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Dynamics of Performing Front Somersault (Straight) Individually and Within Kinetic Routines of Floor Exercises

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Abstract: The aim of study was to identify the dynamic characteristics of performing front somersault (straight) individually and within the kinetic moves, in addition to comparing the dynamics its performance individually and within the motor sentence. The research sample was selected with the intentional method from the Egyptian team players of gymnastics. It was only one player, who was distinct in performing floor exercises. The best three attempts, which individually performed, were selected as well as the best three attempts performed within a group of moves. The researcher used the kinetic analysis program, WIN analyze (2D) in the processes of kinetic analysis of front somersault (straight). The most important findings were that the performance of front somersault (straight) within a kinetic routine took total time less than the one took to perform it individually. There are also statistical significant differences in the values of linear velocity in the direction of horizontal velocity and resultant component. There are statistical significant differences in the values of the linear acceleration in the direction of the vertical component, in addition to statistical significant differences in the values of pushing in the direction of horizontal impulse and resultant component. There are statistical significant differences in the values of the force in the direction of vertical component for the center of gravity of the player through the phases of performing front somersault (straight) individually and within kinetic routine.

Key words: Biomechanics · Front somersault (straight) · Characteristics

INTRODUCTION

The application of mechanical laws on the dynamic human system in gymnastics moves has a particular importance in identifying the accurate rules of the movement and the possibility of estimation under different circumstances [1]. The parameters governing the performance of any motor skills are of the most important measures of the initial analysis, which involved identifying the mechanical environment the skill performed in, such as the surface (floor) skill performed on and the direction and velocity of the wind, the characteristics of the opponent and the position of the player with regard to the place of performance, such as a *"kill"* in volleyball before and after the three meters zone, as well as the characteristics of the player and pre and post-moves of the skill [2].

It is known that for carrying out the kinetic analysis processes, several factors largely related to the extent of the difficulty and complexity of the kinetic performances, which purposed to be studied and analyzed, must be taken into account. It should be noted that the first element of these factors is to determine whether the skill, which purposed to be analyzed, performed at one space-level or it has multi-levels, in addition to the difference in the way of performance or the appearance of inconsistency among the set of procedures used in the performance. Furthermore, changing in performance conditions such as using clothing rather than the one specified for the game or transferring the player from the covered hall to open one, or vice versa. All of these factors are to consider when starting studying one skill of a group in an attempt to remove the matters that may affect the accuracy of data derived from the analysis processes and to create conditions that make the performance of the player's seems naturally as much as possible [3].

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The problem of research lies in that it has been a common practice to conduct kinetic analysis of motor skills in conditions outside the range of competition or individual, contrary to what performed within the kinetic routines. The skill of front somersault (straight) is of one space-level skills, which performed on floor exercises in gymnastics, significantly, within a group of moves, which may be preceded or followed.

It is worth mentioning that this skill is less performed within the kinetic routine during the men's competitions in the sport of gymnastics. Based on the above, researcher indicates that achieving the analysis results of the motor skills in a way similar to its performance in competitions is very important in order to derive more precise information about performance, which can adjust our descriptive information about it. The aim of research is to identify the dynamic characteristics for performing the front somersault (straight) individually and within kinetic routine, in addition to the comparison between the dynamics of its performance individually and within kinetic routine.

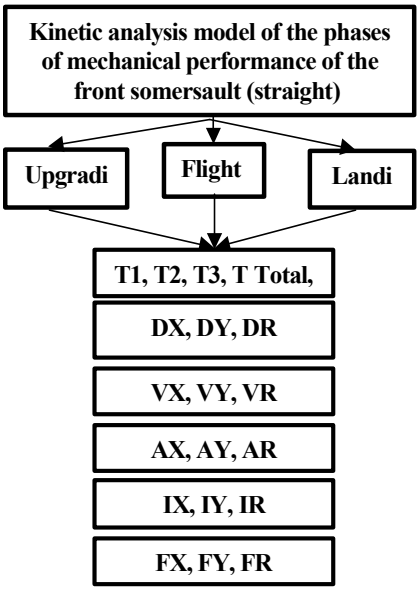

Fig. 1: The Kinetic Analysis Model of the Phases of Mechanical Performance of the Front Somersault (Straight)

