Journal Academica Vol. 7(1), pp. 003-011, April 6 2017 - Physical Education - ISSN 2161-3338
online edition www.journalacademica.org

Full Length Research Paper

The Influence of Different Intensity Swimming Warm-ups on 200m Freestyle Performances

Fragiscos Siamos[1], Vasilios Thanopoulos[1]*, Georgia Rozi[1], Milivoj Dopsaj[2], Epaminontas Gerou[1]

[1] Department of Aquatic Sports, Faculty of Physical Education and Sports Science, University of Athens (Greece)

[2] Department of Theory and Technology of Sports Training, Faculty of Sport and Physical Education, University of Belgrade (Serbia)

Received February 1, 2017; Accepted March 7 2017

ABSTRACT

The effects on physiological responses of two warm-up types were investigated after 200m freestyle. 14 well-trained swimmers performed 200m freestyle swimming after a) 4x25m freestyle maximum intensity and b) 1000m freestyle with moderate intensity. No statistical significant differences were observed between different types of warm-up in all measured variables. With regard to gender, statistical significant differences were observed in blood lactate and time performance with males having higher levels of blood lactate and better performance time (Sig. .003 and .000 respectively). Different types of warm may have different effect on each swimmer.

Keywords: training, competition warm-ups, physiology

INTRODUCTION

The athletic performance, especially in endurance sports, requires prompt activation of almost the total locomotion system as well as rapid adjustment of cardio-respiratory function and metabolism [Chwalbinska-Moneta and Hanninen, 1989].

Warm-up improves the physiologic adjustment of the locomotor and cardiovascular systems [Ingjer and Stromme, 1979] as well as psychological readiness to work [Schmidt, 1975] allowing achievement of better results in the athletic event or other kind of physical work.

The increase in body temperature, which may be caused by warming up exerts a positive effect on the performance capacity [Martin et al., 1975] but is also known to be a factor limiting endurance [Kozlowski et al., 1985].

The effects of an active warming up procedure, involving muscular exercise of various type, intensity, and duration, on body temperature and cardio respiratory or metabolic responses to physical work have not been fully recognized [Chwalbinska-Moneta and Hanninen, 1989].

Coaches and athletes are generally convinced of the positive effect of some warming up procedures in achieving a good performance [De Vries, 1959; Franks, 1983). There are several types of warming up such as active and

*Corresponding author: vthano@phed.uoa.gr

passive, specific and general [De Bruyn- Prevost and Lefebvre, 1980].

The assumed benefits of an active warm-up may be ascribed to changes in physiological mechanisms caused by an increase in muscle temperature [Asmussen and Boje, 1960] in circulatory and oxygen transport systems [Barnard et al., 1973].

It is generally accepted that warm-up is an integral part of physical training and of competition. However, there is a considerable variation as to the warm-up ritual used among athletes, coaches and physical educators. The most common warm-up procedure seems to be active warm-up, involving muscular exercise of varying intensity [Ingjer and Stromme, 1979].

The practice of warm-up prior to any strenuous exertion, has been widespread both for the improvement of athletic performance and for prevention of potential sports injuries. These benefits have been commonly attributed to a number of physiological mechanisms related to the skeletal muscle [Asmussen and Boje, 1960] and the O_2 transport system [Barnard et al., 1973; Gutin et al., 1976]. There have been claims that psychological factors play an important role in the warm-up-related benefits. This aspect has been investigated among others, by Rochelle, Skubic, and Michale, [1960], Massey, Warren, Johnson, and Kramer [1961], and Smith and Bozymowski [1965].

If performed at high intensity, warm-up may cause a negative effect, fatigue and impaired performance [Margaria et al., 1971; Richards, 1967; Stewart et al., 1973].

One way to decrease this fatiguing effect would be the use of an intermittent type warming up [Gutin et al., 1976]. This type of exercise, when performed at intervals less than 60s long, has been shown to cause lower lactacid O_2 debt than a corresponding continuous activity [Astrand et al., 1960; Christensen et al., 1960].

No data on children were available to us in which the physiological effects of warm-up have been systematically looked at, when both the warm-up and the criterion task were controlled in the laboratory.

Inbar and Bar-Or, [1975] studied the influence of intermittent warming up on an anaerobic sub-maximal exercise lasting 30s. They reported higher oxygen consumption (VO_2) and higher heart rate during exercise after warming up.

