The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy ISSN: 2357-1330

http://dx.doi.org/10.15405/epsbs.2017.05.02.214

Edu World 2016
7th International Conference

DETERMINANTS PARAMETERS OF FIGURE SKATING JUMP

Carmen Gugu-Gramnatopol (a), Anca Ionescu (b)*, Ştefan Ochiotan (c), Dragoş Dăncescu (d)

* Corresponding author

(a) Transilvania University, Faculty of Physical Education and Moutain Sports, Colinei Street nr.1 Braşov, Romania, carmen.gg@unitbv.ro
(b) Transilvania University Faculty of Physical Education and Moutain Sports, Colinei Street nr.1 Braşov, Romania, ionescuanca12@gmail.com,
(c) Transilvania University Faculty of Physical Education and Moutain Sports, Colinei Street nr.1 Braşov, Romania, stefan.ochiotan@gmail.com
(d) Transilvania University Faculty of Physical Education and Moutain Sports, Colinei Street nr.1 Braşov, Romania, dancescu.dragos@gmail.com

Abstract

In figure skating, the athletes reach remarkable performances at younger ages than in the last twenty years, when senior's skaters were the only ones who managed to do triple rotation jumps. In the present, rotation jumps are being learned starting from 12 or 13 years old. By increasing efficiency of the learning process it shorten significantly the length of time in which the athletes passes the threshold from one at two, three or four rotations, performance that requires both, special motoric abilities and a careful guidance from the coach. The initial premise from which our study started was the importance of height jumping that is considered being essential in carrying out the difficulty technical elements in figure skating. The purpose of our study is to highlight the differences between parameters at simple vertical jumps and those with one or two rotation at figure skating. For this study we used the OptoJump device, we have identified and measured the jumping determinant parameters in skating, namely: jumping heights, the power generated at the jumping point, the time spent in air and the time spent on the ground, to a lot of 7 junior figure skaters. Doing the statistical analysis of these items, we showed the importance of the jumping height in the preparation of the figure skaters performance, the differences between simple vertical jumps and those with one or two rotation, and we compared these results with the notes obtained by sportsmen at the contests throughout competitive season.

Keywords: Detent, figure skating, vertical jumps, determinant parameters.

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

1. Introduction

Jumps are a set of codified gestures whose aim is to traverse a certain distance, using the longest or highest trajectory (King, 2004a). They can also represent athletic events of a highly spectacular degree, which overtime have known several changes in regards to the technique or the procedure used to achieve performance. In athletics, jumps represent an auto projection of the body in space, in one or several jumps. In essence, the aim is having the longest horizontal trajectory in the air for a length jump, and vertically for a height jump. To achieve this all internal and external forces that engage need to correlate. (Polensky, Kaufman, Calahan, Aleshinsky, Chao, 1990). The specificity of jumps involved in figure skating is the aspect of the trajectory and the rotation or rotations occurring in the air, around own axis. (King, 2000). The more rotations are carried out in the air during jumps, the more spectacular and valuable they are in terms of Code of Points. This involves the skater's detachment in the air and him executing fast rotations, the jumps being finalized in landing. (King, 2000).

2. Theoretical Framework

There are certain limitative factors that converge to successfully finalising a jump with several rotations in the air (Aleshinsky, Smith, Jansen, and Ramirez, 1988). The main motoric actions involved in figure skating jumps are:

- Auto propelling in space – creating oriented actions on ice, in order to realise technical actions specific to each task. (King, Smith, Casey, 2002).
- Using the reaction of the surface of the ice to the own action of the skate's blade, transferring them with minimal loss, the importance of aligning the segments when beating and taking off, as well as the one of the segmentary fixation (King, Arnold, and Smith, 1994).
- Ensuring the balance of the body on the flight trajectory (King, 2005).
- Rationally using the real rotations during flight and due to the force and direction of detachment. The compensation or accentuation of these sorts of rotations in order to keep the balance on trajectory, which is achieved using segmentary compensatory rotations, done by upper and lower limbs (King, Smith Higginson, Muncasy, Scheirman, 2004b).
- Achieving a segmentary controlled displacement in the flight phase, consistent with the mechanical characteristics of the trajectory of flight. (Aleshinsky, 1986).
- Optimising and securing the landing according to the statutory requirements of the jump. (Albert, and Miller, 1996).