MATERIALS AND METHODS

Research sample was selected intentionally from the Egyptian team players of gymnastics. One player was only distinct in performing floor exercises moves. He was 17 years old and weighed 55 kilograms with a height of 167 cm. He performed the skill under discussion for a number of five times individually as well as five times within a kinetic series of forward handspring, front somersault (straight) with a full circle round the longitudinal axis, then front somersault (straight). The best three solo attempts were selected as well as the best ones performed within a series of moves.

Procedures of Photographing Process: The researcher used a video camera "Panasonic", operating with a frequency of (100 frames / sec). The player was filmed individually for 5 attempts of the skill under discussion and for 5 attempts in a kinetic series, which is composed of forward handspring, then front somersault (straight) with a circle around the longitudinal axis and then front somersault (straight). It was taken into account to make the lens of the camera in portrait mode at the space-level in which the skill, under discussion, was performed at a distance of (6 meters) from the player and at a height of (1.5 meters) of land. There were no deviations in the field of photography by water balance existing at camera holder. Photography was taken in club gymnastics hall of the Suez Canal, Port Said, Egypt.

Procedures of Kinetic Analysis Process: The researcher used the following tools and equipments in the kinetic analysis of the skill under discussion:

- The system of sports moves analysis, which consists of a VCR, Panasonic, connected to a TV tuner. It exists inside computer through which video clips, supposed to be analyzed, are recorded.
- Kinetic analysis program, WIN analyzes (2D), through which the beginning and the end of the motor section, supposed to be analyzed, were identified.
- Bernstein was used to determine the body's center of gravity and the center of gravity of parts, which contains 14 parts, represent the various parts of body.
- The critical points were identified in performing front somersault (straight) that was used for making comparisons between individual performance and within kinetic routine according to the following:

Phase I (take-off) (start-end):

- Phase II (Flight) (start-the highest rise in CG-end).
- Phase III (landing) (start-end).
- Dynamic implications were extracted for CG of the player's body mass in the direction of both horizontal and vertical components and their resultant through the phases of performing the skill of front somersault (straight) according to the following dynamic analysis model (Fig. 1).

Statistical Analysis: The researcher used the bundle of Statistical Program of Social Sciences (SPSS) to analyze data using:

The Arithmetic Mean: In the calculation of the values mean of the three individual attempts and within kinetic routine through the critical points in the phases of performing front somersault (straight) for each the moment of the beginning and the end of each phase as well as the moment of the arrival of the center of gravity of the player's body to the maximum height during the phase of flight.

- Wilcoxon Test of reference ranks for correlated samples.

RESULTS AND DISCUSSION

Temporal Analysis: Table 1 explains the temporal and relative distribution of the phases of performing front somersault (straight) individually and within a routine and the angels of release.

Kinematics Analysis: Tables 2-4 indicate the amounts of displacement, velocity and linear acceleration of the center of gravity of the player's body during the critical moments in the phases of performing front somersault (straight) individually and within a routine in terms of the beginning and the end of each three phases of the performance and the moment of maximum height of the center of gravity during the phase of flight in each direction of the horizontal and vertical and resultant component.

Kinesthetic Analysis: Tables 5, 6 indicate that amounts of linear impulse and force of the center of gravity of the player's body during the critical moments in the phases of performing front somersault (straight) individually and within a routine in terms of the beginning and the end of each three phases of the performance and the moment of maximum height of the center of gravity during the phase of flight in each direction of the horizontal and vertical and resultant.

Tables 7-12 present the results found out through the statistical treatments for each an individual measurement and within a routine of the mechanical variables used in studying the skill under discussion.

