LANDING CHARACTERISTICS IN MEN'S FLOOR EXERCISE ON EUROPEAN CHAMPIONSHIPS 2004

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Abstract

In our research we focus on certain characteristics of salto landings that were performed on European Championships 2004. Our goal is to determine characteristics which have influence on the magnitude of the landing mistake. We analyzed saltos which were performed by senior gymnasts (N= 97) who were competing in the qualifications of the European Championships 2004 in Ljubljana. We defined the variables according to a theoretical model for the evaluation of salto landings in the floor exercise. The results show that axis of rotation, number of turns around longitudinal axis, and initial landing height have a significant impact on the magnitude of the landing mistake. The results also show that soft landing is most effective, landing after saltos without twists is optimal with feet together (unless gymnasts' abilities of left and right leg are different) and arms positions at touch down should be upward.

Key words: *Gymnastics, floor exercise, landings*

INTRODUCTION

Landing in modern gymnastics is one of the most important factors which determine the final rank of gymnasts in competitions. The goal of landing is to absorb the body's energy produced at take off. The gymnast has to asses the amount and direction of energy in the flight phase and anticipate the amount and direction of energy at landing. Direction of kinetic energy at contact can be oriented towards or away the energy from the flight phase. If the kinetic energy at landing is oriented towards the energy of the flight phase than the total sum of energies is equal to the difference between them and oriented in the direction of the greater one. If the direction of energies is the same then the total amount is equal to the sum of both energies. Therefore it is necessary for the stuck landing to develop such initial conditions that impulse of the ground reaction force would be oriented towards the energy of the flight phase and equal to its amount. These are characteristics of landings that occur after an independent acrobatic element or at the end of acrobatic series. The ability of a gymnast to control a reaction force during the landing is limited by a muscular coordination, the ability of an individual to predict a magnitude of loading, and the ability to overcome a load, which is created at the time of contact with the surface (McNitt-Gray, Costa, Mathiyakom, and Requejo, 2001). If the body is not capable to efficiently control the loading at the time of landing, acute or overuse injuries can occur.

An additional problem is presented by the rule that the feet should be together at landings (FIG, 2006). One of important factor affecting stability is the magnitude of the base of support. The base of support is an area bound by the outermost regions of the body in contact with the supporting surface. In the feet-together stance the base of support is small and this fact aggravates the gymnasts' stability. Another factor that affects stability is the angle between the line of action of a body's weight and boundaries of the base of support. When the line of action of a body's weight moves outside the base of support stability is disrupted.

Before making (un)necessary step(s) at landing, the gymnast can perform modification movements. Research have shown that the distribution of momentum among segments at flight phase and contact influences stability during interaction with the landing surface

(McNitt – Gray, Hester, Mathiyakom, & Munkasy, 2001; Requejo, McNitt – Gray, & Flashner, 2002). Modifications in shoulder torque during flight phase enables the gymnast to reach kinematics characteristics which are consistent with successful landings. After the contact, gymnasts can circle the arms in the same or the opposite direction to the direction of movement or lower his center of gravity. Modifications with hands help him to preserve and transfer angular momentum (Prassas & Gianikellis, 2002). When he lowers his center of gravity he enhances a time interval in which he can actively lower the impulse of the ground reaction force with his muscles.

Results from some studies show a rather low success of landings in competitions (McNitt-Gray, Requejo, Costa, & Mathiyakom, 2001; Prassas & Gianikellis, 2002). On Olympic games 1996 in Atlanta McNitt – Gray et. al. (1998) investigated landings from high bar and parallel bars. Competitors performed twenty landings. Only one was performed without a mistake.

When performing acrobatic elements mistakes can occur in every phase of the element. These phases are interdependent. Mistakes that occur in later phases can be linked with earlier phases. Therefore, it is important to know the types of landing mistakes in order to find the reasons for their occurrence.

In our research we will try to describe characteristics of saltos which were performed with landing mistakes and determine the influence of chosen variables on magnitude of error.