3. Research Design

3.1. The Study Objectives

The main objective of our study was to identify the determining parameters of rotational jumps in figure skating done on land. The secondary objectives were:

- Measuring the determining parameters of rotational figure skating jumps.
- Conducting the comparative/descriptive statistical analysis
- Highlighting the conditions of carrying out of the rotational jumps.

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

3.2. The Research Data

Our study has been carried out during the competition season Oct 2015 – May 2016. Measuring the determinant parameters of rotational jumps has been performed at the end of the season, on Oct 24th 2016, outside the skating rink, with 7 ice skaters that took part in national and international competitions for beginners. This age category represents a turning point in an ice skater's career and links the competitions for children and the ones for juniors. Subjects were aged 10-13, their height was 136-156 cm, their weight average was 35,3±6 Kg, and their shoe size was 35,14±2 cm.

3.3. The Research Methodology

Testing has been performed with Opto Jump (fig.1), a device used to measure and evaluate some parameters of the detent, like: explosively, elasticity, reaction time, time spent by the sportsman in the air and on the soil.

Fig 1. Opto Jump

In our research we used *The 15 Second Task,* in which the sportsman has to execute, within 15 seconds, as many consecutive straight vertical jumps, jumps involving one or more rotations. All sportsmen have visualized, on the device's display, their results in real time, and also heard the coach's indications, which corroborated with the image given by the device. The software of this device has delivered data concerning the time spent on the soil, TS, time spent in the air during jump, TA, the height of the jump, HJ, and the total jump power, JP, during vertical straight jumps, S1, jumps with one rotation (360°), S2, and two rotations in the air (720°), S3. During the competition season sportsmen have each had observation charts based on the results of arbitration charts from the contest, and the final test has been carried out during a training outside the rink to highlight differences between straight vertical jumps with one and two rotations.

4. Results. Analysis and Interpretation

Final results for time on the soil **TS**, and time in the air **TA**, for straight vertical jumps (**1**), with one rotation (**2**), and two rotations (**3**), are presented in table 1.

Table 1. Statistical data concerning time on soil and in the air for straight vertical jumps, with one and two rotations

Sportsman.	TS1 (sec)	TS2 (sec)	TS3 (sec)	TA1 (sec)	TA2 (sec)	TA3 (sec)
D.O.	0,452	0,896	2,174	0,417	0,322	0,25
V.A.	0,183	0,622	1,04	0,48	0,378	0,38
B.A.	0,256	0,621	2,060	0,467	0,357	0,405
P.B.	0,219	0,372	0,367	0,401	0,405	0,413
I.L.	0,176	0,343	0,884	0,430	0,364	0,428

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

D.A.	0,219	2,681	0,330	0,372	0,334	0,319
P.I.	0,498	0,715	0,398	0,425	0,392	0,366
Average	0,286	0,893	1,036	0,427	0,365	0,366

We have **TS1 -** time on soil for the straight vertical jump, **TS2 –** time on soil for the one-rotation jump, (360°), and **TS3 -** time on soil for the two-rotation jump (720°). **TA1** is the time spent in the air during the straight vertical jump, **TA2** the time spent in the air for the one-rotation jump, (360°), and **TA3** time spent in the air for the two-rotation jump (720°).

4.1. Results regarding contact time on soil

In regards to the time spent on soil, Opto-jump has highlighted the amount of time the sportsman spent on the ground between landing and detachment to perform the next jump, as seen in table no. 1 and graph in fig. no. 2.