Table 1: The temporal analysis of the phases of performing front somersault (straight) individually and within a routine and the angels of release. Data are means (± standard deviation)

Variable	Take-off (s)	Flight (s)	landing (s)	Total time (s)	Angle of flight (°)
OUT	0.14 (0.00)	0.72 (0.02)	0.18 (0.06)	1.04 (0.04)	39.66 (0.58)
IN	0.11 (0.01)	0.55 (0.08)	0.26 (0.03)	0.92 (0.04)	42.66 (3.52)

Table 2: Amounts of linear displacement of the center of gravity of the player's body through the phases of performing front somersault (straight) individually and Within a routine. Data are means (± standard deviation)

		linear Displacement (cm)			
		DX		DY	
Variable		OUT	IN	OUT	IN
Take-off	Start	151.365 (17.22)	294.848 (7.52)	254.566 (0.35)	257.839 (0.54)
	End	216.147 (18.03)	324.721 (0.94)	285.916 (0.23)	287.077 (2.27)
Flight	Start	227.224 (18.36)	332.581 (2.24)	279.400 (25.94)	293.404 (1.080)
	Top CG	361.813 (26.58)	408.293 (14.73)	349.215 (2.82)	324.271 (5.84)
	End	502.944 (32.40)	488.509 (26.33)	257.546 (6.80)	264.239 (16.15)
landing	Start	513.3623 (36.01)	499.427 (24.77)	256.765 (4.22)	253.392 (10.43)
	End	560.720 (5.685)	549.876 (12.50)	258.329 (3.84)	248.848 (1.89)

Table 3: Amounts of linear velocity of the center of gravity of the player's body through the phases of performing front somersault (straight) individually and within a routine. Data are means (± standard deviation)

		linear Velocity [cm/s]					
		VX		VY		VR	
Variable		OUT	IN	OUT	IN	OUT	IN
Take-off	Start	498.862 (18.58)	280.093 (14.77)	143.373 (8.83)	274.829 (23.30)	393.399 (32.98)	379.359(17.44)
	End	422.583 (6.16)	281.065 (14.58)	355.852 (1.428)	265.321 (43.37)	537.823 (9.90)	386.099(39.49)
Flight	Start	409.601 (14.41)	291.932 (6.98)	341.434 (9.27)	224.101 (5.43)	520.101 (20.74)	366.821(2.02)
	Top CG	411.064 (29.33)	346.892 (13.22)	-14.728 (6.10)	-44.988 (73.72)	301.137 (40.73)	269.209(4.02)
	End	360.796 (32.15)	253.084 (38.35)	-197.254 (29.57)	-272.458 (89.77)	275.872 (64.67)	89.470(24.30)
landing	Start	350.699 (41.24)	299.785 (58.06)	-152.404 (29.79)	-176.20 (36.27)	273.986 (18.29)	114.800(85.43)
	End	294.511 (42.28)	152.182 (10.88)	36.672 (21.71)	75.551 (5.77)	281.231 (46.60)	169.453(12.33)

Table 4: Amounts linear acceleration of the center of gravity of the player's body through the phases of performing front somersault (straight) individually and within a routine. Data are means (± standard deviation)

		linear Acceleration [cm/s²]					
		AX		AY		AR	
Variable		OUT	IN	OUT	IN	OUT	IN
Take-off	Start	-2941.696 (238.288)	-1505.023(327.28)	2626.809(425.70)	-1841.926(429.33)	920.565(776.34)	-2311.323(33.51)
	End	-342.019 (320.47)	1056 (139.98)	-79.744(535.94)	-1028.133(1207.72)	-199.521(584.29)	123.763(682.49)
Flight	Start	-1136.934 (274.62)	-482.593(880.48)	-1225.81(22.63)	-2424.845(2089.82)	-1658.160(188.79)	-1912.039 (1997.25)
	Top CG	274.989 (570.05)	-597.781(1039.53)	-1610.804(653.28)	-2552.067(530.98)	-761.222(848.75)	-1969.231(1144.47)
	End	-236.745(445.18)	-398.93(286.62)	3389.774(981.79)	960.043(197.54)	1854.043(444.60)	1559.777(2885.61)
landing	Start	-826.544(1231.89)	-304.870(1845.23)	2914.753(674.19)	2003.047(754.60)	890.662(1648.76)	804.162(1780.22)
	End	-687.022(2345.82)	254.042(1549.14)	982.983(1068.58)	-152.682(359.18)	-345.425(1601.94)	167.461(1258.82)

