By reviewing

previous and related studies in the field of Judo sport that could be reached, the researcher found that there was a nonfeasance on mechanical studies that concerned in studying I.S.G. skill despite its importance, as the rules grant it the complete point (Ippon), if the player mastered this skill, it enables him to end the game in his favor at the fastest time and the least effort, this was motive of the researcher to conduct this study, that aims to identify contribution rate of forces impulse of player's body parts in the total impulse of C.G of body mass on performing I.S.G. skill, as well as, contribution rate of forces impulse of player's body parts in performance point of I.S.G. skill in Judo.

**MATERIALS AND METHODS**

Research sample was selected purposely from the best Judo player at Port Said Club and Military Organization, who achieved advanced ranks at the Republic championships, they were 7 players, each player performed three attempts of the technique under discussion, the best attempt was selected. Research sample specifications are shown in Table 1.

**Data Collection Tools:** The Researcher used the following tools for data collection:

**1- (3D) Video Recording:** Recoding took place at the covered hall, Physical Education Faculty, Port Said, Port Said University, using 2 Panasonic video cameras of light resource with frequency of 25 field/sec. the researcher considered all conditions and procedures mentioned for video recording [8](Fig.1).

**Dynamic Analysis:** Analysis was conducted by using video recording, computer and printer using Win analysis at biomechanics laboratory at the Faculty of Physical Education, Port Said, Port Said University, whereas performance of research sample individuals was analyzed from the beginning of skill performance to its end,

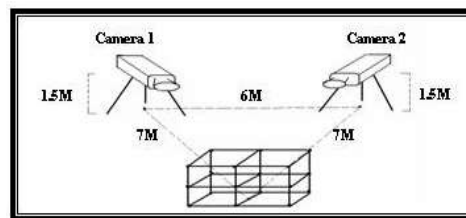


Fig. 1: Diagram shows positions of the two cameras and modulation appliance during recording process

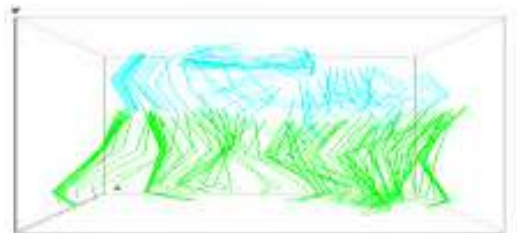


Fig. 2: Consecutive Shots of the Player Who Achieved the Highest Degree in Performing Ippon Seoi Nage skill



Fig. 3: Model of Technical Steps for Performing Ippon Seoi Nage skill

researcher used the resultant of forces impulse of body parts and C.G during skill performance phases under discussion (Fig. 2-4).

**Statistical Treatment:** The researcher used statistical package for the social sciences (SPSS) through computer, using logic analysis of regression, arithmetic mean, standard deviation and torsion modulus.

Table 1: Arithmetic mean, standard deviation, minimum, maximum, extent and torsion modulus in age, height, weight and training age of research sample members (n= 7)

Measures	Unit	-x	S D	Minimum	Maximum	Extent	Torsion modulus value
Age	Year	18.43	0.97	17.00	20.00	3.00	0.28
Height	CM	177.00	3.96	172.00	182.00	10.00	0.14
Weight	Newton	75.14	2.79	71.00	79.00	8.00	-0.01
Training age	Year	9.00	1.15	8.00	11.00	3.00	0.91
Referees degree	Point	8.75	.72	7.75	9.5	1.75	.43

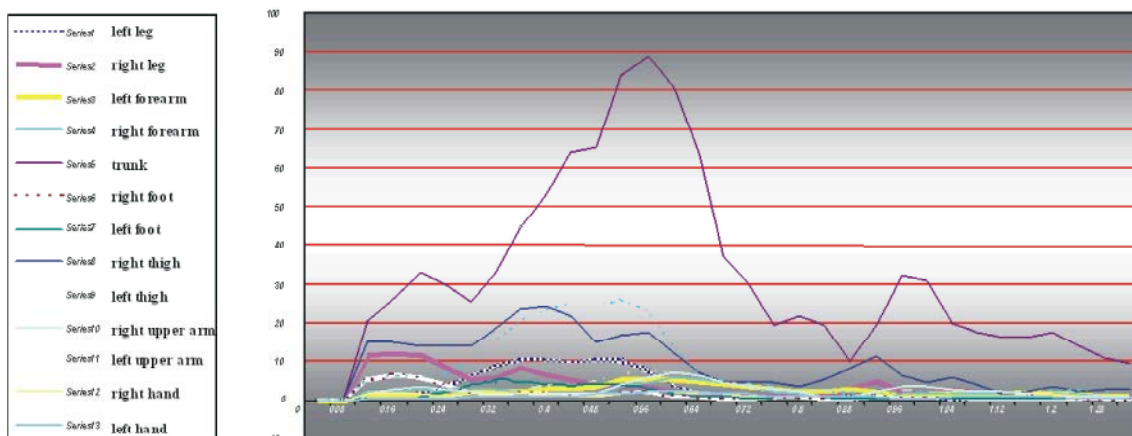


Fig. 4: Model of the curves of forces impulse of player's body parts who achieved the highest degree in performing Ippon Seoi Nage technique

