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The Warm-Up Difference

Preventing Overuse Injuries by Warming-Up the Body

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Introduction

In the context of sports medicine and athletics, the process of warming up with active muscle contraction has long been utilized as a way to successfully prepare the body for physical activity. Although many workplace health programs encourage stretching to prevent injury, there is little medical evidence to support the effectiveness of such a practice. The inherent benefits of warming up, however, can and should be applied in an occupational setting in order to combat the detrimental effects of overuse injuries.

The human body holds extraordinary potential to protect itself from musculoskeletal disorders, and warming up has been proven to be the most effective way to use this potential by preparing the body to handle repetitive and strenuous movements with resilience.

Executive Summary

In this paper, the term warm up refers to any activity that requires the participant to contract the muscles of his or her body. Passive movement of joints or any outside environmental changes that may affect the physiology of the body do not fall within the category of warm up in the present discussion.

Every year, musculoskeletal disorders (MSDs) strike hundreds of thousands of workers, costing businesses billions of dollars. MSD is an umbrella term that encompasses degenerative or inflammatory conditions involving the muscles, tendons, nerves, and other supporting structures of the body. MSDs remain one of the fastest growing causes of occupational injury, and often occur when the body's physical capacity does not match the physical demands of a job task.

The consequences of MSDs continue to impact the well-being and productivity of workers in the United States. According to the Occupational Safety and Health Administration (OSHA), musculoskeletal disorders account for over one third of all workplace injuries, with an average absence of 13 days per injury [1]. OSHA further estimates that the resulting worker injury claims and loss of productivity cost U.S. employers $13 to $20 million per year.

Over the past several decades, a growing body of research has illuminated a strong correlation between workplace hazards and occupational injuries. Although many of these injuries result from hazards in the work environment or equipment, a significant amount are also caused when workers are required to perform demanding, repetitive tasks that exceed their physical capacity—a problem that is clearly rooted in body mechanics rather than ergonomics. However, the fact remains that the completion of certain job tasks is dependent on workers performing these repetitive movements; it is neither practical nor viable to eliminate these movements entirely.

The solution, then, is to correctly prepare the body in anticipation of these strenuous and repetitive movements. The body itself possesses natural mechanisms and built-in elements to protect itself from MSDs. The act of warming up is incredibly valuable in that it unlocks this potential to withstand the rigors of repetitive and stressful tasks.

The Problem of Overuse

Musculoskeletal disorders can affect bones, joints, and soft-tissue structures; most MSDs are characterized by cumulative damage in these areas as opposed to acute damage.
The primary difference between traumatic (or acute) injuries and overuse (or cumulative) injuries can be expressed in terms of a cause-and-effect relationship. Traumatic injuries typically occur suddenly and can be linked to a single cause; for example, someone falls from a ladder and suffers a broken bone; the fall is the direct cause, and the broken bone is the effect.
Overuse injuries, on the other hand, develop over time due to tissues being stretched beyond their physiological limits. There are often multiple causes behind these types of injuries that result in the effect of injured tissue; one common example of this is a stress fracture. Unlike traumatic injuries, it is not a single event but rather a combination of causes that bring about overuse injuries. These causes, or risk factors, include:

- **Excessive force or tension:** The greater the force used, the higher the risk of overuse [9]
- **Repetitive motion:** Activities that involve repeating tasks in cycles of any duration each day
- **Poor posture:** When limbs are forced to be in non-neutral positions

Over-used muscles have, in a sense, “exhausted” their endurance capacity. When muscles are fatigued, they become less efficient and therefore require more force to perform certain tasks. This may result in increased tension and fatigue, compromised posture, and even stress on joints in other areas as the body struggles to perform beyond its capacity.

A food distribution employee addresses shoulder pain brought on from repetitive stress

Warming-Up to Prevent Overuse Injuries

Musculoskeletal injuries and disorders that result from overuse can be prevented by warming up, which can be performed quickly and easily before engaging in strenuous physical activity. In terms of musculoskeletal function, workers are no different from athletes. Just as athletes must warm up before engaging in rigorous physical activity, workers need to physically prepare themselves for performing stressful, repetitive tasks.

