

A BIOMECHANICAL INVESTIGATION OF WARM-UP PROCEDURES FOR MUSICIANS

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ABSTRACT

Published reports indicate that the rates of physical injury in musicians are surprisingly high and costly. One approach taken to minimize the risk of injury is the use of a proper warm-up prior to either a practice session or a performance. There is a lack of consensus among musicians about the nature and components of a proper warm-up. This paper will examine warm-up for musicians (primarily pianists) from a biomechanical point of view drawing first on information from the fields of performing arts medicine and treatises on music pedagogy to summarize the typical or recommended practices for musicians. The biomechanical facets of these practices are then analyzed to assess their affect the body in the context of the forces and movements required to play an instrument. As there is little research investigating the long term affects of warm-up practices on musicians' health it is necessary to use results from analogous athletic activities to evaluate the efficacy of the components of warm-up procedures for musicians. As a result of bringing together and analyzing a range of data from a number of different activities we are able to suggest hypotheses regarding important components of warm-up for musicians and the impacts of these activities. The results can serve as a basis for looking at long-term effects of warm-up on musicians' health.

INTRODUCTION

There is considerable documented evidence pointing to significant levels of playing related injury among musicians (e.g. 1-3) and that the cost of these injuries is significant (2). Injuries types include overuse injuries, misuse injuries and dystonia (4). These injuries (and the often associated occurrence of pain) range from short-term, minor events to significant career-ending injuries.

Many causes and risk factors have been proposed (1, 5) but the data are insufficient for their clear description and identification (1). Zaza (5) does suggest several risk-factors that are under the direct control of the musician: warm-up; breaks; posture, and playing position; technique; repetition; and, pacing.

The focus of this paper is one of these risk-factors: warm-up (6). There are no long-term studies relating detailed warm-up practices of musicians to injury rates so the objective of this work is to bring together published research in a variety of fields (e.g. music education; medical problems in the performing arts; athletics) to establish a clear understanding of the concept of warm-up for a musician and to establish a framework for further research on the biomechanics of warm-up for musicians.

DEFINING WARM-UP

Warm-up

There is no universal definition of warm-up but the term generally refers to a period of preparation prior to an activity. The activities performed during this time are intended to allow an individual to perform optimally. Warm-up is most commonly thought of as pertaining to an athletic activity and it is also strongly associated with injury prevention. Generally, but not universally, research indicates that a proper warm-up does correlate with a reduction in the likelihood of injury. (7)

The term "warm-up" itself is problematic. While in many cases the activities performed as part of a warm-up do result in an increase in muscle temperature it is not clear universally accepted that an increase in temperature improves performance (compare (7) and (8))

The activities involved in warm-up can be classified as either passive or active (7). Passive warm-up increases muscular temperature based on an external heat source. Active warm-up is further classified as specific and general, where specific warm-up is directly associated with the upcoming activity and general warm-up has a broader effect on the whole-body.

Warm-up for the musician

The situation is not as clear when considering warm-up for the musician. The objectives of a musician differ from that of an athlete. In most cases, musicians are not required to generate large forces in order to play their instruments - the main goal of the musician is rather to perform in a manner that gives the musician sufficient control over the instrument to achieve the intended musical goals. This requirement for precise intentional control suggests that smaller motor units and smaller muscles are most appropriate as these give the musician a finer degree of control over the levels of force generated at the risk of over-exerting these smaller muscles and motor units.

WARM-UP ACTIVITIES

The activities that athletes use in warm-up can typically be divided into four categories: aerobic exercise; stretching; repetition of movement; and visualization.

Aerobic Exercise

Aerobic exercise is a general warm-up that serves to increase muscle temperature and initiate the aerobic metabolic processes within the muscles preparing them for significant use. While aerobic exercise has been recommended for musicians (9) on the basis that muscles, after use, become more flexible and are therefore less likely to tear, the low load levels typical of a musician's activities suggest that this is not a necessary component of warm-up for a musician. (10)

Stretching

Stretching is sometimes considered as a separate activity from warm-up for athletes. In general the goal of stretching is to increase the length of the tendon-muscle-tendon unit. This increased length is thought to reduce the risk of muscle damage and to increase joint range of motion.

Beyond maintaining a good level of personal fitness, it is difficult to identify specific benefits of stretching for musicians resulting from a reduced likelihood of muscular damage since the loads are generally speaking low. However, it is important to recall that if we are using small muscles to gain control during musical performance then these muscles may be loaded at a level high enough to cause damage. Great care must be taken if a musician attempts to stretch these small muscles. While benefits may result from increased flexibility, the small size of these muscles greatly increases the risk of muscular damage during the stretching.