**RESULTS AND DISCUSSION**

Through what has been displayed in the tables from 2 to 10, the high rate of the contribution of both trunk and two thighs through the phases of motor performance of (I.S.G.) skill. The player at the Kuzushi phase assumes the

natural right stance (Migi Shizen-tai) by putting his right foot opposite the defender's right foot (uki), then pulling the defender forward and to the right side of the defender and the attacker stands on insteps, as the highest contribution of the trunk and right thigh appeared at this phase [9-11]. For the success of this part of the skill,

Table 2: Outputs of the statistically significant matrix of simple correlation of spearman among the resultants of forces impulse of upper and lower limbs parts, performance time and the resultant of total impulse of C.G during performance phases of Ippon Seoi Nage technique n = 7

Statistically significant variables				
No.	First variable	Second variable	"r"	Phase
1	I.R. (Trunk)	I.R C.G	0.98***	Kuzuchi
2	I.R (left forearm)	Performance time	-0.90***	Kuzushi
3	I.R (left hand)	Performance time	-0.87**	Kuzushi
4	I.R (left forearm)	I.R (left upper arm)	0.71*	Kuzushi
5	I.R (left hand)	I.R (left upper arm)	0.69*	Kuzushi
6	I.R (right forearm)	I.R (right hand)	0.79*	Kuzushi
7	I.R (left forearm)	I.R (left hand)	0.98***	Kuzushi
8	I.R (trunk)	I.R C.G	0.95***	Tsukuri
9	I.R (right upper arm)	I.R (left upper arm)	0.86**	Tsukuri
10	I.R (right upper arm)	I.R (right forearm)	0.70*	Tsukuri
11	I.R (right upper arm)	I.R (left forearm)	0.68*	Tsukuri
12	I.R (right upper arm)	I.R (right hand)	0.91***	Tsukuri
13	I.R (right upper arm)	I.R (left hand)	0.85**	Tsukuri
14	I.R (left upper arm)	I.R (right forearm)	0.86**	Tsukuri
15	I.R (left upper arm)	I.R (left forearm)	0.91***	Tsukuri
16	I.R (left upper arm)	I.R (right hand)	0.89***	Tsukuri
17	I.R (left upper arm)	I.R (left hand)	0.98***	Tsukuri
18	I. R (right forearm)	I.R (left forearm)	0.89***	Tsukuri
19	I. R (right forearm)	I.R (right hand)	0.90***	Tsukur
20	I. R (right forearm)	I.R (left hand)	0.84**	Tsukuri
21	I.R. (left forearm)	I.R (right hand)	0.80**	Tsukuri
22	I.R. (left forearm)	I.R (left hand)	0.94***	Tsukuri
23	I.R. (Trunk)	I.R C.G	0.87**	Take
24	I.R (right forearm)	Performance time	-0.76*	Take
25	I.R (left forearm)	Performance time	-0.96***	Take
26	I.R (left hand)	Performance time	-0.80*	Take
27	I.R (right upper arm)	I.R (left upper arm)	-0.85**	Take
28	I.R (right upper arm)	I.R. (right hand)	0.74*	Take
29	I.R (left forearm)	I.R. (left forearm)	0.71*	Take
30	I.R. (left forearm)	I.R. (left hand)	0.86**	Take
31	I.R. (left foot)	I.R.C.G	0.76*	Kuzushi