Table 5: Amounts of impulse of the center of gravity through the phases of performing front somersault (straight) individually and within a routine. Data are means (± standard deviation)

		Impulse [Ns]					
		IX	IY	IR			
Variable		OUT	IN	OUT	IN	OUT	IN
Take-off	Start	274.353(10.22)	147.845(13.64)	77.018(5.77)	151.112(12.54)	281.062(13.67)	208.905(13.15)
	End	231.685(3.62)	154.056(8.06)	195.392(0.93)	146.803(23.89)	302.623(3.74)	213.386(22.19)
Flight	Start	217.613(8.93)	158.736(5.11)	186.025(6.19)	116.619(11.69)	292.389(9.48)	200.482(3.70)
	Top CG	221.041(18.01)	184.661(13.43)	0.022(9.97)	-2.724(3.89)	227.930(16.62)	181.788(17.96)
	End	205.366(19.59)	129.499(27.13)	-107.173(62.70)	-129.980(60.47)	202.465(14.71)	187.046(59.80)
landing	Start	223.240(57.63)	145.627(5.75)	-62.518(64.90)	77.934(132.44)	226.303(64.27)	192.044(57.55)
	End	194.28(37.15)	77.073(13.41)	22.631(18.17)	36.171(10.16)	215.408(79.44)	88.165(11.77)

Table 6: Amounts of force of the center of gravity through the phases of performing front somersault (straight) individually and within a routine. Data are means (± standard deviation)

		Force [N]					
		FX		FY		FR	
Variable		OUT	IN	OUT	IN	OUT	IN
Take-off	Start	379.812(195.44)	821.895(662.69)	2128.733(353.23)	945.428(627.35)	2154.834(371)	1217.822(874.80)
	End	-198.935(184.77)	546.785(73.12)	-32.408(284.67)	-549.774(651.68)	326.075(36.87)	802.056(318.25)
Flight	Start	-621.157(154.64)	-255.189(475.71)	-664.843(25.39)	-1295.412(1118.96)	899.492(139.16)	1458.071(1458.07)
	Top CG	146.944(309.79)	-321.192(565.34)	-810.409(413.82)	-1411.117(297.25)	872.811(374.65)	1500.975(333.85)
	End	-129.265(244.29)	799.347(1260.51)	454.994(2490.11)	50.754(1086.1)	2041.244(618.44)	1546.964(179.87)
landing	Start	-451.318(680.38)	-176.37(1007.61)	1706.436(411.80)	1094.115(409.56)	1869.269(115.44)	1406.973(88.86)
	End	459.464(422.22)	230.79(432.04)	67.332(41.97)	-383.728(417.70)	505.109(341.75)	669.293(50.139)

Table 7: Significance of differences between an individual measurement and within a routine of the skill under discussion in the variables of temporal analysis and the angels of release by using Wilcoxon Test n = 3

	N		Mane Rank		Sum of Ranks			
Variables	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Z	Asymp. Sig. (2-tailed)
T_1	3.00	0.00	2.00	0.00	6.00	0.00	-1.633	0.102
T_2	3.00	0.00	2.00	0.00	6.00	0.00	-1.604	0.109
T_3	0.00	3.00	0.00	2.00	0.00	6.00	-1.604	0.109
T Total	2.00	0.00	2.00	0.00	6.00	0.00	-1.633	0.102
θ	0.00	2.00	0.00	1.50	0.00	3.00	-1.342	0.180

