

USE OF JACUZZI BATH FOR LOWER LIMBS TIREDNESS RECOVERY AFTER STRENUOUS WORKOUT: A CONTROVERSIAL FINDING

Supriyo Mondal¹, Dr. Abhishek Kumar Yadav² & Chandan Ghosh³

¹Ph.D. Scholar, Lakshmibai National Institution of Physical Education, Gwalior, Madhya Pradesh, India.

Email: supriyomondal25@gmail.com

²Assistant Professor, Lakshmibai National Institution of Physical Education, Gwalior, Madhya Pradesh, India.

³Ph.D. Scholar, Department of Physical Education, Visva Bharati University, West Bengal, India.

Abstract

Lower limbs tiredness is one of the widely accepted indicators of recovery state prediction. The study was designed and purposed to know the rate and trend of lower limbs tiredness recovery due to waist level Jacuzzi bath for 30 minutes after strenuous workout for 10 minutes. Ten athletes from LNIPE, Gwalior having almost similar anthropometric measurements, physiological capacity, chronological age (18-19 year), training age (5-6 year), event (sprinters) etc. residing in same campus having similar daily routine were selected as participant in this experiment. The experiment was conducted in a highly controlled environment using sophisticate equipments. Target Heart Rate Zone of the workout lasting for 10 minutes was 85%-95% of their Maximum Heart Rate. Three readings including pre, post and 30 minutes post workout was considered for both the two tests (Isometric Leg Strength Test and Sergeant Jump Test) selected for the purpose. rANOVA was employed separately to derive out meaningful information from the raw data. In both the tests well controlled workout for 10 minutes resulted in significant decreased state of post workout readings. With passage of time after 30 minutes of Jacuzzi recovery there was improvement in state of isometric leg strength, whereas further decrease in explosive strength was evident. The sports scientists are advised to conduct more basic researches of high scientific nature to justify or reject the use of Jacuzzi bath as a mean of immediate recovery or not as the researcher had got controversial findings.

Keyword: Sports, Recovery, Jacuzzi, Isometric Leg Strength, Explosive Leg Strength, rANOVA

Introduction

Background: A certain amount of muscular strength is prerequisite for any sort of human movement (Thomas, 2008) as the body lever is made up of mainly bones and muscles. The force for functioning of this lever is generated by none other than muscles involved in that particular movement. Better the strength of an individual greater the force generated, as force is directly proportionate to strength of agonist muscles. Due to these reasons strength is one of the most contributing factors for sport involving high level of competition. Exceptional apart, most of the sports demanding immediate and powerful force production, utilizes the lower limbs for the same purpose, resulting in huge deposit of metabolic waste within the lower limbs due to insufficient presence and utilization of oxygen, disturbances in production of K^+ and other factors (Kellmann, 2002). A diminished transsarcolemmal K^+ gradient per se can reduce maximal force in non-fatigued muscle suggesting that K^+ causes fatigue. Changed transsarcolemmal Na^+ , Ca^{2+} , Cl^- and H^+ gradients are insufficient by themselves to cause much fatigue but each ion can interact with K^+ effects (Cairns et al. 2008; Michael et al. 2008).

Water as a medium has added benefit for promotion of physiological as well as psychological recovery after taxing workout. Researches on cold water immersion (Ascensão et al. 2011), hot water shower (Kinugasa et al. 2009), hot-cold alternate immersion (Ingram et al. 2009), active recovery in water (Nair et al. 2010) etc. are in current trends for this decay. The researcher after reviewing literature have an idea that Jacuzzi bath for the target population may be useful in real sense, thus to test this hypothesis present research in a highly controlled manner was conducted.

Purpose: Root behind conducting this study was to know the rate and trend in lower limbs tiredness recovery due to Jacuzzi bath after strenuous workout, as it may help to aid information in the area of sport recovery for planning training and further researches in future.