Table 2: Continued

No.	Statistically significant variables		"r"	Phase
	First variable	Second variable		
32	I.R. (right thigh)	I.R. (right leg)	0.78*	Kuzushi
33	I.R. (right thigh)	I.R. (right foot)	0.70*	Kuzushi
34	I.R. (left thigh)	I.R. (left leg)	0.85**	Kuzushi
35	I.R. (left thigh)	I.R. (left foot)	0.80*	Kuzushi
36	I.R. (right leg)	I.R. (left leg)	-0.73*	Kuzushi
37	I.R. (right leg)	I.R. (right foot)	0.96***	Kuzushi
38	I.R. (left leg)	I.R. (right foot)	-0.68*	kuzushi
39	I.R. (left leg)	I.R. (right foot)	0.83**	Kuzushi
40	I.R. (right thigh)	I.R. C.G	0.92***	Tsukuri
41	I.R. (right thigh)	I.R. (right leg)	0.77*	Tsukuri
42	I.R. (left thigh)	I.R. (left leg)	0.94***	Tsukuri
43	I.R. (left thigh)	I.R. (left foot)	0.90***	Tsukuri
44	I.R. (right leg)	I.R. (right foot)	0.83**	Tsukuri
45	I.R. (left leg)	I.R. (left foot)	0.97***	Tsukuri
46	I.R. (left thigh)	I.R. C.G	-0.72*	Take
47	I.R. (left foot)	I.R. C.G	0.75*	Take
48	I.R. (right thigh)	I.R. (right leg)	0.85**	Take
49	I.R. (left thigh)	I.R. (left leg)	0.79*	Take

\* sig. (0.05)\*\* sig (0.01)\*\*\* sig (00.00) (I.R.) impulse resultant

Table 3: Outputs of last step of logic analysis of Step-Wise Regression (SWR) of forces impulse of body's upper limb parts and performance time on the resultant of total impulse of C.G during Kuzushi phase

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage %
Fixed amount	--	-46.58	--	--	--	-
Performance time	Sec.	194.85	--	--	--	0.7
Trunk impulse resultant	Newton.sec.	1.16	--	--	--	96.40
Right upper arm impulse resultant	Newton.sec.	-4.07	--	--	--	0.70
Left upper arm impulse resultant	Newton.sec.	0.034	--	--	--	0.50
Right forearm impulse resultant	Newton.sec.	-0.98	--	--	--	0.10
Left forearm impulse resultant	Newton.sec.	53.09	--	--	--	1.60
Total						100%

The resultant of total impulse of C.G during Kuzushi phase = 46.58 + 194.85 (performance time) + 1.16 (trunk impulse resultant) - 4.07 (right upper arm impulse resultant) + 0.034 (left upper arm impulse resultant) - 0.98 (right forearm impulse resultant) + 53.09 (left forearm impulse resultant)

Table 4: Outputs of last step of logic analysis of SWR of forces impulse of body's upper limb parts and performance Time on the Resultant of Total Impulse of C.G during Tsukuri Phase n = 7

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage %
Fixed amount	--	137.89	--	--	--	-
Performance time	Sec.	-247.62	--	--	--	31.00
Trunk impulse resultant	Newton.sec.	1.08	--	--	--	60.70
Right upper arm impulse resultant	Newton.sec.	10.16	--	--	--	4.30
Left upper arm impulse resultant	Newton.sec.	-11.28	--	--	--	---
Right forearm impulse resultant	Newton.sec.	42.41	--	--	--	3.70
Left forearm impulse resultant	Newton.sec.	11.10	--	--	--	0.30
Total						100%

The resultant of total impulse of C.G during Tsukuri phase = 137.89 - 247.62 (performance time) + 1.08 (trunk impulse resultant) + 10.16 (right upper arm impulse resultant) - 11.28 (left upper arm impulse resultant) + 42.41 (right forearm impulse resultant) + 11.10 (left forearm impulse resultant)

Table 5: Outputs of Last Step of Logic Analysis of SWR of Forces Impulse of Body's Upper Limb Parts and Performance Time on the Resultant of Total Impulse of C.G during Kake Phase n = 7

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage %
Fixed amount	--	272.69	--	--	--	-
Performance time	Sec.	-186.86	--	--	--	23.30
Trunk impulse resultant	Newton.sec.	1.05	--	--	--	53.00
Right upper arm impulse resultant	Newton.sec.	-3.27	--	--	--	1.70
Left upper arm impulse resultant	Newton.sec.	23.29	--	--	--	0.30
Right forearm impulse resultant	Newton.sec.	-32.88	--	--	--	10.70
Left forearm impulse resultant	Newton.sec.	-68.65	--	--	--	11.00
Total						100%

The resultant of total impulse of C.G during Kake phase = 272.69 - 186.86 (trunk impulse resultant) + 1.05 (performance time) - 3.27 (right upper arm impulse resultant) + 23.29 (left upper arm impulse resultant) - 32.88 (right forearm impulse resultant) - 68.65 (left forearm impulse resultant)