Table 8: Significance of differences between individual measurements and within a routine of the skill under discussion in the variables of linear displacement of the center of gravity of the player's body by using Wilcoxon Test n = 7

	N		Mane Rank		Sum of Ranks			
Variables	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Z	Asymp. Sig. (2-tailed)
DX	3.00	4.00	2.00	5.50	6.00	22.00	-1.352	0.176
DY	3.00	4.00	5.00	3.25	15.00	13.00	-0.169	0.866

Table 9: Significance of differences between individual measurements and within a routine of the skill under discussion in the variables of linear velocity of the center of gravity of the player's body by using Wilcoxon *Test n = 7*

	N		Mane Rank		Sum of Ranks			
Variables	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Z	Asymp. Sig. (2-tailed)
VX	7.00	0.00	4.00	0.00	28.00	0.00	-2.366	0.018*
VY	5.00	2.00	3.60	5.00	18.00	10.00	-0.676	0.499
VR	7.00	0.00	4.00	0.00	28.00	0.00	-2.366	0.018*

* means statistical significant at 0.05

Table 10: Significance of differences between individual measurements and within a routine of the skill under discussion in the variables of linear acceleration of the center of gravity of the player's body by using Wilcoxon Test n = 7

	N		Mane Rank		Sum of Ranks			
Variables	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Z	Asymp. Sig. (2-tailed)
AX	2.00	5.00	2.50	4.60	5.00	23.00	-1.521	0.128
AY	7.00	0.00	4.00	0.00	28.00	0.00	-2.366	0.018*
AR	5.00	2.00	3.80	4.50	19.00	9.00	-0.845	0.398

* means statistically significant at 0.05

Table 11: Significance of differences between individual measurements and within a routine of the skill under discussion in the variables of linear impulse of the of the center of gravity of the player's body by using Wilcoxon Test n = 7

	N		Mane Rank		Sum of Ranks			
Variables	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Z	Asymp. Sig. (2-tailed)
IX	7.00	0.00	4.00	0.00	28.00	0.00	-2.366	0.018*
IY	4.00	3.00	3.25	5.00	13.00	15.00	-0.169	0.866
IR	7.00	0.00	4.00	0.00	28.00	0.00	-2.366	0.018*

* means statistically significant at 0.05

Table 12: Significance of differences between individual measurements and within a routine of the skill under discussion in the variables of force of the of the center of gravity of the player's body by using Wilcoxon Test n = 7

	N		Mane Rank		Sum of Ranks			
Variables	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Negative Ranks	Positive Ranks	Z	Asymp. Sig. (2-tailed)
FX	2.00	5.00	3.00	4.40	6.00	22.00	-1.352	0.176
FY	7.00	0.00	4.00	0.00	28.00	0.00	-2.366	0.018*
FR	3.00	4.00	4.33	3.75	13.00	15.00	-0.169	0.866

* means statistically significant at 0.05

Temporal Analysis: It's clear from Table 1 that performance within a routine, for the skill under discussion, took total time less than the one took to perform individually. It also shows that the time of the second phase (flight) to perform the skill under discussion individually took longer time than the one the same phase took when performing within a routine.

The researcher attributes that when a series of moves is performed, some phases are reduced, especially pre-trial phase of the following movement to become an overlapped stage with the final or last phase of the movement which preceded it and in keeping with the division of moves according to the foundations associated with the phases of the movement, which reduces the total time and the time of some phases. [1]

Kinematics Analysis: The results in Tables 2 and 8 indicated that there are differences in the values of the horizontal and vertical displacements of the center of gravity of the player's body through the phases of performing the skill, under discussion, individually and within a routine. However, these differences are not true as shown by the statistical treatment of the values of horizontal and vertical linear displacements of the center of gravity of the player's body. It showed the absence of statistically significant differences between single measurements and within a routine for the skill, under discussion, in the variables of linear displacements of the center of gravity of the player's body.