Methodology

Participants: Ten athletes from LNIPE, Gwalior were selected for this research. They had almost similar anthropometric measurements, physiological capacity, chronological age (18-19 year), training age (5-6 year), and event (sprinting in track and field) etc. residing in same campus, again they had similar daily routine.

Criterion Measures: Leg strength was selected to be studied at different time interval with the help of two widely accepted tests i.e. sergeant jump test (Johnson et al.1996; Linnamo et al. 1998) and isometric leg strength test (Carpenter et al. 2006; Leveritt et al. 2000)

Administration of the Experiment: The experiment was conducted in the fitness center of LNIPE, Gwalior having controlled temperature ($28^{\circ}C$) inside A/C fitness centre during the month of August and September, 2013. Equipments used were Treadmill (FreeMotion co.), Heart Rate Monitor Watch (Garmin Forerunner), Jacuzzi Tub, Room Temperature Thermometer

(Omsons), Portable Leg Dynamometer etc. The participants were informed about the pros and cons of experiment to be conducted in detail and their willing concern was taken on paper. The experiment started with a mild warm up session consisting of self stretching. The treadmill intensity was manipulated in a slow progression manner to such that the heart rate remained within the Target Heart Rate Zone (THR) of 85%-95% of their Maximum Heart Rate (Tanaka et al. 2001) ($HR_{max} = 208 - (0.7 \times \text{age})$) for at least 7 minutes of the total 10 minutes of duration during treadmill workout. The well established Karvonen formula (Karvonen et al. 1957) ($THR = ((HR_{max} - HR_{rest}) \times \% \text{ intensity}) + HR_{rest}$) for calculating target heart rate was used. Participants were free to withdraw themselves at any point of workout. Best of two readings on leg strength of both the test were taken at regular interval just before workout, just after workout and 30 minutes after workout. Post recovery till the last reading the participants kept sitting inside the Jacuzzi tub up to the waist level and had Jacuzzi bath for 30 minutes at water temperature around 30°C (Bompa, 1994.; Boone et al. 1999; Hashiguchi et al. 2002).

Statistical Technique: Repeated measure design approach was followed for the study. For analyzing the obtained data and derive the meaningful information from it descriptive statistics, one way repeated measure analysis of variance (rANOVA) and Bonferroni post hoc test was conducted using IBM SPSS-17 software (Verma, 2011). Level of significance chosen was 0.05.

Results & Findings

Table 1: Descriptive Statistics of Leg Strength

Reading at Different Time	Isometric Leg Strength			Explosive Leg Strength		
	Mean	Std. Deviation	Std. Error	Mean	Std. Deviation	Std. Error
Leg Strength Pre Activity	174.90	31.09	9.83	58.90	7.09	2.24
Leg Strength Post Activity	152.20	21.07	6.66	52.50	7.20	2.28
Leg Strength Post Recovery	171.20	20.80	6.58	50.00	7.73	2.44

Table 1 indicates descriptive scores of mean, standard deviation & standard error of mean for both isometric leg strength & explosive leg strength of the participants.

Table 2: Mauchly's Test for Testing Assumption of Sphericity

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	P-Value	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Isometric Strength	0.74	2.42	2	0.30	0.79	0.93	0.50

Explosive Strength	0.94	0.51	2	0.78	0.94	1.00	0.50
--------------------	------	------	---	------	------	------	------

Results of table 2 shows that in both the case assumption of sphericity has been met as Mauchly's Test of Sphericity is nonsignificant having P-Values more than 0.05.

Table 3: Within-Subjects Effects of Leg Strength Tests

Test	Type III Sum of Squares	df	Mean Square	F	P-Value
Isometric Leg Strength	2966.60	2	1483.30	8.58*	.002
Error(Isometric Leg Strength)	3113.40	18	172.97		
Explosive Strength	421.40	2	210.70	101.77*	.000
Error (Explosive Strength)	37.27	18	2.07		

*Significant at 0.05 level.

