Should you take the time for

WARM-UP, WARM-DOWN

by Tim Micka\n\nWARM-UP is probably one of the most over-used and abused terms in competitive sports today. For example, so-called warm-up activities for some sports, events, or positions are not vigorous enough to elicit the internal temperature change which the term implies. Many warm-up activities, particularly those associated with the improvement of muscle and joint flexibility, will not significantly elevate body metabolism; other forms of “warm-up” exercises prepare the athlete psychologically or stimulate a greater awareness for different visual, audio, or proprio-receptive cues. These latter forms apply extensively to team preparation in baseball, basketball, and football.

Warm-down, which has not enjoyed the popularity of its counterpart warm-up, indicates a return of body metabolism and internal temperature to normal levels; if the psyche is also to be included in its broad definition, then the act of warming-down could perhaps alleviate the frustrations of a poor performance or calm the excited winner.

Only studies of fatigue surpass the quantity of literature available on the topic of warm-up and, like fatigue, warm-up is still a controversial and mysterious area. The specific physiological and psychological benefits of various types of warm-up activities have been questioned by a number of coaches and members of the scientific community. It has been very difficult to control this variable in an experimental situation and because it has so many meanings, most of the warm-up and warm-down studies have been poorly designed. The majority of workers who have studied warm-up agree that it benefits performance, but they cannot agree on the optimal mode, intensity, or duration of warm-up, or the relative degree of benefit.

A complete discussion of warm-up and warm-down is beyond the scope of this paper. It will be our purpose to discuss only the potential and real physiological effects of these two phenomena.

The purpose of warm-up seems to be generally two-fold: to improve performance and to prevent injury. The athlete attempts to improve performance by preparing the body for training or competition, perhaps through neuromuscularly-oriented exercises such as a basketball player’s swinging a weighted bat or simply adjusting to a new arena or playing field; one may also prepare the body physiologically with warm-up exercises that increase circulatory, respiratory, and metabolic functions. Athletes such as wrestlers, sprint cyclists and sprint runners engage in a variety of warm-up exercises designed to protect the muscles and joints.

Warm-up may be either passive, including rub-downs, whirlpool baths, showers, and electro-therapy, or active, which entails engaging in some form of exercise.

Active warm-up may be classified as related or unrelated. Related warm-up involves participation in the whole sport or specific parts of it prior to competition or training; in other words, one actually engages in the activity (shooting lay-ups prior to a basketball game). Unrelated warm-up usually includes general conditioning exercises that may have no neuromuscular activities precisely in common with the sport; callisthenics or running prior to competition are examples. Many sports use a combination of related and unrelated warm-up before competition.

Warm-up

Caramen, oarswomen and rowing coaches have their favorite warm-up procedures which may consist of full power away from the dock or an elaborate progression ending in a full power piece. For a complete understanding of the values of warm-up it is important to know what happens physiologically during warm-up, why warm-up is beneficial, and how a good warm-up is formulated for a particular boat. These topics should be of primary concern to any coach or rower.

Physiologically, warm-up is defined as increasing blood and muscle temperature. If there is an increase in core temperature by 1-2°C, the following physiological changes are apparent:

1) Decreased resistance to blood flow in the vascular bed.
2) Increased rate of metabolic processes (i.e., biochemical reactions proceed at a faster rate).
3) Hemoglobin gives up more oxygen and dissociates more rapidly at higher temperatures.
4) Myoglobin reacts similarly to hemoglobin at higher temperatures.
5) Increased efficiency due to lowered viscous resistance in skeletal muscles.
6) Significantly decreased pulmonary resistance to blood flow.
7) Increase in speed of nerve messages at higher temperatures.

In addition to these responses, cardiac and respiratory functions are also improved. Cardiac output, blood pressure, pulmonary ventilation, and O$_2$ uptake are all increased as a result of warm-up.

It is difficult to determine objectively when one is properly warmed-up but as core temperature rises it will trigger sweating, the most significant means of cooling the body during exercise; the onset of this physiological response is indicative of optimal warm-up. In addition to the sweating mechanism, an athlete often experiences a second wind phenomenon when warm-up is complete. This phenomenon involves a respiratory-metabolic adjustment so that the level of metabolism has reached a steady-state when the O$_2$ requirements of the exercise are being met totally by aerobic energy pathways. Sweating and the subjective feeling of performing the exercise in a metabolic steady state are good barometers of proper warm-up.

