THE EFFECT OF CONTROLLED WARM-UP EXERCISES ON THE CRAWL SWIMMING PERFORMANCE OF UNDER-15 MALE WATER POLO PLAYERS

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ABSTRACT

The effect of controlled warm-up exercises on crawl swimming performance was determined in 31 under-15 male water polo players. The study employed a two-group crossover design in which the subjects were randomly assigned to one of two groups. One group swam a 50m crawl sprint with no preliminary warm-up, followed two days later by a 50m crawl sprint with a preliminary controlled warm-up. The other group did the two swims in reverse order. The controlled warm-up programme consisted of approximately 4 minutes of dynamic exercise and 8 minutes of passive stretching. Results showed a decrease in performance times of 71% of the subjects after exposure to a controlled warm-up programme. This positive effect was attributed to the increase in muscle temperature, leading to an increase in the speed of muscle contraction, smoother muscle contraction and an improved strength of muscle contraction. Thus it was concluded that controlled warm-up exercises have a positive effect on the crawl swimming performance of under 15 male water polo players.

ABSTRAK

Die effek van gekontroleerde opwarmingsoefeninge op kruipslagswemprestasie van 31 onder-15 manlike waterpolospelers is bepaal. Daar is gebruik gemaak van 'n twee-groep-oorkruis patroon waarvolgens die proefpersone op 'n arbitrêre basis aan een van die twee groepe toegedeel is. Een groep het 50 meter kruipslag sonder enige voorafgaande opwarming geswem, en is twee dae daarna opgevolg met 50m kruipslag met 'n voorafgaande gekontroleerde opwarming. Die ander groep het die twee swemsessies in die teenoorgestelde volgorde afgelê. Die gekontroleerde opwarmingsprogram het uit ongeveer 4 minute van dinamiese oefening en 8 minute van passiewe strekoefeninge bestaan. Die resultate het 'n afname in prestatasietye van 71 persent van die proefsubjekte na blootstelling aan 'n gekontroleerde opwarmingsprogram aangedui. Hierdie positiewe effek is toegeskryf aan die verhoging in spiertemperatuur, wat tot 'n verhoging in die snelheid van spiersametrekking, met egalige spiersametrekking en verbeterde krag van spiersametrekking gelei het. Daar is dus tot die gevolgtrekking gekom dat gekontroleerde opwarmingsoefeninge 'n positiewe effek op die kruipslagswemprestasie van onder-15 manlike waterpolospelers het.

INTRODUCTION

During rehabilitation of patients, a physiotherapist uses some form of warm-up to prepare the patient for his/her strengthening or stretching exercises. Little has been done to show the effect of these warm-up procedures, be they active or passive, on anything other than the prevention of injury. After realising the need for such research, it was decided that the most obvious place to start with such research was in sportsmen, where the subjects are fit, and an effect (be it positive or negative), can be seen quickly and clearly. The hypothesis states that controlled warm-up exercises positively effect the performance times of under-15 male water polo players in a 50m crawl sprint. If the hypothesis is retained, it is hoped that further research into the use of active warm-up exercises in specific physiotherapy treatments will be promoted.

The role of the physiotherapist in sport has become increasingly important as the sporting fraternity have come to realise the knowledge of the physiotherapist in the treatment of acute sporting injuries. Through television exposure of the World Cup soccer, rugby and cricket tournaments, physiotherapists were seen to be treating acute musculo-skeletal injuries, a role previously performed by doctors. As this is only one aspect of the physiotherapist's role in sport, the less elite sportsmen, who do not have a team physiotherapist at their disposal, are not aware of the full potential of the physiotherapist in sport. A further aim of this research project is to make young sportsmen and coaches aware of the role of the physiotherapist regarding warm-up, training procedures and the correct and safe execution of exercises and stretches.

Not much research has been done regarding the influence of warm-up on performance in specific sports. The researchers decided to choose water polo, a sport where no such research has been reported to date. Due to the team nature of the sport, and the personal involvement of the researchers therein, this choice of sport seemed both logical and practical. As crawl sprint swimming is one of the most important aspects of water polo, it was decided to use this as a measure of performance.