MATERIALS AND METHODS

In our research, we analyzed landings of saltos performed after an independent salto or at the end of an acrobatic series of saltos (N= 241). The analyzed saltos were performed by senior gymnasts (N= 97) who were competing in the of the European Championships 2004 in Ljubljana. For analysis we defined following variables:

1. Position of the body:
   - tucked
   - piked
   - stretched
2 Initial landing height (at contact):
   - high landing (body's center of gravity is above the hips)
   - medium landing (body's center of gravity is in the height of the hips)
   - low landing (body's center of gravity is below the hips)
3. Axis of rotation (in accordance with FIG's Code of Points 2006):
   - around transverse axis (saltos forward and saltos backward)
   - around sagital axis (saltos sideways)
   - complex rotations
     - forward around transverse and around longitudinal axis (saltos forward with turns)
     - backward around transverse and around longitudinal axis (saltos backward with turns)
     - around longitudinal and forward or backward around transversal (jumps with ½ turn to saltos forward or backward)
4. Number of turns around transverse axis (90^0 of salto = 1)
5. Number of turns around longitudinal axis (180^0 of salto = 1)
6. Number of turns around sagital axis (90^0 of salto = 1)
7. Base of support:
   - feet together
   - <=shoulder width
   - >=shoulder width
   - support with hands
8. Amortization
   - stiff landing
   - soft landing
   - deep landing
9. Hands position at contact:

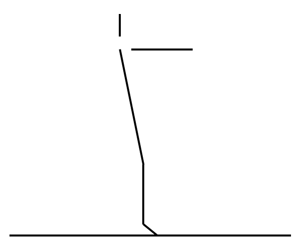

Figure 1: *forward position*

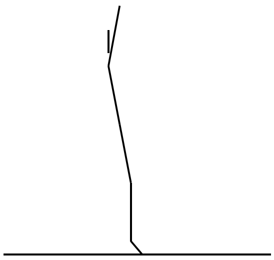

Figure 2: *upward position*

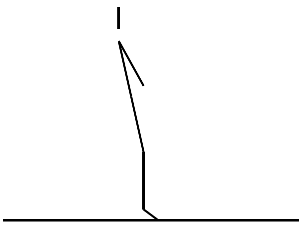

Figure 3: *downward position*

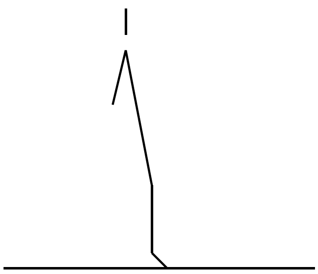

Figure 4: *backward position*

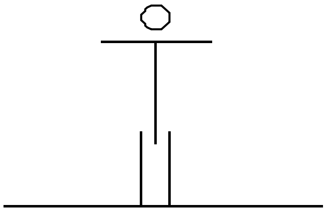

Figure 5: *outward position*

Landings were determined with video analyses (50Hz). For all variables we computed the frequencies and their percentages in comparison with the magnitude of the landing mistake (cross tabs). With Chi square test we determined the difference between good landings and bad landings by virtue of the differences between these landings as operationalized by the selected variables.

RESULTS

Out of all performed saltos with the intention to stick the landing at the EC 2004 (N = 344), 30 % (N = 103) were performed without error and 70 % (N = 241) were performed with errors. Distribution of the error magnitudes among saltos with errors (N = 241) is: small errors (62,7 %), medium errors (31,5 %), large errors (1,7 %) and falls (4,1 %) (Table 1). Short hop (37,3 %), short step (25,3 %) and large step (23,2 %) are the most frequent mistakes made. Large errors were always made by falling to support with both hands on the floor. The highest frequency of small errors was in the high and medium initial landing height, while most medium and large errors and all falls were performed with a low initial landing height and these differences between the magnitude of error and the initial landing height are statistically significant
(Table 2).

The most frequent landing errors occurred during saltos forward (fwd.) with and without turns (51,0 %; N = 123), much less so saltos backward (bwd.) with or without turns (34,9 %; N = 84), and the lowest frequency saltos with ½ turn and salto or saltos sideways (14,1 %; N = 34). Forward saltos with turns (29,0 %) were performed more frequently with. errors than saltos fwd. without turns (22,0 %). Saltos bwd. with turns (27,0 %) were also performed more frequently with errors than saltos bwd. without turns (7,9 %). Gymnasts did 12,0 % saltos with ½ turn and salto with errors while only 2,1 % of saltos sideways were performed with errors (Table 3). The differences between the magnitude of error and the axis of rotation are statistically significant.