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Depending on the racing schedule, the warm-up procedures for race day could involve two workouts on the water. If the race is in the afternoon there is value in a morning workout, though it would not really be classified as part of a warm-up procedure since any residual benefit would be lost by afternoon. The warm-up just prior to the race begins with static stretching and a short jog representing unrelated forms of warm-up. The related warm-up phase should always be a procedure that has been a part of the regular training regimen and one with which every crew member is familiar. This familiarity is especially important in timed pieces. Warm-up pieces before a race should be consistent with those conducted in practice as these pieces could be used for comparative purposes to determine when a warm-up is adequate. Some athletes who feel they need additional warm-up should begin this procedure earlier and include a higher volume and/or intensity of unrelated forms of warm-up.

We believe it is important that each athlete row at race cadence and at full power for a brief period during the warm-up and that this part of the related warm-up should come toward the end of the warm-up period. This will help establish the race rhythm for the boat and prove to each member of the crew that they are ready to go the distance. Warm-ups should also provide an opportunity for the crew to focus its full attention in the boat, bringing the crew together as one to tackle the task ahead. However, full power rowing during the warm-up should not be overemphasized.

Environmental factors must be taken into consideration when planning a warm-up. If the weather is hot and humid then warm-up should be abbreviated and ample water and an electrolytic drink should be provided both at dockside and in the boat (plastic squeeze bottles are handy items for this purpose). Also, the vigorous part of the related warm-up can be accomplished earlier than normal since the residual effect will be retained longer. In cold weather it might be a good idea to carry extra clothing in the boat, to start the warm-up a little later but at the same time try to work with more intensity. Don’t let the crew cool down or become chilled; the warm-up can continue almost until the race with a hard paddle to the starting position.

Warm-Down

Warming-down for competitive oarsmen is automatically built into the activity as each crew usually rows back to the boathouse. Depending on the distance from the end of the race course or from where the workout ends, a crew could perform a significant warm-down exercise prior to docking.

If we are to adequately examine the physiological effects of warming-down, it is important to examine the condition of the physiological systems supporting exercise just prior to the cessation of the race or training session. All systems are usually working at or near maximum levels and this means an elevated heart rate, cardiac output and blood pressure, increased respiratory rate and depth, and an increase in the metabolism of skeletal muscle by 50-100 times resting level. Also, in the later stages of heavy work, metabolism is shifting to anaerobic energy sources so that lactic acid is reaching higher levels in the muscle and blood. The severe physical and metabolic trauma of the rowing exercise is also affecting the pain receptors in and around muscle fibers which signal the central nervous system of the severe wear and tear on muscle cells.

The benefits of warm-down seem to be primarily related to the protection of all tissues during and following exhaustive exercise. Although the precise mechanisms are not known, it appears that the circulatory, respiratory, and metabolic systems make significant adjustments during the warm-down.

Stopping an exhaustive exercise abruptly causes systolic blood pressure to drop immediately, cardiac output is decreased, and ventilation and O2 consumption are markedly reduced. Dizziness following a complete cessation of work after a vigorous 2000m. piece results from a decrease in blood

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pressure and O₂ transport to the brain and changes in the local blood flow to that area. In addition, cardiovascular and respiratory parameters are sometimes erratic in their response, some remaining elevated or showing irregular patterns after stopping quickly. Thermoregulation is very important during exercise and this mechanism is accentuated during extremes of temperature. Discontinuing exercise during hot and humid weather may overload this mechanism while cooler temperatures may tend to cause excessive chilling and too rapid a drop in body temperature. The amount of oxygen consumed during recovery following exertion has been defined as the O₂ debt and physiologists have identified two components of this debt, a fast early component and a slower, more delayed component. It has been suggested that the O₂ consumed during the first two minutes of recovery (lactacid debt) is utilized to resynthesize the high energy phosphate compounds often referred to as phosphagens and usually stored in small quantities in resting skeletal muscle cells. The major function of O₂ consumed during the latter stages of the recovery period (lactacid debt) is to replenish the glycogen stores and phosphagens by resynthesis of accumulated lactic acid via oxidative metabolism. The fate of lactic acid following exercise is not well documented and recent studies indicate that the major site of resynthesis is probably in the muscle cell instead of the liver which was formerly thought to be the primary metabolic site for this process. This finding presents an even stronger case for warming-down as direct muscular involvement will improve the local O₂ environment and thus enhance the recovery process. The lactic O₂ debt is as expected considerably smaller than the lactacid debt because of the inefficiency in the use of oxygen in the oxidation of lactic acid. Stopping the exercise lowers the circulatory and respiratory responses so that much-needed O₂ for recovery is reduced and the lactic acid which has accumulated extracellularly tends to remain longer and at high levels near all tissues. The accumulation of lactic acid seems to have a deleterious effect on muscle cell function by keeping the cell pH at a critically low level and in addition the excess lactate is probably a direct precursor of general and/or local muscular pain and soreness.