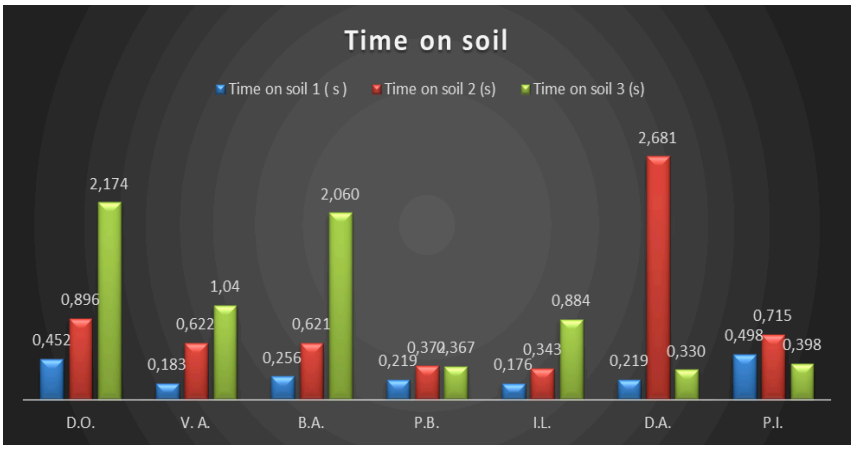

Fig. 2. Time on soil between vertical jumps, one- and two turns

Time on soil is different depending on the difficulty of the jump that the sportsman has to perform and the executant's level of training. We can see from the previous graph that the sportsman needs more preparation time for harder jumps (in our case one-rotation and two-rotation jumps) and their frequency within 15 seconds decreases from 15-20 simple jumps, to 2-4 two-rotation jumps. The average time spent on soil for first jump, TS1, was 0,286 seconds, second, TS2, was 0,893 seconds, and for the third jump, TS3, was 1,036 seconds. The difference between the contact time on soil for the straight vertical jump and the one-rotation jump was 0,607 seconds, and this significant difference is due to the 6th contestant, who needed a preparation time of over 2 seconds for the one-rotation jump following the straight vertical jump. The difference between the average of the first jump, TS1 and the third, TS3 is 0,75 seconds, and between the second, TS2 and the third, TS3 is 0,143 seconds. Therefore, the contact time on soil, the preparation time for the jump, considerably increases when the rotation is present, and there is no significant difference between the preparation time for the two-rotation jump compared to the one for the one-rotation jump. Different results only occured for the first sportsman, for whom TS3 was three times TS1, sportsman no. 3 with TS3 almost 10 times TS1, and sportsmen no. 6 and 7 with TS3 less than TS1.

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

4.2. Results regarding time spent in the air

In the following graph we compared times spent in the air for each jump the sportsmen have performed :