Numerous studies have been carried out to clarify the assumed effects of warm-up but the results have been conflicting. Some reports conclude that active warm-up is beneficial for optimal performance [Asmussen and Boje, 1960; Inbar and Bar-Or, 1975; Michael et al., 1957; Pacheco, 1957] while other studies have failed to find any favorable effects of warm-up [Lotter, 1959; Massey et al., 1961; Mathews and Snyder, 1959; Sedgwick & Whalen, 1964; Thompson, 1958].

While Carlile [1956] reported a positive influence of warming up on performance, some authors like Karpovich and Hale, [1956] and Lotter [1959] were unable to demonstrate a statistically significant difference between performance with- and without warming up. Moreover, De Vries [1959] observed a negative effect upon swimmers performance following calisthenics while the same subjects attained better results when swimming was used as warming up procedure.

According to Karpovich and Hale [1956], warming up activates the same movements as those involved in the actual exercise. Better coordination may result from this procedure.

Previous studies have provided conflicting research results which are difficult to interpret. Several studies suggest a favorable effect derived from warm-up exercise [Asmussen and Boje, 1960; Martin et al., 1975; Ingjer and Stromme, 1979; DeBruyn –Prevost, 1980] while others report no effects [Knowlton et al., 1978; Sedgewick, 1964; Sedgewick and Whalen, 1964].

Results from several investigations suggest that elevated blood lactate concentration associated with prior exercise may contribute to fatigue [Karlsson et al., 1975; Klausen et al., 1972]. Other studies indicate that elevated blood lactate concentration prior to maximal exercise does not impair performance [Weltman et al., 1977; Weltman et al., 1979].

Swimming is a very demanding sport that requires extreme muscle strength and endurance. Only fractions of a second may separate the first place from the second [Bobo, 1999].

The purpose of this research is to investigate whether the effect of two different types of warm, moderate and high intensity, changes the concentration of lactate in the blood and heart rate of athletes after swimming with maximum intensity at the distance of 200m freestyle.

METHODS

This study involved 14 volunteer sprinter swimmers of competitive level, n=7 male aged 16±1 years, height 174±8.5cm, weight 64±7 kg and n=7 female aged 16±0.6 years, height 160±4.5cm and weight 52.1±5.5kg, who attended a daily training 5 to 6 times per week lasting 2 hours. Before the conduction of the measurements, ethical approval was granted for the study by the ethics panel of Athens University.

SAMPLE

The sample consisted of 114 athletes. 69 athletes of classical swimming (30 male and 39 female, age 15 ± 1 and 15 ± 1,1 years, height 174,1 ± 6,7 and 165,7 ± 6,1cm and weight 61,8 ± 9 3 and 56,4 ± 7,4 kg respectively for male and female) and 45 fin swimming athletes (32 male and 13 female, age 16 ± 0,8 and 16 ± 1,2 years, height 173 ± 4, 8 and 162,4 ± 4,5cm and weight 69,8 ± 9,1 and 55,5 ± 8,0 kg respectively for male and female). All participants were active athletes and participated in systematic training six times per week.

INSTRUMENTS AND PROCEDURE

Since participants and their parents were informed of the purpose of the investigation and gave their written consent, we proceeded with the conduction of the measurements. All measurements were taken during morning hours in 4 different sessions. The research was conducted 15 days before competition of the summer period in a 50m indoor swimming pool with water temperature 26±1C^{o}. For the purpose of the research we measured the height and weight of the subjects.

On the first day of the measurements 6 participants randomly swam the distance of 1000m freestyle with 50% intensity of their better performance in 200m freestyle. The choice of 200m was made because longer swimming events would require multiple laps and flip turns which would have diluted the impact of the warm-up [Balilionis et al., 2012]. Hand signals were used by the coach to communicate with the swimmers, showing them to speed up or slow down to maintain an appropriate pace [West et al., 2005].

After a five minutes rest, they performed 200m freestyle swimming with maximum intensity.
At the next session two days later, they swam the distance of 4x25m freestyle with 45΄΄ mixed time for each 25m. After five minutes rest, they performed 200m freestyle swimming with maximum intensity. All types of warm-up started from the water and the 200m freestyle started from the start block. At the next sessions the remaining 6 participants were measured.
Immediately after each test, heart rate was measured by manual palpation method at the wrist or neck. All the participants were familiar with this procedure because they used this method in regular swimming training. The participants counted their own heart rate for 10 seconds [Balilionis et al., 2012]. Also, for determining the maximum concentration of lactic acid in the blood, capillary blood samples were taken from the fingertip in the 3rd, 5th and 10th minute after each test and analyzed with an automatic analyzer Scout Lactate Germany.