The highest frequency of small errors occurred with saltos bwd. with turns (28,5 %; N = 43) and saltos fwd. with turns (26,5 %. N = 40), followed by saltos fwd. (19,2 %; N = 29), saltos with ½ turn to saltos fwd. or bwd. (15,2 %;

Table 1: *Distribution of saltos with landing mistakes according to the magnitude and the type of the landing mistake*

	Number of saltos	% according to magnitude of error	% according to type of error
Small error	151	62.7 %	
- short step	61		25.3 %
- short hop	90		37.3 %
Medium error	76	31.5 %	
- large step	56		23.2 %
- large hop	20		8.3 %
Large error	4	1.7 %	
- touch with hands	0		0.0 %
- support with hands	4		1.7 %
Fall	10	4.1 %	
Sum	**241**		

Table 2: *Distribution of the magnitude of errors and the initial landing height*

	Magnitude of error							Sum
INITIAL LANDING HEIGHT	Small		Medium		Large		Fall	
	Step	Hop	Step	Hop	Touch	Support		
High landing	**22**	**26**	**13**	**12**		**1**		**69**
% within initial landing height	31.9 %	37.7 %	18.8 %	17.4 %		1.4 %		100.0 %
% within magnitude of error	36.1 %	28.9 %	23.2 %	60.0 %		25.0 %		28.6%
Medium landing	**20**	**40**	**22**	**3**		**1**		**78**
% within initial landing height	25.6 %	51.3 %	28.2 %	3.8 %		1.3 %		100.0 %
% within magnitude of error	32.8 %	44.4 %	39.3 %	15.0 %		25.0 %		32.4 %
Low landing	**19**	**24**	**21**	**5**		**2**	**10**	**70**
% within initial landing height	27.1 %	34.3 %	30.0 %	7.1 %		2.9 %	14.3 %	100.0 %
% within magnitude of error	31.1 %	26.7 %	37.5 %	25.0 %		50.0 %	100.0 %	29.0 %
Sum	**61**	**90**	**56**	**20**	**0**	**4**	**10**	**241**
% within initial landing height	25.3 %	37.3 %	23.2 %	8.3 %	0.0 %	1.7 %	4.1 %	100.0 %

Chi square test between magnitude of error and initial landing height		
Value	Degrees of freedom	Significance
20.323	6	0.002

N = 23) and saltos bwd. (7,3 %; N = 11); the lowest frequency of errors occurred in saltos sideways (3,3 %; N = 5). Small errors show that gymnasts did more often a small hop rather than a small step. A small hop was more often seen in saltos fwd. with turns, while a small step was more foften observed in saltos bwd. with turns. Medium errors mostly occurred in saltos fwd. with turns (35,5 %; N = 27) and without turns (35,5 %; N = 27); slightly less frequently in saltos bwd. with turns (23,7 %; N = 18) and in saltos bwd. without turns (10,5 %; N=8); only only 7,9 % of saltos with ½ turn to saltos fwd. or bwd. were performed with medium errors (N=6). In middle errors, there is higher prevalence of long steps than long hops. All large errors occurred in saltos backward and all falls happened in saltos forward (Table 3).

Table 3: *Distribution of landing mistakes according to the axis of rotation*

	Magnitude of error							Sum
AXIS OF ROTATION	Small		Medium		Large		Fall	
	Step	Hop	Step	Hop	Touch	Support		
Salto fwd.	**14**	**15**	**14**	**13**			**7**	**53**
% within axis of rotation	26.4 %	28.3 %	26.4 %	24.5 %			13.2 %	100.0 %
% within magnitude of error	23.0 %	16.7 %	25.0 %	65.0 %			70.0 %	22.0 %
Salto fwd.with turns	**13**	**27**	**21**	**6**			**3**	**70**
% within axis of rotation	18.6 %	38.6 %	30.0 %	8.6 %			4.3 %	100.0 %
% within magnitude of error	21.3 %	30.0%	37.5%	30.0%			30.0%	29.0 %
Salto bwd.	**2**	**9**	**7**	**1**				**19**
% within axis of rotation	10.5 %	47.4 %	36.8 %	5.3 %				100.0 %
% within magnitude of error	3.3 %	10.0 %	12.5 %	5.0 %				7.9 %
Salto bwd. with turns	**18**	**25**	**10**	**8**		**4**		**65**
% within axis of rotation	27.7 %	38.5 %	15.4 %	12.3 %		6.2 %		100.0 %
% within magnitude of error	29.5 %	27.8 %	17.9 %	40.0 %		100.0 %		27.0 %
Saltos sideways	**3**	**2**						**5**
% within axis of rotation	60.0 %	40.0 %						100.0 %
% within magnitude of error	4.9 %	2.2 %						2.1 %
Jumps with ½ turn to saltos fwd. or bwd.	**11**	**12**	**4**	**2**				**29**
% within axis of rotation	37.9 %	41.4 %	13.8 %	6.9 %				100.0 %
% within magnitude of error	18.0 %	13.3 %	7.1 %	10.0 %				12.0 %
Sum	**61**	**90**	**56**	**20**		**4**	**10**	**241**
% within axis of rotation	25.3 %	37.3 %	23.2 %	8.3 %	0.0 %	1.7 %	4.1 %	100.0 %