According to Table 3, as the significance of F in the first case is 0.002 and in the later case is 0.000 both of which is less than the criterion value of 0.05 statistical significant differences is present in both the cases. We can, therefore, conclude that there was a significant difference between the leg strength readings at different time point calculated by Isometric Leg Strength Test and Sergeant Jump Test. However, this test does not tell us exactly in between which readings the difference exists. For availing this detail information we conducted Bonferroni post Hoc test.

Table 4: Pairwise Comparisons of Marginal Leg Strength Means

	Leg Strength (I)	Leg Strength (J)	Mean Difference (I-J)	Std. Error	P-Value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Isometric Leg Strength	Pre Activity	Post Activity	22.70*	4.77	.003	8.71	36.69
	Pre Activity	Post Recovery	3.70	7.20	1.000	-17.43	24.83
	Post activity	Post Recovery	-19.00*	5.40	.020	-34.84	-3.16
Explosive Leg Strength	Pre Activity	Post Activity	6.40*	0.60	.000	4.64	8.16
	Pre Activity	Post Recovery	8.90*	0.60	.000	7.13	10.67
	Post activity	Post Recovery	2.50*	0.72	.021	0.39	4.61

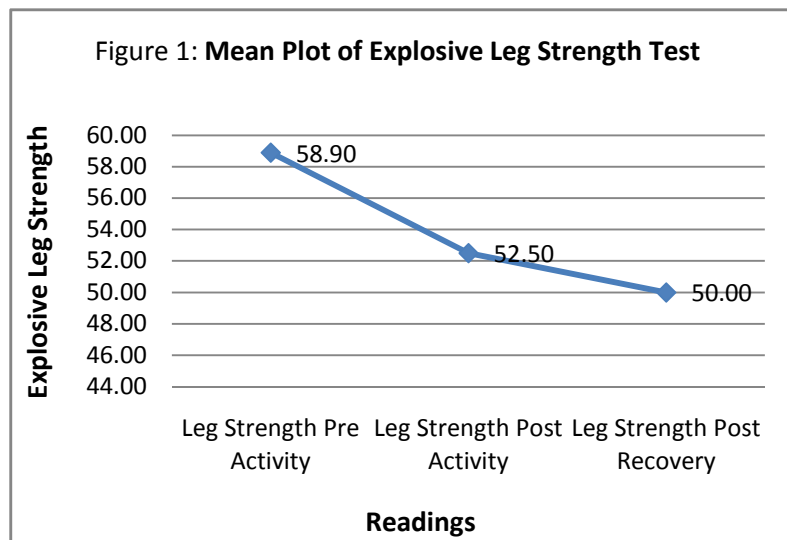
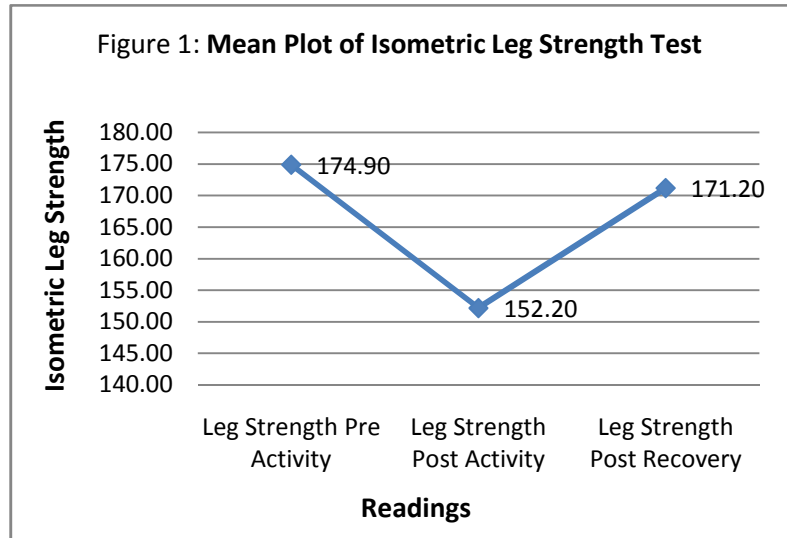
* Significant at 0.05 level

The rows having mean difference followed by star (*) in the above Table 4 indicates the presence of significant difference between various reading points of both the leg strength test.