Over the years, a variety of research has been conducted into many aspects of warm-up and performance. Because of the variety of warming-up methods used, and the fact that many studies fail to define the exact duration and severity of the warm-up procedure, comparison between different experimental results is made almost impossible[2,4].

The term warm-up entails an increase in body temperature. In their update on warm-up and muscular injury prevention, Safran *et al*[1] defined warm-up as being both active and passive. Asmussen and Boje[2] refuted the assumption that improved performance after warm-up was due to an increase in core or rectal temperature. In further research Carlisle[3] showed that performance is dependent on muscle temperature, and that muscle temperature is not closely related to rectal temperature.

The question that now arises is how an increase in muscle temperature will improve performance. Warmer muscles have a better ability to perform work because the increased temperature accelerates the chemical process in the muscles and decreases the intramuscular viscous resistance[2]. These factors lead to an increased speed of muscle contraction, a smoother muscle contraction and an improved strength of muscle contraction[2]. Preliminary exercise (warm-up) also leads to an increase in oxygen delivery to the muscles through changes in the oxygen dissociation curve which, in turn, leads to a lower overall oxygen deficit during maximum performance[4,5].

One factor must always be taken into consideration when a warm-up precedes a criterion exercise, and that is fatigue caused by excessive warm-up. In their research into the effect of a task-specific warm-up on anaerobic power, Hawley *et al*[6] found that the warm-up had no effect on performance. This result possibly could be attributed to the fact that the fatigue index was significantly greater following the warm-up.

Exercise above anaerobic threshold can be defined as that requiring more than 60% of the subject's VO2 max (or 60% of the subject's maximum heart rate) being sustained for longer than 6 minutes[5,9].

Genovely and Stamford[7] researched the effect of prolonged exercise (60 minutes) above anaerobic threshold on maximal performance, and found that maximal performance is impaired following prolonged warm-up exercise above anaerobic threshold.

According to Siff[8] flexibility exercises must be included in an effective warm-up as sporting prowess correlates strongly with active

flexibility. On the findings of Siff[8] and Hemstrom[9] the following 5 guidelines for developing an effective warm-up programme should be taken into account:

- It is vitally important not to cause an increase in blood lactate levels, thus causing fatigue.
- The temperature of the specific muscle needed for the sporting activity should be increased to 39°C.
- The ideal warm-up time is between 10-15 minutes, including both active and passive exercise.
- Passive stretches must be preceded by some low-intensity activity, thus increasing blood supply to the muscles and decreasing the risk of injury during stretching.
- All stretches must be held for at least 30 seconds without bouncing at the end of range. Ballistic stretching can cause injury.

The question now arises whether warm-up has a positive effect on the performance of a water polo player. As an individual's performance cannot be measured by the outcome of a match, the game was looked at more closely and a representative measure of individual performance chosen. Sprint swimming was chosen because the game entails periods of treading water interspersed with short bursts of sprint swimming. As 50m is the shortest recognisable distance for competitive sprint swimming, this distance was decided upon for research purposes. As players swim crawl during matches this stroke has been chosen for research purposes.

METHOD

Before developing a specific warm-up programme to be used in the research project, a careful biomechanical analysis of the crawl swimming stroke was carried out to identify all the important agonists which power the swimmer through the water.

Three boys' high schools were involved in the research project. Criteria for inclusion and exclusion of subjects were as follows:

Exclusion

- Recent injury involving any part of the body ie. muscle, tendon or ligament injury of a Gr 1 or worse, having returned to sport for less than 1 week.
- Recent illness ie. any illness putting the participant out of sport for one week or more, having returned to sport for less than one week.
- Participants 13 years or younger.
- Participants 16 years or older.
- Negative attitude to participation.

Inclusion

- Under-15 male water polo players from the three participating schools.
- A and B teams.
- Volunteers

Boys from one school were used for the two pilot studies which were carried out to test the warm-up exercises, as well as other experimental factors such as exercise duration, rest periods and timing techniques. Only then were the specific exercises and the duration thereof finally decided upon.