Chi square test between landing mistakes and axis of rotation		
Value	Degrees of freedom	Significance
34.415	15	0.003

The highest frequency of errors was noticed in saltos with turns (68,5 %). The difference between the number of turns and the magnitude of error is significant. Small errors and falls are most frequent in saltos without turns, while middle and large errors are mostly performed in saltos with turns. Small hops are characteristic of small errors and large steps are a more frequent medium error (Table 4).

Base of support at landing and magnitude of error showed statistically significant differences (Table 6). A bigger base of support should mean a larger error deduction (also according to Code of Points (FIG, 2006). Most of the landings are to a standing position with legs apart up to hip width (69,6 %), fewer landings led to a stand with feet together (17,1 %) and to stand with feet apart more than hip width (11,5 %) and the smallest number of landings were to a support on the arms (1,8 %).
Between magnitude of error and type of amortization there are statistically significant differences (Table 6). The numerous errors were observed during soft landings (58,9 %), followed by stiff landings (37,3 %) and deep landings (3,7 %). Large errors and falls mostly occured with deep landings (11,1 % and 22,2 %) and stiff landings (2,2 % and 5,6 %), and less on soft landings (0,7 % and 2,1 %).

Between the magnitudes of errors and hand positions at contact there were statistically significant differences (Table 7). Gymnasts have had mostly arms in outward position (53,1 %), than forward position (18,4 %), downward position (17,0 %), upward position (9,8 %) and backward position (1,2 %). The highest number of small (55,6 %) and medium (56,6 %) errors occurred with outward arms position. The highest number of large errors (50,0 %) occurred with forward arms position and the largest amount of falls occurred with arms in downward position.

Differences between body positions during the flight, the number of turns around the transverse axis and the number of turns around the sagital axis were not statistically significant (Table 8).

Table 4: *Distribution of landing mistakes according to the number of turns around the longitudinal axis*

	Magnitude errors							Sum
NUM. OF TURNS – LONGIT. AXIS	Small		Medium		Large		Fall	
	Step	Hop	Step	Hop	Touch	Support		
Without twist	**18**	**26**	**21**	**4**			**7**	**76**
% within number of turns	23.7 %	34.2 %	27.6 %	5.3 %			9.2 %	
% within magnitude of error	29.5 %	28.9 %	37.5 %	20.0 %			70.0 %	31.5 %
1/2 (180^0)	**11**	**14**	**5**	**3**				**33**
% within number of turns	33.3 %	42.4 %	15.2 %	9.1 %				
% within magnitude of error	18.0 %	15.6 %	8.9 %	15.0 %				13.7 %
1/1 (360^0)	**12**	**16**	**15**	**2**			**1**	**46**
% within number of turns	26.1 %	34.8 %	32.6 %	4.3 %			2.2 %	
% within magnitude of error	19.7 %	17.8 %	26.8 %	10.0 %			10.0 %	19.1 %
3/2 (540^0)	**7**	**16**	**6**	**4**			**2**	**35**
% within number of turns	20.0 %	45.7 %	17.1 %	11.4 %			5.7 %	
% within magnitude of error	11.5 %	17.8 %	10.7 %	20.0 %			20.0 %	14.5 %
2/1 (720^0)	**12**	**18**	**6**	**7**		**3**		**46**
% within number of turns	26.1 %	39.1 %	13.0 %	15.2 %		6.5 %		
% within magnitude of error	19.7 %	20.0 %	10.7 %	35.0 %		75.0 %		19.1 %
5/2 (900^0)	**1**		**3**			**1**		**5**
% within number of turns	20.0 %		60.0 %			20.0 %		
% within magnitude of error	1.6 %		5.4 %			25.0 %		2.1 %
sum	**61**	**90**	**56**	**20**		**4**	**10**	**241**
% within number of turns	25.3 %	37.3 %	23.2 %	8.3 %	0.0 %	1.7 %	4.1 %	100.0 %

Chi square test between magnitude errors and number of turns around longitudinal axis		
Value	Degrees of freedom	Significance
33.978	15	0.003