Table 6: Outputs of Last Step of Logic Analysis of SWR of Forces Impulse of Body's Lower Limb Parts on the Resultant of Total Impulse of C.G during Kuzushi Phase n = 7

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage %
Fixed amount	--	19.33	--	--	--	-
Right thigh impulse resultant	Newton.sec.	-11.23	--	--	--	33.6
Left thigh impulse resultant	Newton.sec.	13.16	--	--	--	17.3
Right leg impulse resultant	Newton.sec.	7.73	--	--	--	7.00
Left leg impulse resultant	Newton.sec.	-26.82	--	--	--	22.7
Right foot impulse resultant	Newton.sec.	25.74	--	--	--	10.1
Left foot impulse resultant	Newton.sec.	37.09	--	--	--	9.3
Total						100%

The resultant of total impulse of C.G during Kuzushi phase = 19.33 - 11.23 (right thigh impulse resultant) + 13.16 (left thigh impulse resultant) + 7.73 (right leg impulse resultant) - 26.82 (left leg impulse resultant) + 25.74 (right foot impulse resultant) + 37.09 (left foot impulse resultant)

Table 7: Outputs of Last Step of Logic Analysis of SWR of Forces Impulse of Body's Lower Limb Parts On the Resultant of Total Impulse of C.G during Tsukuri Phase n = 7

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage %
Fixed amount	--	-105.66	--	--	--	-
Right thigh impulse resultant	Newton.sec.	24.86	--	--	--	45.8
Left thigh impulse resultant	Newton.sec.	40.21	--	--	--	37.9
Right leg impulse resultant	Newton.sec.	-242.90	--	--	--	8.3
Left leg impulse resultant	Newton.sec.	3.44	--	--	--	5.4
Right foot impulse resultant	Newton.sec.	243.19	--	--	--	0.4
Left foot impulse resultant	Newton.sec.	-143.83	--	--	--	2.20
Total						100%

The resultant of total impulse of C.G of body mass during Tsukuri = -105.66 + 24.86 (right thigh impulse resultant) + 40.21 (left thigh impulse resultant) - 242.90 (right leg impulse resultant) + 3.44 (left leg impulse resultant) + 243.19 (right foot impulse resultant) - 143.83 (left foot impulse resultant)

Table 8: Outputs of Last Step of Logic Analysis of SWR of Forces Impulse of Body's Lower Limb Parts On the Resultant of Total Impulse of C.G during Kake Phase n = 7

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage%
Fixed amount	--	35.07	--	--	--	-
Right thigh impulse resultant	Newton.sec.	-2.34	--	--	--	2.3
Left thigh impulse resultant	Newton.sec.	4.88	--	--	--	51.7
Right leg impulse resultant	Newton.sec.	-2.83	--	--	--	0.8
Left leg impulse resultant	Newton.sec.	-24.27	--	--	--	20.3
Right foot impulse resultant	Newton.sec.	4.25	--	--	--	18.8
Left foot impulse resultant	Newton.sec.	44.35	--	--	--	6.1
Total						100%

The resultant of total impulse of C.G of body mass during Tsukuri = 35.7 - 2.34 (right thigh impulse resultant) + 4.88 (left thigh impulse resultant) - 2.83 (right leg impulse resultant) - 24.27 (left leg impulse resultant) + 4.25 (right foot impulse resultant) + 44.35 (left foot impulse resultant)

Table 9: Simple Correlation Matrix of Spearman among the Most Contributing Body's Parts in Total Impulse of C.G and Performance Point of (I.S.G.) skill n=7

Variables	Performance Point	Performance Time	I.R. of Right Thigh at Kuzushi Phase	I.R of Trunk at Kuzushi Phase	I.R of Left Thigh at Tsukuri Phase	I.R of Right Thigh at Tsukuri Phase	I.R Trunk at Tsukuri Phase	Main Phase Time	I.R of Left Thigh at Kake Phase
Total Performance Point									
Performance Time	-0.50								
I.R. of Right Thigh at Kuzushi Phase	0.52	0.05							
I.R of Trunk at Kuzushi Phase	0.22	0.11	0.58						
I.R of Left Thigh at Tsukuri Phase	0.68*	-0.22	0.28	-0.24					
I.R of Right Thigh at Tsukuri Phase	0.69*	-0.47	0.04	-0.29	0.67*				
I.R Trunk at Tsukuri Phase	0.74*	-0.35	0.09	-0.28	0.69*	0.97***			
Main Phase Time	-0.93**	0.34	-0.70*	-0.43	-0.69*	-0.45	-0.50		
I.R of Left Thigh at Kake Phase	-0.76*	0.44	-0.39	-0.10	-0.88**	-0.51	-0.47	0.84**	