STATISTICAL ANALYSIS

All data went through descriptive and preliminary statistics for the evaluation of normality of distributions (MEAN = average, SD = standard deviation) and the homogeneity of variances was examined.
For the analysis of the data, analysis MANOVA was applied. For the investigation of individual differences among male and female swimmers and the two warm-up conditions, ANOVA analysis was applied.
For all statistical analysis, the statistical program SPSS 22 was used.
The level of statistical significance was set at $p > .05$.

RESULTS

Descriptive statistics of variables are shown in Table 1.
The results of multivariate analysis MANOVA showed no significant effect of the variable ‘warm-up’ to the linear combination of the dependent variables. The multivariate index Wilk's L was equal to 0.928, corresponding to $F (4,13) = 0,252$, Sig. .903, $p <.05$. The index η^2 is equal to 0.07, i.e., 7% of the distribution of the linear combination of the dependent variable was explained by the statistical effect of the independent variable ‘warm-up’.
Statistical significant effect of the independent variable ‘gender’ was observed to the linear combination of the dependent variables. The multivariate index Wilk's L was equal to 0.202, corresponding to $F (4,13) = 12,819$, Sig. .000, $p <.05$.
Finally, no statistically significant interaction occurred between the variables ‘warm-up’ and ‘gender’ to the linear combination of the dependent variables. The multivariable index Wilk's L was equal to 0.750, corresponding to $F (4,13) = 1,085$, Sig. .404, $p < .05$.

Table 1 Mean and standard deviation between the two types of warm-up and between the two genders

	1000m warm-up			4x25m warm-up		
	Male	Female	Total	Male	Female	Total
Blood lactate (mmol/l)	12.3±2.35	8.6±1.4	10.4±2.7	13.3±3.6	9.2±2,2	11.2±3.5
Heart rate (beats/min)	178±25.1	164.3±9.2	171±19.2	172.4±22.5	180.2±18.3	176.3±20.2
Performance Time (s)	215±6,3	229±8,3	222.0±10.1	215,6±5,5	232,8±7,0	224,2±10.8

Table 2 Statistical significance between warm-up types and gender (ANOVA)

	Blood lactate	Heart rate	Performance time
Warm-up type	n.s	n.s	n.s
Gender	.003*	n.s	.000*
Warm-up*gender	n.s	n.s	n.s

*Statistical significance

On individual level, statistical significant differences were observed in some variables between male and female swimmers (Table 2).
ANOVA analysis showed that male swimmers had a higher level of blood lactate in comparison to female swimmers. Heart rate showed no difference between the two different types of warm-ups or between gender. Furthermore, male swimmers had better performance time than female swimmers, as expected.

DISCUSSION

The analysis of the results showed no statistical significant differences between the two different types of warm-up in all measured variables.

Similar results were found in previous research [Houmard et al., 1991] which found no differences in lactate and heart rate by applying different types of warm-up before swimming effort. Swimming warm-up serves to raise the body's core temperature, increase blood flow, respiration rate, heart rate, and flexibility of involved muscles, which may prepare a swimmer for optimal performance [Bishop, 2003a; King, 1979]. To date, there are limited numbers of studies available that have examined swimming performance using different types of warm-up protocols. The results from previous reports have been equivocal with conflicting evidence of warm-ups vs. no warm-ups benefits [Balilionis et al., 2012]. The results of this study report from Nethery [1993], who found a significantly faster 100m swim time after 15 minutes of swimming warm-up compared with no warm-up.

However, King [1979] found no significant difference in 50m swimming time between a 400m swimming warm-up vs. no warm-up. Bobo [1999] found no significant differences in 100m swimming time between 800m swimming warm-up vs. no warm-up. Mitchell and Huston [1993] found no significant differences in 200m swimming time between no-, low intensity- and high intensity warm-ups. According to Balilionis et al. [2012], heart rate was significantly different after 3 types of warm-ups in the performance of 50m freestyle. In this study, the heart rate was higher after regular warm-up compared with short and no warm-up. These results confirm earlier findings by Mitchell and Huston [1993] and Zochowski et al. [2007]. Previously reported improvements in swimming performance after warm-up have been attributed to an increase in heart rate causing elevated baseline VO_2, increased muscle and core temperature [Bishop, 2003a].