Table 5: *Distribution of the magnitude of error and the base of support*

	Magnitude of error							sum
BASE OF SUPPORT	small		medium		large		fall	
	step	hop	step	hop	touch	support		
feet together	**7**	**19**	**6**	**5**				**37**
% within base of support	18. 9 %	51. 4 %	16. 2 %	13. 5 %				100. 00 %
% within magnitude of error	11. 5 %	21. 1 %	10. 7 %	25. 0 %				17. 10 %
< shoulder width	**32**	**58**	**42**	**13**		**3**	**3**	**151**
% within base of support	21. 2 %	38. 4 %	27. 8 %	8. 6 %		2. 0 %	2. 0 %	100. 00 %
% within magnitude of error	52. 5 %	64. 4 %	75. 0 %	65. 0 %		75. 0 %	37. 5 %	69. 60 %
> shoulder width	**9**	**6**	**6**	**2**		**1**	**1**	**25**
% within base of support	36. 0 %	24. 0 %	24. 0 %	8. 0 %		4. 0 %	4. 0 %	100. 00 %
% within magnitude of error	14. 8 %	6. 7 %	10. 7 %	10. 0 %		25. 0 %	12. 5 %	11. 50 %
support with hands							**4**	**4**
% within base of support							100. 0 %	100. 00 %
% within magnitude of error							50. 0 %	1. 80 %
sum	**61**	**90**	**56**	**20**		**4**	**8**	**217**
% within base of support	25. 3 %	37. 3 %	23. 2 %	8. 3 %		1. 7 %	3. 7 %	100. 00 %

Chi square test between magnitude of error and base of support		
value	degrees of freedom	significance
109. 479	9	0. 000

CONCLUSSION

Each element is expected to be performed to the perfect end position (FIG, 2006). Any deviation from the perfect end position means error and is penalized by the judges. Errors on landings are caused by the previous phases of the element, e.g., the take off and the flight. Flight characteristics, such as the

Table 6: *Distribution of the magnitude of error and the amortization*

	Magnitude of error							sum
AMORTIZATION	small		medium		large		fall	
	step	hop	step	hop	touch	support		
stiff landing	**16**	**31**	**22**	**14**		**2**	**5**	**90**
% within amortization	17. 8 %	34. 4 %	24. 4 %	15. 6 %		2. 2 %	5. 6 %	100. 00 %
% within magnitude of error	26. 2 %	34. 4 %	39. 3 %	70. 0 %		50. 0 %	50. 0 %	37. 30 %
soft landing	**45**	**57**	**30**	**6**		**1**	**3**	**142**
% within amortization	31. 7 %	40. 1 %	21. 1 %	4. 2 %		0. 7 %	2. 1 %	100. 00 %
% within magnitude of error	73. 8 %	63. 3 %	53. 6 %	30. 0 %		25. 0 %	30. 0 %	58. 90 %
deep landing		**2**	**4**			**1**	**2**	**9**
% within amortization		22. 2 %	44. 4 %			11. 1 %	22. 2 %	100. 00 %
% within magnitude of error		2. 2 %	7. 1 %			25. 0 %	20. 0 %	3. 70 %
sum	**61**	**90**	**56**	**20**		**4**	**10**	**241**
% within amortization	25. 3 %	37. 3 %	23. 2 %	8. 3 %		1. 7 %	4. 1 %	100. 00 %

Chi square test between magnitude of error and amortization		
value	degrees of freedom	significance
24. 792	6	0. 000

Table 7: *Distribution of the magnitude of error and the hands position at contacts*

	Magnitude of error							sum
HANDS POSITION AT CONTACT	small		medium		large		fall	
	step	hop	step	hop	touch	support		
forward position	**6**	**23**	**10**	**1**		**2**	**3**	**45**
% within hands position	13. 3 %	51. 1 %	22. 2 %	2. 2 %		4. 4 %	6. 7 %	100. 00 %
% within magnitude of error	9. 8 %	25. 6 %	17. 9 %	5. 0 %		50. 0 %	30. 0 %	18. 40 %
outward position	**37**	**47**	**29**	**14**			**1**	**128**
% within hands position	28. 9 %	36. 7 %	22. 7 %	10. 9 %			. 8 %	100. 00 %
% within magnitude of error	60. 7 %	52. 2 %	51. 8 %	70. 0 %			10. 0 %	53. 10 %
upward position	**12**	**7**	**3**			**1**	**1**	**24**
% within hands position	50. 0 %	29. 2 %	12. 5 %			4. 2 %	4. 2 %	100. 00 %
% within magnitude of error	19. 7 %	7. 8 %	5. 4 %			25. 0 %	10. 0 %	9. 80 %
downward position	**6**	**11**	**14**	**5**		**1**	**4**	**41**
% within hands position	14. 6 %	26. 8 %	34. 1 %	12. 2 %		2. 4 %	9. 8 %	100. 00 %
% within magnitude of error	9. 8 %	12. 2 %	25. 0 %	25. 0 %		25. 0 %	40. 0 %	17. 00 %
backward position		**2**					**1**	**3**
% within hands position		66. 7 %					33. 3 %	100. 00 %
% within magnitude of error		2. 2 %					10. 0 %	1. 20 %
sum	**61**	**90**	**56**	**20**		**4**	**10**	**241**
% within hands position	25. 3 %	37. 3 %	23. 2 %	8. 3 %		1. 7 %	4. 1 %	100. 00 %