(\*) sig at (0.05) (\*\*) sig at (0.01)(\*\*\*) sig at (00.00) (I.R.) impulse resultant

Table 10: Last Step of logic analysis of SWR of the most contributing body's parts in total impulse of C.G on performance point of (I.S.G.) skill n = 7

Manifest	Unit	Partial Regression Modulus	Standard Error	Computed t	Sig.	Contribution Percentage%
Fixed amount	--		--	--	--	-
Performance time	Sec.	7.32	--	--	--	25.4
Right thigh impulse resultant at Kuzushi	. Newton.sec.	-2.38	--	--	--	29.4
Trunk impulse resultant at Kuzushi	Newton.sec.	-0.06	--	--	--	32.2
Left thigh impulse resultant at Tsukuri	Newton.sec.	0.056	--	--	--	
Right thigh impulse resultant at Tsukuri	Newton.sec.	0.08	--	--	--	13.00
Trunk impulse resultant at Tsukuri	Newton.sec.	-0.43	--	--	--	
Total		0.138				100%

Performance point of (I.S.G.)technique = (7, 32) - 2.38 (performance time) - 0.06 (right thigh impulse resultant during Kuzushi) + 0.056 (trunk impulse resultant during Kuzushi) + 0.08 (left thigh impulse resultant during Tsukuri) - 0.43 (right thigh impulse resultant during Tsukuri) + 0.138 (trunk impulse resultant during Tsukuri)

the consistency and conformity of the player's body parts are a necessity, which all work on achieving the motor duty of this phase, which is unbalancing of the opponent. The trunk occupies about 50% of the weight of the whole body according to the experiments of the scientists (Fischer and Brown). The C.G of the player's body mass lies in a place so close to the trunk, so its impact appeared clearly on the C.G. Yusuf and Al-Sioufi [12] pointed out that 65% of the requirements for obtaining a full point in judo is the ability and that the amount of movement resulting from the trunk is very large, as  $M = 50\% (m) \times V$ , where (M) is the amount of heat and (m) is the movement and (v) is the body velocity. This is consistent with what was reported in previous studies [13, 14] that the impulse of any force to the body during a period of time is equal to the change occurred in the amount of movement of the body in that period. By increasing momentum of the trunk, the total momentum of the center of body weight increases.

During the phase of tsukuri, the offensive player (tori) begins to leave the right hand grasping the suit collar of the defender (uki) to settle around the defender's right upper arm with the body rotation so that the left foot settles next to the right and with the width of pelvis and the buttocks is bottom of the defender's belt and the striker's back is fully straight. Thus, the main role of the motor transition appears at this stage between the thighs and trunk. Results of other researches [15-17] pointed out that the movement transfers from the thighs smoothly to the trunk to prepare the player to throw the opponent strongly. It is one of the basic requirements for this part of the skill which is in agreement with what was reported by previous studies [18, 19]. Then, the player stretches his feet in the phase of kake and turnover of the face in the direction of throwing, which is at the maximum speed in less time, where all forces in the two previous phases turn to serve the motor duty at this stage that should be

performed in a flow without cut in performance. That is consistent with what reported by other researches [15,17, 20], in that the change required in the speed of performance is not done only if there is the power necessary for this change as well as providing the right time, which leads to the flow in performance and not to be cut [16, 18, 19]

### CONCLUSION

- The highest rate of contribution to the variables of the upper and lower limbs in the resultant of total impulse of C.G during Kuzushi phase was the resultant of the trunk impulse and the resultant of the right thigh.
- The highest rate of contribution to the variables of the upper and lower limbs in the resultant of total impulse of C.G of body mass during Tsukuri phase was the resultant of the trunk impulse and the resultant of the thighs impulse.
- The highest rate of contribution to the variables of the upper and lower limbs in the resultant of total impulse of C.G of body mass during Kake phase was the performance time and the resultant of the left thigh impulse.
- The highest rate of contribution to the variables of the upper and lower limbs in the performance degree of (I.S.G.) skill was the resultant of both left and right thighs during Tsukuri followed by the trunk and thigh resultant during Kuzushi.
- The performance degree of (I.S.G.) skill = 7.32-2.38 (performance time)- 0.06 (resultant of the right thigh impulse during Kuzushi )+ 0.056 (resultant of trunk impulse during Kuzushi )+ 0.08 (resultant of the left thigh impulse during Tsukuri) - 0.43 (resultant of the right thigh impulse during Tsukuri) + 0.138 (resultant of trunk impulse during Tsukuri)

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