Why Not Stretching?

A growing body of research has revealed that the age-old mantra of “stretch, stretch, stretch” does not, in fact, help prevent injuries or muscle soreness. Numerous studies show that those who stretch instead of warming up before an activity demonstrate a decrease in overall performance [3]. Injuries and muscle soreness also appeared more significant in people who had a high level of flexibility and stretched before physical activity.

Comparing the act of stretching to a warm-up can best be understood in the context of muscle physiology. The muscles in the body are constantly working together to create limb movement; when one muscle group contracts, the opposite muscle group lengthens in response [12]. Warming up activates these muscles through either lengthening (eccentric contractions) or shortening (concentric contractions) while generating force.

Stretching, on the other hand, simply lengthens the muscles while it remains in a passive state; it does not require muscle activation. By increasing the range-of-motion in certain joints, stretching often causes unnecessary lengthening of tendons and can be dangerous when performed incorrectly [11].

Proper warming up can be accomplished only by performing active movements using external forces. Stretching, which calls for people to push and pull on their joints, is not active in this sense and does not in itself warm up the body.

Performing active movements with resistance will challenge the muscles and warm them up even more rapidly. Unlike stretching, warming up challenges the body to trigger all the built-in elements and mechanisms that will help prevent RSIs and MSDs. Because performing repetitively stressful movements throughout the day is physically taxing, warming up must become a consistent habit for people who engage regularly in these movements.

How Warming-Up Works?

Warming up prepares the body both physically and psychologically, and is therefore imperative for anyone who plans on engaging in physical activity. Not only does warming up help the body withstand the stresses of repetitive movements with better efficiency, it also reduces the risk of suffering from RSIs or MSDs.

A proper warm-up consists of several principal steps, which should:

- Involve movements that are specific to the activity in which one is about to partake [4]
- Use large muscles first, and then move into smaller muscle groups
- Start with simple movements first, then move to more complex movements
- Start with muscles that will be used throughout the day, then move to opposite muscles that won't be used

What Happens to the Body as it Warms Up?

During a warm-up, the body moves from a relaxed state to a readied state, preparing itself for physical activity by:

- Signaling the sympathetic nervous system
- Increasing blood circulation
- Readying nutrients in the liver to be delivered to the working muscles
- Increasing cellular metabolism
- Dilating the lungs
- Slowing down organs that are not primarily used during physical activity
- Warming muscles
- Loosening tendons, ligaments, and fascia
- Preparing joints for movements
- Increasing circulation of the lymphatic fluid
- Priming the somatic nervous system
- Enhancing psychological preparation

Signaling the sympathetic nervous system. During physical activity, the sympathetic nervous system functions as a signaling mechanism that alerts different areas of the body to get ready for action, relying on neurotransmitters to deliver messages to the organs. When the body begins to warm up, the neurotransmitter norepinephrine is secreted into the blood, signaling the heart to increase cardiac output, heart rate and stroke volume, and dilation of blood vessels. Warming up also engages the sympathetic nervous system to signal and stimulate the nutrient production in the liver, increase enzymatic activity within the muscle, dilate the lungs, and slow down other organs in order to conserve energy for movement.

Employee's perform a morning warm-up using the WOW™ by BIOKINETIX

Increasing blood circulation. As the body engages in a warm-up, it signals the heart to begin increasing the amount of blood it pumps to the body. The heart does this in two ways. First, the heart rate—the number of contractions, or heartbeats, per minute—will increase. Second, the stroke volume—the amount of blood that is pumped with each beat—will also increase. Together, these two factors result in a greater amount of blood being pumped out of the heart to the peripheral tissues. This is accompanied by dilation of arteries that travel to the muscles and the constriction of the arteries that travel to organs that are not primarily used, allowing quicker blood flow to the muscles and other areas of the body that need blood during exercise.

Blood flowing to the muscles carries oxygen and nutrients—the energy that muscles need in order to produce movement. While engaging in repetitive movements overtime, the body can start to break down. Nutrients and oxygen help the body repair and regenerate, combating the effect of repetitive stress and work-related activities. Warming up increases circulation, which brings this energy to muscles more quickly [10]. Increased circulation also allows carbon dioxide and waste products to be brought away from the muscles more rapidly.

