

# Biomechanics 1

## Introduction

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# Importance of Biomechanics Studies

We often hear the following questions:

- Why do I have to do this skill exactly this way?
- Why do I have to use exactly this piece of equipment?
- What is the advantage of this technical execution?
- Why do I have to use exactly this load during strength training?

Biomechanics answers these questions, and many more.

**Using the knowledge of biomechanics you can achieve better performance of your charges and teach new skills to your students on a higher level or, as the case may be, in a shorter time.**

Students of sports training, physiotherapy, or sport medicine can use the knowledge of biomechanics in their work.

# Biomechanics as a branch of science

Looking into on-line scientific databases, we find several journals with „biomechanics“ in their title:

- *Sports Biomechanics,*
- *Journal of Biomechanics,*
- *Journal of Applied Biomechanics,*
- *Journal of Biomechanical Engineering,*
- *Clinical Biomechanics,*
- *Applied Bionics and Biomechanics,*
- *Computer methods in Biomechanics and Biomedical Engineering*

Biomechanics is not focused only on sports or on human (or animal) motion. In some of articles you can find information on plant biomechanics, the biomechanics of blood flow, etc.

# Definitions

**Biomechanics studies forces and their impact on living systems.**

**Human biomechanics is a branch of science studying the impact of internal and external forces on human body.**

**Biomechanics of sport<sup>1</sup> and physical exercise<sup>2</sup> studies forces and their impact on human body during physical exercise and sport.**

<sup>1</sup> By sport it is meant an organized, competitive, fun activity, requiring skills, ability, determination, strategy, and fair play, in which the winner can be determined by objective means within a firm set of rules.

<sup>2</sup> By physical exercise it is meant any intentional physical activity which enhances or maintains physical fitness, performance, health, or wellness.

# **What are the goals of biomechanics of sport and physical exercise?**

**The major goal of biomechanics of sport and physical exercise is to improve performance in given sport or physical exercise.**

**The secondary goal of sport biomechanics is to provide recommendations for injury prevention and rehabilitation.**

In a wider context the goal of biomechanics of sport and physical exercise is also to increase physical fitness. For instance the correct biomechanics of running allows athletes to carry out regular physical exercise for long enough periods of time without being seriously limited by injuries and their consequences.

# How can biomechanics fulfil its goals?

- **Technique Improvement**
- **Equipment Improvement**
- **Training Improvement**

# Technique Improvement

**With the use of biomechanics it is possible to specify motor actions or positions that can increase sport performance.**

- Improvement of technique with the help of biomechanics can be used by teachers and coaches to correct movements of students or athletes – qualitative analysis. Example – three recommendations to help the gymnast execute somersault correctly.
- Moreover, research workers in the field of biomechanics may develop a new and more effective technique for better execution of a sport motion – quantitative analysis. Example - stance position is a factor that affects the mechanical performance of taekwondo athletes' kicks

**Sport technique is a physical action of an athlete which leads to the best possible execution of a physical motion, in conformity with a required task of a given sporting event.**



# Equipment Improvement

Use of biomechanics can also lead to a better look and better functioning of sport equipment.

Sophisticated sport equipment gives advantage to both elite and recreational athletes.

Example: New vaulting table, swimming suit, javelin et al.

# Training Improvement

**By the analysis of mechanical values a coach defines such training conditions that may lead to threshold stimuli.**

Example – the load optimization for maximal power output during strength training.

**By the analysis of technical imperfections of a given athlete the coach/teacher identifies the type of training needed for this athlete to improve.**

An athlete is limited by strength or endurance of certain muscle groups, by speed of motion, or by specific aspects of motion technique. For example a gymnast executing the crucifix on the gymnastic rings must have very strong shoulder adductors. In the case of certain sport skills the required abilities to execute a motor task are not easy to detect and quantitative biomechanics analysis must be used.

# Injury Prevention

**By injury prevention it is meant an attempt to prevent or to limit the seriousness of injuries before they are actually incurred.**

- Biomechanics is a tool that can be used in sport medicine to identify forces and mechanical energy that cause injuries.
- It helps to understand how injuries originate, how to avoid them during sport performance, and how to identify exercise suitable for injury prevention and rehabilitation.
- Biomechanics offers possibilities to create alternative techniques of executing specific movements, using new equipment, and carrying out more effective training methods, which also contributes to injury prevention.