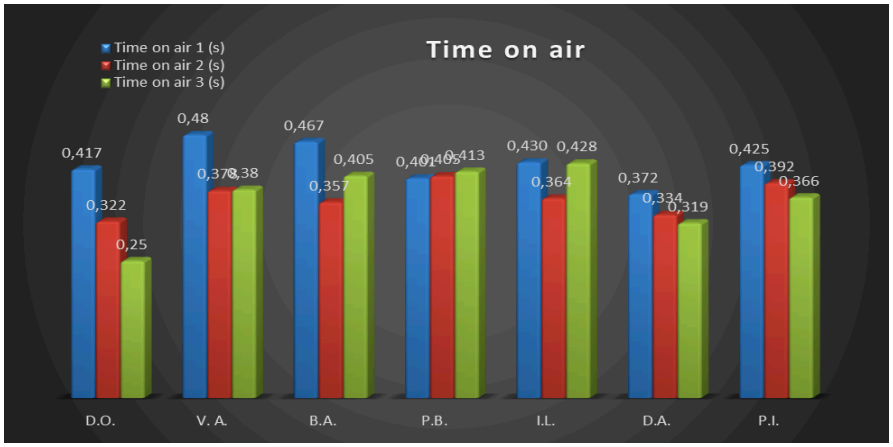

Fig. 3. Time on air between vertical jumps, one- and two turns

As it can be seen the time spent in the air for the vertical jump TA1, (in blue) is on average 0,063 sec longer than for one-rotation jumps, TA2, (in red). The difference between the amount of time spent in the air during straight vertical jumps, TA1 and the two-rotation jumps, TA3 is 0,061 sec. The difference between the amount of time spent in the air during the one-rotation jumps, TA2, and two-rotation jumps, TA3, (in green) is just 0,001 sec. According to these results, the time spent in the air for a two-rotation jump is approximately equal to the time for a one-rotation jump and less than for the straight vertical jump, with one exception when time on air 1 is less than time on air 2 and 3. The time average for the first jump is 0,427 seconds, and for the one- and two-rotation jumps times are approximately equal, 0,365 and 0,366 seconds.

4.3. Results regarding the height of the jump

The straight vertical jumps have been analysed acording to their validity, as in invalid jumps were the ones when the sportsman has gone over the surface of the sensors and they were eliminated. The results recorded for jump height are represented in table no.2 and graph in fig. 4, where **HJ1 -** vertical jump height, **HJ2 –** one-rotation jump height and **HJ3 –** two-rotation jump height.

Table 2. Statistical data regarding height of jump - HJ and power of jump – JP – straight vertical, one/two-rotation jumps

Sportsman.	HJ1 (cm)	HJ2 (cm)	HJ3 (cm)	JP1 (w/kg)	JP2 (w/kg)	JP3 (w/kg)
D.O.	21,294	20,144	18,575	19,034	14,149	7,066
V.A.	28,213	24,775	18,56	42,339	23,971	19,212
B.A.	26,814	23,083	25,525	32,837	23,334	12,840
P.B.	19,900	20,107	20,960	28,090	19,381	18,805
I.L.	22,690	16,993	19,160	35,704	20,111	14,442
D.A.	17,023	13,650	12,600	24,566	9,033	9,403
P.I.	22,147	18,891	16,425	18,913	14,576	16,993
Average	22,583	19,663	18,829	28,783	17,794	14,109

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

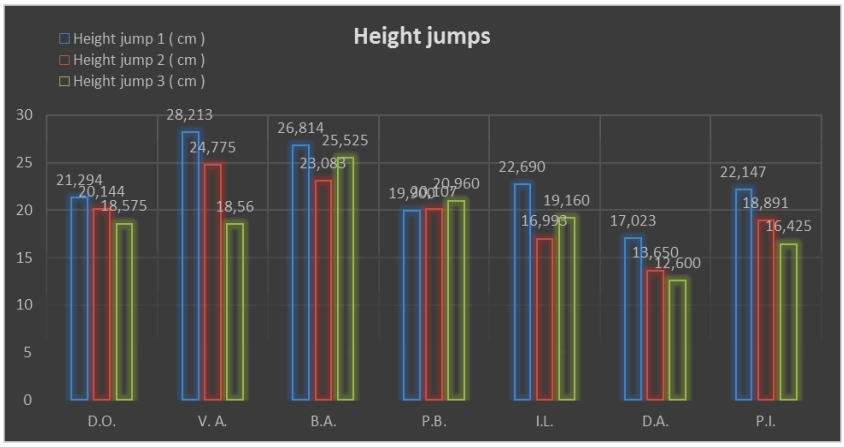

Fig. 4. The height jump at the vertical jumps, one- and two turns

In our research we measured the height of jumps in cm, we calculated and used the average of statistical data. From table 2 and graph in fig. 4, we can see that the average height of straight vertical jumps, HJ1 is 2,92 cm greater than the average height of one-rotation jumps, HJ2, and 3,754 cm greater than the average of jumps 3, HJ3. The aveerage of one-rotation jumps, HJ2 is 0,834 cm greater than the average height of two-rotation jumps, HJ3, so a minimal difference. Just sportsman 4, P.B., had the height of the second and third jump 0,207cm, and 1,06 cm higher than the first jump.