Warm-up Programme

3 minutes active exercise

- modified step test (45 seconds)
- arm swinging forwards (45 seconds)
- arm swinging backwards (45 seconds)
- crawl stroke imitation (45 seconds)

8 minutes passive stretching of the following muscles, each stretch being held for 30 seconds:

- pectoralis major
- biceps
- wrist flexors and anterior fibres of deltoid
- triceps
- gluteus maximus
- hip adductors
- hamstring group
- rectus femoris and iliopsoas
- gastrocnemius
- latissimus dorsi

1 minute active exercise

- (as at the beginning of the warm-up).

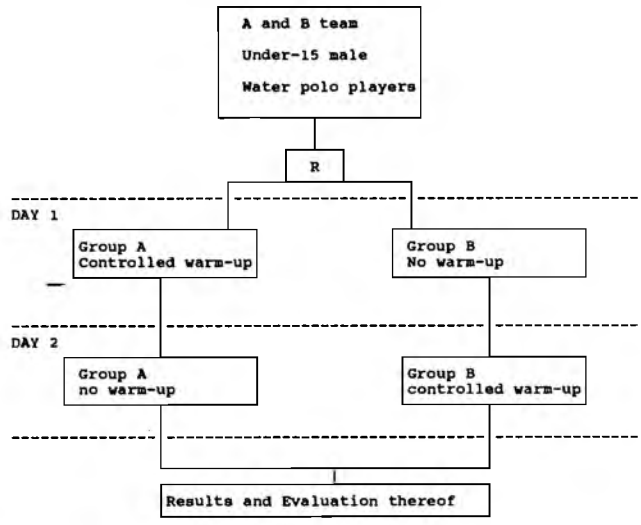


FIG 1 Experimental Design : Two Group Crossover

Boys from the remaining two schools were used to obtain experimental data. Of these two schools, thirty-one boys were randomly assigned to one of two groups (figure 1). On day 1, Group A underwent a controlled warm-up and their performance over 50m was measured. Group B swam 50m without a preliminary warm-up and their performance was also measured. Forty eight hours later, the performance times of the two groups were once again measured, with the difference now that Group B underwent a preliminary warm-up and Group A did not. Each swimmer thus served as his own control. In this way the researchers obtained 31 pairs of data.

As the dependent variable in this research project is the time in seconds for a 50m crawl sprint swim, the method of evaluation used had to be very accurate and well controlled. Reliable timekeepers and their accuracy of timekeeping was very important. Five timekeepers were used throughout the experimentation process, each using the same digital stopwatch on each occasion. They underwent a series of tests to establish accuracy and thus ensured the best possible results.

To ensure the best results the method of timekeeping was strictly controlled. Timekeeping began when the swimmers' forefoot left the edge of the pool, and not with the whistle (this effectively cancelled out the reaction time of the swimmer to the whistle). The same timekeeper timed each individual during both tests to minimise faults even further. Swimmers were required to swim in the same lane for both tests, and the same number of people swam in the pool each time. This ensured that the waves caused by the swimmers were not significantly different each time. The pool filter was switched off for both swims. The times of each swimmer were noted to the nearest one tenth of a second.

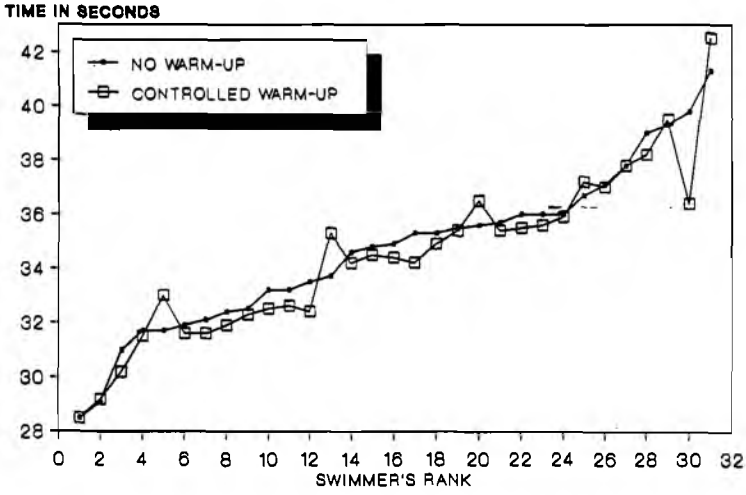
Once all the experimental data had been received it was explored graphically. As the researchers were comparing two "treatments", statistical analysis involved a paired T-test to determine the significance level of the results.