## Examples

How reduce impact reaction forces acting on knee joints during landing after the block in volleyball?

What is a causative factor in developing the iliotibial band syndrome?

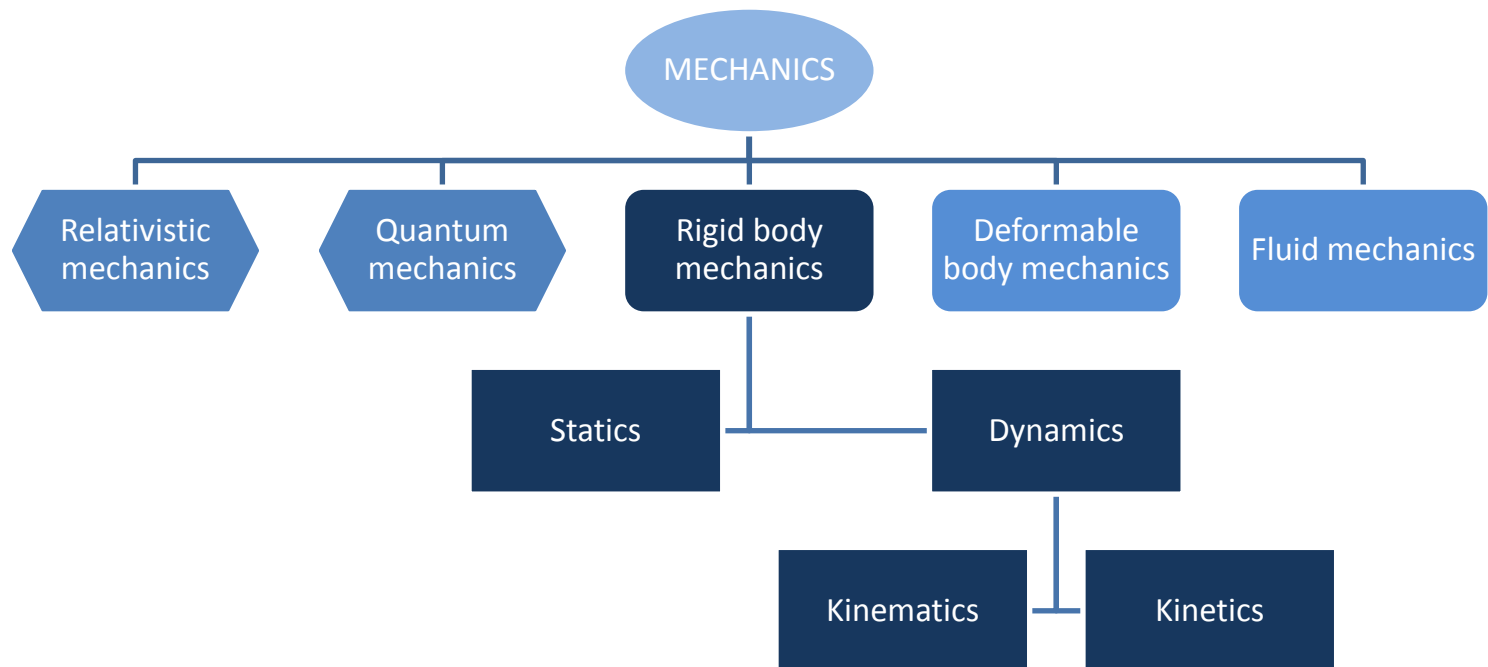
# Injury reduction through changes to equipment function

Biomechanics research has made it possible to manufacture running shoes which reduce impact forces and, at the same time, offer good stability and motor control.

With the help of biomechanics it is even possible to recommend custom made shoes for individual athletes. Prevalence of injuries in running has decreased again.

Není však nejlepším vybavením pro běh samotné lidské tělo?

Branches of mechanics divided according to the nature of studied objects, and the division of rigid body mechanics.



# Elementary quantities and units of measurement used in mechanics

- **Length**

Length is used to describe space in which motion happens. In the SI system the unit for length is metre (m). The symbol used is  $l$ .

- **Time**

SI jednotkou pro čas je sekunda (s). Značka pro veličinu čas je písmeno  $t$ .

- **Inertia** is the resistance of any physical object to a change to its state of motion.
- **Mass**  $m$  (kg) is the quantitative measure of inertia.

So far we have defined three elementary units: those of mass, time, and length. All other units of mechanical quantities may be derived from these three.

Thank you for your  
attention



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