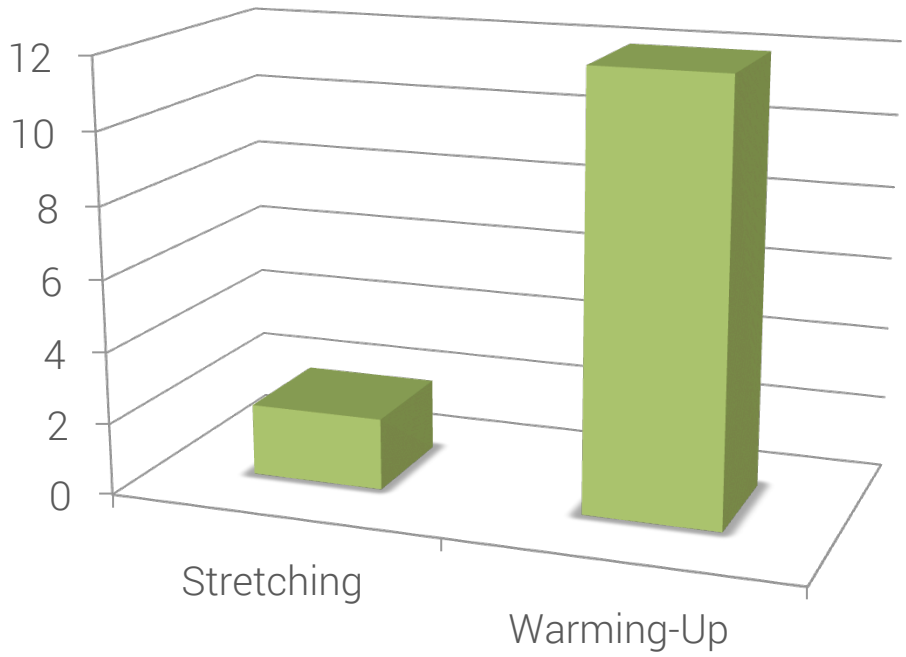
Readying nutrients in the liver to be delivered to the working muscles. Before the blood can carry nutrients to the muscles to be converted into energy, the blood must pick up these nutrients in the liver. The liver stores glycogen—a form of glucose that can be converted to energy. As the body starts to engage in a warm-up, the sympathetic nervous system signals the liver to prepare glycogen for transport to the muscles. Once prepared, the blood picks up the glycogen and transports it to the cells to be converted into energy.

Increasing cellular metabolism. Warming up also stimulates the cells to increase their metabolism—the process by which cells take in nutrients from outside the cell, convert those nutrients into energy, and then rid themselves of waste products. Cells absorb oxygen and nutrients by utilizing enzymes, which take these nutrients and convert them to energy. Warming up increases the activity of the enzymes that are used to absorb this “food” as well as the enzymes used to convert “food” into energy, thereby increasing the rate at which the oxygen and nutrients are absorbed from the blood and converted to energy [6]. As energy is produced more rapidly, the muscles become adequately supplied for the demand of physical activity.

An increase in cellular metabolism also rids the muscles of waste products more quickly. As muscles contract to move the body, they utilize energy, producing waste products and heat. When cellular metabolism is at an increased level, the waste products are carried out of the cells more quickly. If this does not occur at the same pace that waste products were being produced, toxicity would result within the cell, slowing the cell’s ability to convert nutrients to energy and energy to movement.

Dilating the lungs. When the body warms up, the neurotransmitter norepinephrine is secreted into the blood to signal the lungs to dilate, which includes the large bronchial tubes as well as the tiny air sacs located within the lungs. As the bronchial tubes and the air sacs dilate, more surface area is created to exchange old carbon dioxide for new oxygen. The increase in the exchange of oxygen and carbon dioxide accounts for the muscles’ increased need for oxygen and increased need to excrete carbon dioxide.