There is considerable disagreement amongst researchers about the benefits of stretching and the best approach to stretching. Shrier (11) presents five main arguments against stretching for athletes.

Here we consider them in terms of the musician.

1. Compliance Shrier (11) questions the linkage between increased flexibility and injury resistance. The issue revolves around the perceived causes of muscular injury. In the case of slow movements, the injury is most likely the result of forces in the muscle becoming too large however, for high speed movements and interactions, injury is more likely associated with energy absorption ability. Compliance is not directly related to either maximum muscle force or maximum energy absorption. For the musician, the typical activity usually does not involve excessive muscular force or significant impact loading. Increased muscular compliance is therefore unlikely to be a specific benefit to the musician.

2. Micro-damage to the muscle Shrier (11) questions the relationship between changes in overall muscle compliance (which includes tendon stretching and stretching of the connective tissue within the muscle) and injury to the fundamental contractile unit within the muscle - the sarcomere. The relationship between the loads is complex and will depend on the level of muscular contraction. Again this issue is not likely significant for most musical activities.

3. Passive versus active muscle stretching Stretching is typically performed when a muscle is relaxed while injuries occur when the muscle is active. Shrier (11) questions the benefits of increased passive muscular compliance in preventing damage when muscles are active.

4. Injuries during stretching Shrier (11) further raises the issue of the well-documented numbers of injuries caused by improper stretching. His position is that this risk is not warranted given the tenuous link between increased compliance and injury prevention. For musicians who are generally using small muscles this is a relevant point as great care must be taken to not damage small muscles.

5. Increased range of motion Finally, Shrier (11) hypothesizes that the increased range of motion created by proper

stretching is related to increased tolerance to pain rather than significant changes in muscle compliance. As proper musical technique avoids postures that result in pain, this is also unlikely to be an issue for musicians.

Shrier's opinions are not universally supported and evidence can be found on both sides of the issues he raises. There is substantial evidence that stretching has benefit in some cases for athletes.

However, in general, for most activities required of the musician, proper technique and the maintenance of a good level of overall fitness will negate the need for significant stretching in a warm-up. There may be certain circumstances where an individual's range of motion about a joint is affecting their ability to perform properly and in these cases stretching may be appropriate but should be undertaken carefully to avoid damaging smaller muscles.

Repetition of Movement

A common aspect of warm-up for athletes is the repetition of basic movements related to the intended activity. This serves as training and also ensures that all joints and muscles have been moved through their expected ranges of motion before the activity starts.

One significant difference between many athletic activities and most musical performances is the variety of movements performed during the task. In many athletic activities (e.g. running) a small number of movements are repeated many times. In most musical activities the sequence of movements is regularly changing and rarely repeats. As a result, this component of warm-up for a musician is better regarded as the performance of related movements.

The repetition of movements similar to those required during performance may also have the effect of easing those movements by adjusting the activation levels on synapses involved in that movement.

Visualization

The process of visualizing an activity before undertaking that activity is a

common step in preparing for both athletic events and musical performances. The effects of visualization include increased mental focus and self-awareness which lead to improved accuracy and a reduction in anxiety (10).

Psychological

While not the focus of this paper, the psychological effects of warm-up for musicians may be most important. Taking the time to warm-up involves a transition from previous activities to a focus on musical goals. The apparently common tendency towards carrying stress as increased muscular tension can be overcome by the calmness involved with an appropriate warm-up routine.

SHOULD MUSICIAN'S WARM-UP?

Yes, but, based on the information summarized in this paper the connection between warm-up and injury prevention is not well supported. Warm-up is generally understood to prevent injuries such as muscle tears resulting from high loads or high energy impacts. These are not the same types of events associated with the typical injuries found in musicians (overuse, misuse and dystonia).

Nevertheless, the muscular warmth that results from a general aerobic warm-up or passive strategies can at the very least give the performer some feeling of comfort and increased awareness of the body. Aerobic activity together with the flexibility that results from appropriate stretching are the benefits of a good overall level of fitness. It is difficult to argue that improved fitness is a disadvantage for the musician. Movement repetition and visualization both contribute to the refinement of particular actions and increased focus and awareness.

CONCLUSIONS

The primary difficulty in applying the wealth of (sometimes contradictory) knowledge of warm-up in athletics to musical endeavors is the lack of understanding of the role that small muscles play in musical performance. Research is

needed to both understand the role of these smaller muscles in performance and in the impact of athletic style warm-up on these small muscles.

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