4.4. Results regarding the power of jump

In the present research power is represented by the force with which the sportsman pushes the ground in orider to propel himself in the air. As for the time spent in the air, power is strongly correlated with the height of the jump, therefore the results are similar to the ones regarding the height of the jump and the ones regarding time spent in the air. We have **JP1** power of straight verrtical jump, **JP2** power of one-rotation jump (360°), and **JP3** power of two-rotation jump (720°). Results can be seen in table no.2 and graph in fig. no.5.

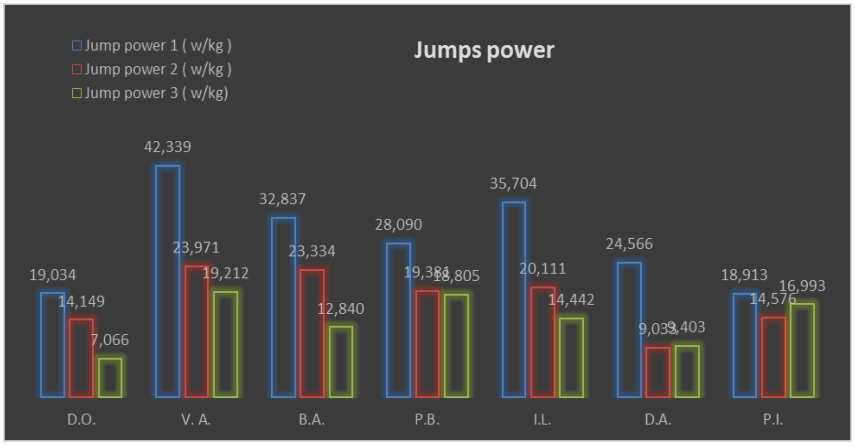

Fig. 5. The jumps power at the vertical jumps, one- and two turns

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

In regards to the power of jumps performed, for all sportsmen involved in the measurements, the power of the first jump, the straight vertical one, JP1, is greater than the power of the second jump, JP2, and the third, JP3. Only one sportsman has developed greater power for the second jump, JP2, omparing to the third, JP3, by 2,417 w/kg. The average power for straight vertical jumps, JP1, is 10,989 w/kg greater than the one for one-rotation jumps, JP2, and 14,674 w/kg greater than the average power for two-rotation jumps, JP3. The average power of one-rotation jumps, JP2, is 3,685 greater than the average for two-rotation jumps JP3.

5. Conclusion

By identifying the determinant parameters of the rotational jumps involved in figure skating, the main objective of our study has been achieved. In our view these are: the time spent on the ground, meaning the preparation time (TS), the time spent in the air (TA), the height of the jumps (HJ), and the power of the jumps (JP).

Through measuring these parameters and the statistical analysis performed, we also achieved two of our secondary objectives of our study. Hence, through the graphical analysis we reached the conclusions that the time spent in the air (TA), the height (HJ) and power (JP), the statistical data for the one- and two-rotation jumps is less than the statistical data for the straight vertical jumps.

As for the time spent on soil, with one exception, sportsmen spent a greater amount of time on the ground for the third jump, TS3, than for the second TS2, - by 0,143 seconds, - and 0,75 seconds less than for the first jump, TS1. So it takes a greater amount of preparation time on the ground for the one-rotation jump, and for the two-rotation jump.

As for the time spent in the air, we expected that to be a greater amount of time in which regards the one- and two-rotation jump. Our research proved that the greatest time is required for the straight vertical jump, TA1, which is 0,062 seconds greater than the one for the one-rotation jump, TA2, and 0,061 seconds greater than the time spent in the air for the two-rotation jump, TA3.