Chi square test between magnitude of error and hands position at contact		
value	degrees of freedom	significance
30. 423	12	0. 002

axis of rotation, the number of turns or the initial landing height, appear to influence the success and quality of landing.

The salto's height is important for the initial landing height. The lower the initial landing height the higher the probability of a larger error. With a lower initial landing height the time for landing preparation is shorter which means a higher probability for an error. With a higher initial landing height, the time for landing preparation is longer and therefore there is less room for errors. It is very important to perform saltos with high amplitude and prolonged flight time for landing preparation.

The gymnast needs to solve different tasks during his training – landing from different heights (saltos from horse, springboard, mini trampoline etc.) (Minetti, Ardigo, Susta, & Cotelli, 1998) and landing saltos with different angular velocities (»fast« salto, »slow« salto)

Table 8: *Chi square test between magnitude of error and other variables*

Chi square test between magnitude of error and:			
	Value	Degrees of freedom	Significance
Body position	5.534	6	0.477
Number of turns around transverse axis	11.896	9	0.219
Number of turns around sagital axis	3.043	3	0.385

and to do landings on different surfaces (soft, hard, elastic, etc.). Athlete's training should change so that the athlete is better able to correct positions in the air and upon contact with the surface. The gymnast will acquire the knowledge to adjust his landing according to the circumstances and therefore become more successful.

Coaches should be more focused on correct landings during saltos with turns as the load on the left and on the right legs are different. Also, coaches should be more focused on the take off characteristics, aiming to prolong the time of flight during saltos with turns as height gives better chances of stuck landings. For more turns during saltos, higher angular velocity around the longitudinal axis is needed, which makes stuck landings more difficult to achieve or control. The gymnast receives during saltos with turns at least two types of backup information: the first type is about the technical execution of elements (e.g. how many turns have already been performed) and the second is about the landing execution (what corrections are needed for the perfect landing). During element execution, both information types are coming into the central nervous system and they require different reactions. In our opinion, problems occur when an element has not yet been mastered and the gymnast is focused on its technical execution information which disables the processing and the use of information for the landing execution. Usually such processing problems end with an uncontrolled landing and a large error or fall. Among other things, the gymnast also receives information from the environment (e.g. cheering, applauding, music, bright light etc.) and a correct selection of this information is also needed. During his training, the gymnast needs to learn to select the useful information which will lead him to the stuck landing.with the surface. The gymnast will acquire the knowledge to adjust his landing according to the stuck landing.

Stuck landings were performed with different foot positions. Mostly they perform the landing with legs apart up to hip width, but this type of landing was not very successful. Stability of body in forward and backward direction (saltos without twists) is not better if feet are apart as stability angle does not rise as well, so to land with legs apart has no biomechanics reason. Such landing with feet apart (raised base of support) are successful with landing after sideways salto and with saltos with twists as stability angle in left right direction is raised.

Results show that soft landing is most effective, while stiff landing and deep landings are reasons for more severe errors. Even when gymnast performs soft landing, he should be aware not to lower knee angle to much as moment of inertia in salto direction can be too small and raises angular velocity which causes too fast movement in the direction of rotation.

Before gymnasts perform unnecessary hops or steps during the landing, they can also do some other movements to correct position such as – swing with arms in or opposite the direction of movement. The smallest errors were observed while the gymnast held their arms in an upward position at the moment of touch down with the feet. The highest amount of errors we noticed with an arms downward position. The arms upward position is the best as the arms can swing forward, backward, outward in accordance with landing characteristics.

Only 30 % of saltos we analyzed were performed to a stuck landing. This means that a huge majority of coaches and gymnasts should restructure their training programs by type of activity and by loads in order to raise the skill level of their landings.

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