Additional, psychological changes may contribute to improved performance in athletes [Bishop, 2003b]. Previous research has shown that warm-up increases preparedness and provides time to concentrate before the race [Bishop, 2003b]. In parallel, some participants might be discouraged and have lack of motivation to race with no warm-up or a short warm-up which may explain the tendency toward lower mean times [Balilionis et al., 2012]. If an individual performs consistently better after a specific warm-up such as no-, short- or regular warm-up, coaches should recognize the individuality and employ specific warm-ups to maximize the athlete's performance [Balilionis et al., 2012].

CONCLUSION

The aim of the present study was to provide information about the contribution of warm-up in the performance in 200m freestyle of young swimmers. No significant results occurred as expected between performances after the two conditions of different warm-up. Observed differences between the two genders are obvious and may be due to physiological and biological differences between male and female.

The results showed that we cannot conclude in giving superiority to one of

the two types of warm-ups therefore, warm-ups with different intensity provoke almost the same physiological responses before competition. To maximize the 200m performance, coaches and swimmers should experiment to determine each individual's optimal warm-up.
These results lead us to the conclusion that the field of warm-up needs more investigation, with larger samples, longer distances and in a 25m swimming pool.

ACKNOWLEDGEMENT

We thank the swimming team of 'Haidari' for conducting the research, their coach, and the swimming pool of Nikaia of Athens where all measurements took place.

REFERENCES

1. Astrand, I., Astrand, P.O., Christensen, E.H., and Hedman, R. (1960). Intermittent muscular work, *Acta Physiologica Scandinavica*, *48,* 488-493

2. Balilionis, G., Nepocatych, S., Ellis, C.M., Richardson, M.T., Neggers, Y.H., and Bishop, P.A. (2012). Effects of different types of warm-up on swimming performance, reaction time, and dive distance, *Journal of Strength and Conditioning Research*, *26,* 3297-3303

3. Barnard, R.J., Gardner, G.W., Diaco, N.V., MacAlpin, R.N., Kattus, A.A. (1973). Cardiovascular responses to sudden strenuous exercise – heart rate, blood pressure and ECG, *Journal of Applied Physiology, 34,* 833-837

4. Bishop, D. (2003a). Warm-up I. Potential mechanisms and the effects of passive warm-up on exercise performance, *Sports Medicine, 33,* 439-454

5. Bishop, D. (2003b). Warm-up II. Performance changes following active warm-up and how to structure the warm-up, *Sports Medicine, 33,* 483-498

6. Bobo, M. (1999). The effect of selected types of warm-up on swimming performance, *International Sports Journal, 5,* 37-43

7. Carlile, F. (1956). Effect of preliminary passive warming on swimming performance, *Research Quarterly American Association Health Physical Education, 27,* 143-151

8. Christensen, E., Hedman, R., and Saltin, B. (1960). Intermittent and continuous running, *Acta physiologica Scandinavica, 50,* 269-286

9. Chwalbinska-Moneta, J., and Hanninen, O. (1989). Effect of Active warming up thermoregulatory, circulatory and metabolic responses to incremental exercise in endurance trained athletes, *International Journal of Sports Medicine, 1,* 25-29

10. De Bruyn-Prevost, P., and Lefebvre, F. (1980). The effects of various warming up intensities and durations during a short maximal anaerobic exercise, European *Journal of Applied Physiology, 43,* 101-107

11. De Vries, H.A. (1959). Effects of various warm up procedures on 100yard times of competitive swimmers, R*esearch Quarterly American Association Health Physical Education, 30,* 11-22

12. Franks, B.D. (1983). Physical Warm up. In Williams, M.H. (Eds.) Ergogenic Aids in Sport (pp. 340-75). Champaign, Illinois: Human Kinetics Publishers

13. Gutin, B., Stewart, K., Lewis, D., and Kruper, J. (1976). Oxygen consumption in the first stages of strenuous work as a function of prior exercise, *Journal of Sports Medicine, 16,* 60-65

14. Houmard, J.A., Johns, R.A., Smith, L.L., Wells, J.M., Kobe, R.W., and McGoogan, S.A. (1991). The effect of warm up on responses to intense exercise, *International Journal of Sports Medicine, 12,* 480-483

15. Inbar, O., and Bar-Or, O. (1975). The effects of intermittent warm up on 7-9 year old boys, *European Journal of Applied Physiology, 34,* 81-89