Slowing down organs that are not primarily used during physical activity. Norepinephrine also is used to reduce the activity of organs that do not play a central role in physical activity. Norepinephrine shunts blood away from the skin, reduces peristalsis (the movement of the gastrointestinal tract), and inhibits contraction of the bladder and rectum. This conserves blood and energy to be used by the muscles during physical activity.



Total number of warm-up health benefits compared to static stretching

Warming muscles. As muscles contract during a warm-up, more than two thirds of the energy produced by the body's muscles is lost as heat. This heat warms the muscles and further prepares them for physical activity. Warm muscles function more safely and efficiently in general; they contract more forcefully, have more elasticity, and are less susceptible to being strained or pulled [4, 5].

Loosening tendons, ligaments, and fascia. The heat generated by muscle contraction warms up not only the muscles, but also the surrounding tissues, which include tendons, ligaments, and fascia. The tissues of these structures become more pliable as they warm up, making them less susceptible to irritation, sprains, and tears. As the ligaments and fascia become more pliable, they allow the joints to move with greater ease, reducing the stiffness of movement that often occurs within the first moments of engaging in physical activity.

Tenosynovium—a thin sheath that surrounds tendons—is a slippery substance that allows the tendons to slide more easily alongside other tendons and other surrounding tissue. The temperature increase generated by warm muscles allows the tendons to slide more easily through the tenosynovium sheaths.

Preparing joints for movements. As the body starts to move, synovial fluid is secreted into the joints (the interface between two bones) and becomes less viscous within the joints. Joints are covered by tissue called the synovial membrane, which secretes synovial fluid to lubricate the joint. As synovial fluid is secreted and becomes less viscous, friction at the joint is greatly reduced. Synovial fluid also serves as a transport medium to provide nutrients to the articulating cartilage and to remove waste [6]. This is critical, as articulating cartilage has little vascularity to provide this function. Together, these factors allow the joints to function healthier and safer.

Increasing circulation of the lymphatic fluid. Lymphatic fluid travels in the lymphatic vessels, carrying waste products from the blood vessels. Like the venous system of the blood, the lymphatic vessels constitute a passive system, meaning that they rely on muscular contraction to move the fluid through the vessel system. As the body engages in a warm-up and the muscles start to contract, the lymphatic fluid is pushed through the system of vessels and removed from the body. This helps to clean out old waste products and to make room for new waste products that will be produced as the body engages in physical activity.

Priming the somatic nervous system. In order for the body to initiate and sustain physical activity, nerves must send messages from the brain to the muscles telling them to move. These nerves are part of the somatic nervous system; as the body warms up, they send messages more easily and at a higher speed. This is especially important to the body when it begins a physical activity that requires a great deal of coordination or fine motor skills, such as typing on a keyboard, cutting hair, or playing a musical instrument [7].

Enhancing psychological preparation. Warming up the body allows the mind to clear itself of any thoughts or stimuli that is unrelated to the upcoming physical activity. This increases the mind's ability to focus on the skills and strategies that will be used while the body performs the physical activity. Positive imagery, or the mental imagery of success, has also been shown to relax the body and enhance concentration [8].

Conclusion

Although significant regulatory measures have been implemented over the past several decades to address the causes of occupational injury, MSDs continue to impact the workforce at alarming rates. Sports science has also shown us that stretching and performing active movements without resistance fail to adequately prepare individuals for repetitive stress, because they do not stimulate the body to ready itself for activity. Instead, workers must protect themselves from MSDs by warming up, an activity that is proven to properly prepare the body for the repetitive stress of daily physical tasks.
Warming up helps reduce the risk of suffering overuse injuries by preparing the muscles, tendons, fascia, ligaments, and joints for the strenuous movements that are required to complete most job tasks. Engaging in warm-up activities ultimately helps the body become more resilient and better equipped to handle repetitive stress.

If, in addition to mitigating workplace hazards and providing ergonomically correct equipment, individual employees adopt the practice of warming up regularly, they can avoid the pain, discomfort, and loss of productivity caused by MSDs. Furthermore, by encouraging employees to warm up, businesses can reduce the risk of workplace injuries, along with the loss of productivity and burdensome financial consequences that inevitably result from each injury.

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