The results, in Tables 3 and 9 also showed that there are statistically significant differences in the values of linear velocity of the center of gravity of the player's body through the stages of performing the skill in question individually and within a routine in the direction of horizontal velocity and resultant component. There are also no statistically significant differences in the values of

linear velocities of the center of gravity of the player's body in the direction of the vertical component between the individual measurements and within a routine for the skill under discussion.

The researcher attributed this difference to the increase in the values of linear velocity of the center of gravity of the player's body in the direction of the horizontal component and resultant as the player gained significant amount of linear movement through performing a series of follow-up moves followed by performing the skill under discussion.

The results, in Tables 4 and 10 also indicated that there are statistically significant differences in the values of linear acceleration of the center of gravity of the player's body through the phases of performing the skill, under discussion, individually and within a routine in the direction of the vertical component. There also no statistically significant differences in the values of the linear acceleration the center of gravity of the player's body through the phases of performing the skill under discussion individually and within a routine in the direction of the horizontal and the resultant component.

Kinetics Analysis: The results in Tables 5 and 11 also indicated that there are statistical significant differences in the values of linear impulse of the center of gravity of the player's body through the phases of performing the skill under discussion individually and within a routine in the direction of horizontal impulse and the resultant component. There are also no statistically significant differences in the values of linear impulse the center of gravity of the player's body in the direction of the vertical component between individual measurements and within a routine for the skill under discussion.

The results in Tables 6 and 12 also indicated that there are statistical significant differences in the values of force of the center of gravity of the player's body through the phases of performing the skill, under discussion, individual and within a routine in the direction of vertical component. There are also no statistical significant differences in the values of force of the center of gravity the player's body through the phases of performing the skill under discussion individually and within a routine in the direction of horizontal forces and resultant component.

From the above, it becomes clear that there are differences among some of the dynamic variables that characterized performing the skill of front somersault (straight) either individually or within a routine. This answers the question research aims to find out that there are statistically significant differences when performing skills individually, contrary to what is performed in competition in terms of being performed within a series or kinetic routine. This is similar to the nature of the mechanical conditions governing the performance of the skill, under discussion, during the championships and is much less performed individually during the men's competitions on the floor exercises in the sport of gymnastics. Therefore, it's necessary to conduct kinetic analysis processes of sports motor skills in mechanical conditions similar to those circumstances in which the skill performed in order to remove all the factors that may affect the accuracy of the data extracted from the kinetic analysis.

CONCLUSIONS

- The average time of performing the front somersault (straight) skill within a routine took total time of (0.092) second, which is less than the total time taken to perform individually, (1.04) second.
- There are no statistically significant differences in the values of linear displacements of the center of gravity of the player's body through the phases of performing the skill of front somersault (straight) individually and within a routine.
- There are significant differences in the variables of linear velocity of the center of gravity of the player's body in the direction of both horizontal and resultant components through the phases of performing the skill of front somersault (straight) individually and within a routine.
- There are significant differences in the variable of linear acceleration of the center of gravity of the player's body in the direction of the vertical component through the phases of performing the skill of front somersault (straight) individually and within a routine.
- There are significant differences in the variables of the linear impulse of the center of gravity of the player's body in the direction of both horizontal and resultant component through the phases of performing the skill front somersault (straight) individually and within a routine.
- There are significant differences in the force variable of the center of gravity of the player's body in the direction of vertical component through the phases of performing the skill of front somersault (straight) and within a routine.

Recommendations:

- It should be taken into account the parameters governing the performance of any motor skills in terms of identifying the mechanical environment in which the skill performed as well as the characteristics of the player and the moves which precede and follow.
- It's necessary to conduct kinetic analysis processes of motor skills to be similar to the nature of performing those skills in the competitions organized for those sports activities.
- Further similar researches must be conducted to other motor skills in different sports activities to emphasize the need for conducting kinetic analysis processes of the sports motor skills in a way from which we derive more accurate data helping to improve the performance of our players in all activities.

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