RESULTS

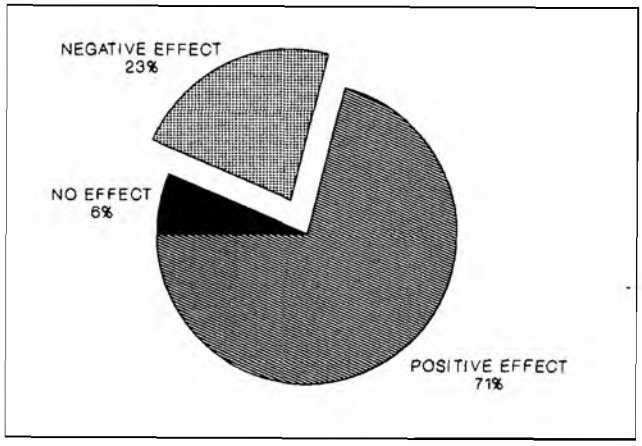
The time taken to swim 50m after no preliminary warm-up and the time taken to swim 50m after a controlled warm-up, against each

swimmer is shown in Graph 1. The swimmers were ranked according to the time taken to swim 50m with no preliminary warm-up. As can be seen, most swimmers' performance times after no preliminary warm-up improved after exposure to a controlled warm-up. An improvement in performance is shown by a decrease in swimming time. Those swimmers whose performance times were affected negatively after exposure to a controlled warm-up did not come from a specific group (fast, medium or slow swimmers), but were spread evenly throughout the ranking.

GRAPH 1
COMPARISON OF RANKED SWIMMERS' TIMES



GRAPH 2
REPRESENTATION OF FINAL RESULTS



From Graph 2 it can be seen that the performance of 71% of the swimmers improved after exposure to a controlled warm-up, while only 23% of the swimmers showed a negative effect. Six percent of the swimmers experienced no change in swimming time at all.

A statistical analysis of the obtained data using the paired T-test, was carried out. Results were found to be significant at a 90% level.

DISCUSSION

An important finding of the research project was that the performance of 23% of the swimmers was effected negatively by a controlled warm-up. The researchers felt this to be an alarmingly high figure, and suggested the following reasons for the increase in performance time:

The researchers had no control over swimmers' participation in other strenuous sporting activities prior to experimentation. This could have resulted in warm-up causing further fatigue.

The researchers used a once-off warm-up on swimmers who were not used to stretching. It is felt that if the warm-up procedure were to be implemented for a period of about a month, and the experimental process repeated, more swimmers may experience the positive effect of warm-up because the muscles will be accustomed to stretching.

The researchers feel that the possibility does exist that the performance of some people may be inherently negatively effected by preliminary warm-up.

Although the results were only found to be statistically significant on a 90% level, the researchers feel it necessary to point out that the results fell only slightly short of the 95% level. The results were however, of a high clinical significance.

One of the aims of the research project was to educate the swimmers and the coaches about the importance of a good warm-up and the correct execution thereof. Both the swimmers and the coaches were aware of the fact that they should warm-up, but their warm-up was purely task-specific and incorrectly executed. During the implementation of the controlled warm-up, swimmers were educated as to correct warm-up techniques. Once the results were finalised an edited version of the results and conclusions were sent back to the coaches, providing them with a reference copy of the warm-up programme. Hereby both the coaches and the young sportsmen were made more aware of the role of the physiotherapist in sport.

CONCLUSION

The researchers have been highly successful in showing that warm-up has a positive effect on the swimming performance of under-15 male water polo players. An optimal warm-up programme for water polo and crawl sprint swimming was thus developed. Furthermore, this warm-up programme was accepted and used by the national water polo team on a recent tour to Hungary and Israel.

It is hoped that these research results will form a solid foundation for further research into proving the benefit of warm-up in the clinical settings of physiotherapy.

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