Pairwise Comparisons of Marginal Means of the Isometric Leg Strength Test shows there existed significant difference with pre activity reading to post activity readings and with post activity reading to post recovery reading but had no significance different between pre activity to post recovery readings. In case of Sergeant Jump Test significant difference was found with pre activity reading to post activity readings and post recovery reading. Again difference is present between post activity and post recovery readings.

Discussion of Findings

The trend of tiredness of lower limbs after strenuous workout followed by Jacuzzi bath recovery is shown in Figure 1, for Isometric Leg Strength and Figure 2, for Explosive Leg Strength. The findings of isometric as well as explosive leg strength tests disclose that there was significant decrease in both of it (P-Value = 0.003 and 0.000 respectively) due to 10 minutes of highly controlled workout at 85%-95% of their HR_{max} . Isometric leg strength did recover significantly (P-Value = 0.020) till 30 minutes post workout due to waist height Jacuzzi bath at 30°C during this recovery phase whereas the same recovery modality has caused decrease in explosive leg strength further. As the pre workout to post recovery readings not only remained significantly (P-Value = 0.000) different but also decreased further more in case of explosive leg strength. In case of isometric leg strength pre activity to post recovery readings are not significant (P-Value = 1.00) as it is seen that this particular strength has come back near to base line resulting in huge recovery. Considering the findings we may conclude that Jacuzzi bath up to waist height at 30°C during 30 minute of recovery phase promotes isometric strength recovery from tiredness of lower limbs after strenuous workout, but causes further decrease in explosive strength. The positive results



seen may be due to combine effect of hydrostatic pressure and turbulence effect causing better venous return, removal of metabolic waste, better transport of nutrition and oxygen due to increased circulation of blood through the kidneys and heart during this recovery period (Wilcock et al. 2006; Mondal, 2013). The sports scientists are advised to conduct more basic researches of high scientific nature to justify or reject the use of Jacuzzi bath as a mean of immediate recovery or not as the researcher had got controversial findings.

Conclusion

In both the tests Isometric Leg Strength Test and Sergeant Jump Test for assessing tiredness of lower limbs after strenuous well controlled workout for 20 minutes we found significant increase state of post workout readings. With passage of time after 30 minutes post Jacuzzi bath recovery there was improvement in state of lower limbs tiredness after strenuous workout, though further scope of more recovery is there in explosive strength as the same recovery modality has caused decrease in explosive leg strength further. In future more research can be framed to have clear idea on this controversial finding and to promote strength recovery during this post recovery period by incorporating other different means, methods, modalities etc.

Acknowledgement

Sincere & honest thanks from core of the heart to **Prof. Manika Debnath**, HOD, DHS&F, LNIPE, and **Shri K.K. Bhatia**, Assistant Registrar (Procurement & Finance), LNIPE for extending their help in providing equipments and facilities required to accomplish the research smoothly. I also thank the participants for their voluntary interest in the experiment.