By continuing to exercise, circulatory, respiratory, and metabolic parameters will remain reasonably high and as the intensity and duration of the work is gradually reduced the body can react to rather gradual changes as opposed to acute and abrupt changes in body functions.

Warm-down exercises therefore appear to specifically benefit the athlete in the following ways:

1) Cardiac output, VO₂, and systolic blood pressure are reduced gradually, thus maintaining normal O₂ conditions at all tissues.

2) Cardiovascular parameters demonstrate slowly declining steady-states, thus lessening any intrinsic or neurogenic abnormalities; the control mechanisms for heart rate, stroke volume, blood pressure, and respiration do not have to undergo rapid and erratic changes.

3) A steady change or re-adaptation of the thermoregulating system to resting conditions prevents overloading of the cooling system when it’s hot, and reduces chilling in cold weather.

4) A more efficient delivery of O₂ during the recovery process enhances oxidation of exercise-induced metabolic substrates.

5) Elevated circulatory function insures more rapid delivery of lactic acid to sites where the resynthesis process occurs.

6) The more rapid resynthesis of lactic acid eliminates an important muscular pain, soreness, and fatigue factor and helps greatly to re-establish the normal biochemical environment of cells by permitting the pH to rise more quickly to resting levels.

Static stretching exercises following work are just as important as their role in warm-up since these exercises reduce the incidence and severity of local muscular pain and soreness.

In summary, it appears that some form of warm-down speeds up the recovery process following severe work and the quality of recovery is also improved. Some recent studies have shown conclusively that if an athlete engages in a mild form of exercise following a maximal training bout or a competitive event, the time needed for complete recovery is cut in half. This finding is particularly pertinent to an athlete or group of athletes who must compete in heats or trials prior to gaining entry into the finals of an event.

The type of warm-down activity an athlete should use and the duration and intensity of this activity are dependent upon: the sport, event, or position of the athlete; the severity of the actual exercise; and the environmental conditions. Rowing not only demands high cardiovascular-respiratory-metabolic outputs, but muscular strength, endurance, and mobility are very important, too. Each crew should spend at least as much time warming-down on the water as they did in their warm-up and in a cooler environment or after an extremely exhaustive race or workout, even longer; a conservative rowing warm-down would be 15 minutes (minimum) and a more liberal ap-
approach set at 30 minutes (maximum). The rowing should consist of steady-state rowing at 26-28 strokes/min. at half power or less with brief rest periods; heart rates should be reduced to between 90-110 b/min. for most of the crew by end of warm-down. If it is a chilly day then provisions should be made to have additional protective clothing and on hot days more water or a liquid replenishment should be made available. A 15-20 minute static stretching session should follow docking and the exercises should stretch muscles and connective tissues over joints contributing major power output to rowing; perform the exercises deliberately and systematically.

Although some type of warm-down has been a part of an individual athlete's training and competitive routine for a long time, team sports have generally failed to take advantage of this beneficial phenomenon. The values of warm-down for team sports are often lost in the excitement of after-game interviews and meetings with relatives and friends. Can you imagine a warm-down period for baseball, basketball, or football? However, these sports sometimes require rather large energy outputs during game situations and in many cases athletes are required to jog or run the day following a game to relieve the pain and soreness caused by physical trauma, proprioceptor activation, and lactic acid accumulation. Recently, it was found that a group of football players warming-down by using running and static stretching exercises immediately after the contest experienced significantly less muscular pain and soreness and reduced local muscular and general fatigue symptoms to a greater degree than another group of football players who performed identical warm-down exercises but not until the morning following the game. Both groups experienced better results than a no-warm-down group. These results were confirmed by analyzing recovery blood lactates and measuring and comparing, electromyographically, major leg muscles. This study has been repeated and the results were the same. Although a delayed warm-down will help, an immediate warm-down seems to be the most beneficial.

Summary

Although all the physiological mechanisms that are involved in warm-up and warm-down are not known, studies in our lab and others have shown that these procedures are effective in improving performance and reducing the incidence of injury. We are aware of the time allotments involved in rowing practices but would like to stress the point that some sacrifices or better management of hard work time should be made to incorporate warm-up and warm-down. Taking the required time may help make the necessary improvements needed for a successful season or prevent a serious injury. Warm-up and warm-down — give them some serious thought when you sit down to make up your next workout schedule.

References