Statistical data for the height of the jump show that the first jump, HJ1, with no rotations, is the highest jump, 2,920 cm higher than the one-rotation HJ2, and 3,754 cm higher than the two-rotation jump, HJ3. The one-rotation jump HJ2 is 0,834 higher than the two-rotation jump HJ3.

Also, the statistical data for the power of the jump show that the power of the first jump, JP1, is 10,990 w/kg greater than the power of the one-rotation jump, JP2, and 14,675 w/kg greater than the two-rotation jump, JP3. The power of the one-rotation jump, JP2, is 3,685 w/kg greater than the two-rotation jump, JP3.

As far as the determinant parameters of the jumps involved in figure skating (outside the ice rink) are concerned, as measured with Opto-jump, analysing the results has shown that the factors considered to be limitative traditionally speaking were not to be applied for 6 out of 7 sportsmen. The height of a jump is not limitative criteria for performing multiple-rotation jumps, that being equal or grater for the straight vertical jump, which is considered a low-difficulty jump, compared to the jumps involving rotations in the air which are specific to ice skating.

After centralising the data from arbitration charts from the „Santa Claus Cup" contest in Budapest and comparing that to the indicators for height and power of jumps measured during our research, we

http://dx.doi.org/10.15405/epsbs.2017.05.02.214
Corresponding Author: Anca Ionescu
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

reached the conclusion there is no direct link between the score in the contest and the height or power of the jumps.

Acknowledgements

The professional Opto Jump device, was acquired through the structural funds project: „RTD Institute: High-tech Products for Sustainable Development" (ID123, SMIS 2637, ctr. No. 11/2009).

References

Albert, W.J., and Miller, D.I. (1996). Take-off characteristics of single and double axel figure skating jumps. *Journal Appl. Biomech*. 12: 72-87.

Aleshinsky, S.Y. (1986). What biomechanics can do for figure skating: Part II. *Skating 63*(10): 11-15.

Aleshinsky, S.Y., Smith, S.L., Jansen, L.B., and Ramirez, F. (1988). Comparison of biomechanical parameters demonstrated by Brian Boitono in the triple and double axel jumps. In: *Proceedings of the 12th Annual Meeting of the American Society of Biomechanics* (p. 201). Urbana, IL: University of Illinois.

King, D.L., Arnold, A.S., and Smith, S.L. (1994). A kinematic comparison of single, double, and triple axels. *J. Appl. Biomech*. 10: 51-60.

King, D.L. (2000) Jumping in Figure Skating, in *Biomechanics in Sport*: Performance Enhancement and Injury Prevention (ed V. M. Zatsiorsky), Blackwell Science Ltd, Oxford, UK.

King, D.L., Smith, S., and Casey, K. (2002). How'd they do that toe-loop? Part I. *Skating 79*(3): 62-63, 76.

King, D.L. (2004a). Biomechanics. In: M.A. Bradley and D. Miller (Eds.), *Coach's Guide to Figure Skating Sports Sciences and Medicine* (2nd ed.). Rochester, MN: Professional Skaters Association.

King, D.L., Smith S.L., Higginson, B.K., Muncasy, B., and Scheirman, G.L. (2004b). Characteristics of triple and quadruple figure skating jumps performed during the Salt Lake City 2002 Winter Olympics. *Sport Biomechanics. 3*: 109-123.

King, D.L. "Performing Triple and Quadruple Figure Skating Jumps, (2005). Implications for Training" Can. J. Appl. Physiol. 30(6): 743-753. *Canadian Society for Exercise Physiology*.

Podolsky, A., Kaufman, K.R., Calahan, T.D., Aleshinsky, S.Y., and Chao, E.Y.S. (1990). The relationship of strength and jump height in figure skaters. Am. *J. Sports. Med*. 18: 400-405.