References

- Ascensão A, Leite M, Rebelo AN, Magalhães S, Magalhães J. (2011). Effects of cold water immersion on the recovery of physical performance and muscle damage following a one-off soccer match, *J Sports Sci.*29(3):217-25.
- Bompa, Tudor. O. (1994). *Periodization: Theory and Methodology of Training 4th edition*, United States of America, Human Kinetics Publishers.
- Boone, T., Westendorf, T., & Ayres, P. (1999). Cardiovascular responses to a hot tub bath, *The Journal of Alternative and Complementary Medicine.* 5(3): 301-304. doi:10.1089/acm.1999.5.301.
- Cairns, S. P., & Lindinger, M. I. (2008). Do multiple ionic interactions contribute to skeletal muscle fatigue?, *J Physiol.*, 586(17): 4039–4054
- Carpenter, MR., Carpenter, R.L., Peel, J., Zukley, L.M., Angelopoulou, K.M., Fischer, I., Angelopoulos, T.J., & Rippe, J.M. (2006) The reliability of isokinetic and isometric leg strength measures among individuals with symptoms of mild osteoarthritis. *J Sports Med Phys Fitness.* 46(4):585-9.
- Hashiguchi, Nobuko., Ni, Furong., & Tochihara, Yutaka. (2002). Effects of Room Temperature on Physiological and Subjective Responses during Whole-body Bathing, Half-body

- Bathing and Showering, *Journal of Physiological Anthropology and Applied Human Science*. 21(6): 277-283
- Ingram, J., Dawson, B., Goodman, C., Wallman, K., & Beilby, J. (2009) Effect of water immersion methods on post-exercise recovery from simulated team sport exercise, *J Sci Med Sport*. 12(3):417-21.
- Johnson, D.L., and Bahamonde, R. (1996) Power Output Estimate in University Athletes. *Journal of Strength and Conditioning Research*, 10(3), 161-66.
- Karvonen, J.J., Kentala, E., & Mustala, O. (1957) The effects of training on heart rate: a "longitudinal" study. *Ann Med Exp Biol Fenn.*, 35: 307-15.
- Kellmann, Michael, (2002), *Enhancing Recovery : Preventing Underperformance in Athletes*, United States of America, Human Kinetics Publishers
- Kinugasa T, Kilding AE. (2009). A comparison of post-match recovery strategies in youth soccer players, *J Strength Cond Res*.23(5):1402-7.
- Leveritt, M., MacLaughlin, H., & Abernethy, P.J. (2000). Changes in leg strength 8 and 32 h after endurance exercise, *J Sports Sci*. 18(11): 865-71.
- Linnamo, V., Hakkinen, K., Komi, P.V., (1998) Neuromuscular fatigue and recovery in maximal compared to explosive strength loading. *European journal of applied physiology*. 77: 176-181.
- Michael J. McKenna, Jens Jean-Marc Renaud. (2008). Muscle K⁺, Na⁺, and Cl⁻ disturbances and Na⁺-K⁺ pump inactivation: implications for fatigue, *Journal of Applied Physiology*. 104(1): 288-295 Retrived on 7.12.2013 from <http://www.jappp.org/content/104/1/288.full>
- Mondal, S. (2013). *Hydro Activity for Stress Recovery in Sports*, LAP Lambert Academic Publishing.
- Nair, Usha. S., Mondal, Supriyo., & Tiwari, Sandhya. (2010). Effect of low impact water exercise on stress recovery of college football players, *Br J Sports Med*. 44:i18 doi:10.1136/bjism.2010.078725.58
- Tanaka, Hirofumi., Monahan, Kevin. D., & Seals, Douglas. R. (2001) "Age-predicted maximal heart rate revisited". *Journal of the American College of Cardiology*. 37 (1): 153-6. doi:10.1016/S0735-1097(00)01054-8. PMID 11153730
- Thomas, R. Baechle. (2008). *Essentials of Strength Training and Conditioning-3rd Edition*, NSCA -National Strength & Conditioning Association.
- Verma, J. P. (2011). *Statistical Methods for Sports and Physical Education*, Tata McGraw Hill Education Private Ltd.
- Wilcock, I.M., Cronin, J.B., Hing, W.A., (2006) Water immersion: does it enhance recovery from exercise?, *Int J Sports Physiol Perform*. 1(3):195-206. PMID: 19116434 [PubMed - indexed for MEDLINE]