16. Ingjer, F., and Stromme, S.B. (1979). Effects of active, passive, or no warm up on the physiological response to heavy exercise, *European Journal of Applied Physiology, 40,* 273-282

17. Karlsson, J., Bonde-Peterson, F., Henriksson, J., and Knuttgen, H.G. (1975). Effects of previous exercise with arms or legs on metabolism and performance in exhaustive exercise, *Journal of Applied Physiology, 38,* 763-767

18. King, A. (1979). The relative effects of various warm-up procedures on 50 meter times of trained, competitive swimmers, *Journal of Physical Education, 7,* 22-24

19. Klausen, K., Knuttgen, H.G., and Forster, H. (1972). Effect of preexisting high blood lactate concentration on maximal exercise performance, *Scandinavian Journal of Clinical Laboratory Investigation, 30,* 415-419

20. Knowlton, R.G., Miles, D.S., and Sawka, M.N. (1978). Metabolic responses of untrained individuals to warm up, *European Journal of Applied Physiology, 40,* 1-5

21. Kozlowski, S., Brzezinska, Z., Kruk, B., Kaciuba- Uscilko, H., Greenleaf, J.E., and Nazar, K. (1985). Exercise hyperthermia as a factor limiting physical performance: Temperature effect on muscle metabolism, *Journal of Applied Physiology, 59,* 766-773

22. Lotter, W. (1959). Effects of fatigue and warm up on speed of arm movements, *Research Quarterly of American Association in Health and Physical Education, 30,* 57-65

23. Margaria, R., di Prampero, R.E., Derevenco, L., Agheno, P., and Mariani, M. (1971). Effect of a steady state exercise on maximal anaerobic power in man, *Journal of Applied Physiology, 30,* 885-890

24. Massey, B.H., Warren, R., Johnson, W.R., and Kramer, G.F. (1961). Effect of warm up exercise upon muscular performance using hypnosis to control the psychological variable, *Research Quarterly of American Association in Health and Physical Education, 32,* 63-71

25. Mathews, D.K., and Snyder, H.A. (1959). Effect of warm up on the 440 yard dash., *Research Quarterly of American Association in Health and Physical Education, 30,* 446-451

26. Michael, E., Skubic, B., and Richelle, R. (1957). Effect of warm up on softball throw for distance, *Research Quarterly of American Association in Health and Physical Education, 28,* 357-363

27. Mitchell, J.B., and Huston, J.S. (1993). The effect of high- and low-intensity warm-up on the physiological responses to a standardized swim and tethered swimming performance, *Journal of Sports Science, 11,* 159-165

28. Pacheco, B.A. (1957). Improvement in jumping performance due to preliminary exercise. *Research Quarterly of American Association in Health and Physical Education, 28,* 55-63

29. Richards, D.K. (1967). A two factor theory of the warm up effect in jumping performance, *Research Quarterly of American Association for Health, Physical Education and Recreation, 39,* 668-673

30. Rochelle, R.H., Skubic, V., and Michale, E.D. (1960). Performance as affected by incentive and preliminary warm up, *Research Quarterly of American Association for Health, Physical Education and Recreation, 31,* 499-504

31. Schmidt, P. (1975). Frustration and the pre-start period, *Schweizerische Zeitschrift fur Sport und Medizin, 23,* 93-99

32. Sedgwick, A.W., and Whalen, H.R. (1964). Effect of passive warm up on muscular strength and endurance, *Research Quarterly of American Association in Health and Physical Education, 35*, 45-59

33. Stewart, K., Gutin, B., and Lewis, S. (1973). Prior exercise and circulorespiratory endurance, *Research Quarterly of American Association in Health and Physical Education, 4,* 169-177

34. Thompson, H. (1958). Effect of warm up upon physical performance in selected activities, *Research Quarterly of American Association in Health and Physical Education, 29,* 231-246

35. Weltman, A., Stamford, B.A., Moffatt, R.J., and Katch, V.L. (1977). Exercise recovery, lactate removal, and subsequent high intensity exercise performance, *Research Quarterly of American Association in Health and Physical Education, 48,* 786-796

36. Weltman, A., Stamford, B.A., and Fulco, C. (1979). Recovery from maximal effort exercise, lactate disappearance and subsequent performance, *Journal of Applied Physiology, 47,* 677-682

37. Zochowski, T., Johnoson, E., and Sleivert, G.G. (2007). Effects of varying post-warm-up recovery time on 200-m time-trial swim performance, *International Journal of Sports Physiology and Performance, 2,* 201-211