CHAPTER 9

BIOMECHANICS OF PHYSICAL ACTIVITY

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Chapter Objectives

• Describe what biomechanics is and what it encompasses.
• Explain how biomechanics is useful to you and in careers in kinesiology and related areas.
• Address what biomechanists and related specialists do.
• Explain how biomechanics emerged in the field of physical activity.
• Introduce biomechanical concepts and the processes by which biomechanists and professionals in physical activity and related fields answer questions of interest in professional settings.
Goals of Biomechanics of Physical Activity

• To understand how basic laws of mechanical physics and engineering affect and shape the structure and function of the human body

• To apply this understanding to
  • improve the outcomes of our movements (i.e., performance effectiveness) and
  • increase or maintain the safety and health of our tissues.
Why Use Biomechanics of Physical Activity?

• Mechanics: a branch of physics that documents motion (kinematics) and the causes of motion (kinetics)

• Our structures help us to function—for example, to breathe, run, text, and eat.

• Conversely, our movement (i.e., our functioning) affects our structure.

• Forces are needed to accomplish any task with movement; they also help maintain health of our body structures.
Why Use Biomechanics of Physical Activity? (continued)

• Some typical forces that influence body structure and function:
  • Forces applied to us by another object (see figure 9.1a)
  • Forces we apply to another object to manipulate its motion (see figure 9.1b)
  • Forces acting on a bone (see figure 9.1c)
Figure 9.1a
Application of Biomechanics

- Improve movement techniques for sport performance, locomotion, and motor skill acquisition
- Improve equipment
- Prevent injury
- Guide rehabilitation and treatment
- Biomechanics of human movement must account for factors influencing movement that include sensations, other performers, environment, emotions, prior experience, cultural expectations, socioeconomic class, and anatomy
Improving Performance Through Understanding Mechanical Laws

• The performance of any person can be improved in almost any situation that involves physical activity—for example, repetitive work tasks, activities of daily living, exercise, occupational or sport training, sport performance, music playing, dance, and even lying in bed.

• If we understand how living organisms can best exploit the mechanical laws that govern how motion is controlled, then we can intelligently select the best movement techniques for a given performer to use in completing a certain movement task.
Two Main Themes of Biomechanics of Physical Activity

- **Function**: how we produce forces to generate, maintain, or slow down movement during physical activity
- **Structure**: how forces (such as gravity) affect our body tissues
Biomechanics and Kinesiology Degree Programs

• Most kinesiology degree-program specializations require at least one biomechanics course.

• You will learn
  • to apply the mechanical principles for manipulating movement, as well as other principles that can affect tissue health and
  • to use practical methods and tools to answer human movement questions related to assessing or improving performance effectiveness or tissue health, including injury prevention.

• Most biomechanical assessments and diagnoses made by kinesiology professionals involve qualitative judgments based on observation.
Working With Other Subdisciplines

• Anatomy, exercise physiology, and motor behavior are crucial to understanding how our body structures produce movement.

• A kinesiology professional recognizes that our movements are also affected by psychological, sociological, and cultural factors.
What Do Biomechanists Do?

- Researcher
- Clinical biomechanist
- Performance enhancement specialist
- Ergonomist or human factors engineer (industrial task analysis specialist)
- Forensic biomechanist
- University professor
- Certified orthotist or prosthetist
History of Biomechanics

- Antecedents in ancient world and Renaissance (Descartes, 1596-1650; Borelli, 1608–1679)
- Biomechanics applications begin in late 1800s
- Late 1890s-early 1930s: Efficiency Movement (Taylor)
- Taylor influenced Russian Vsevolod Meyerhold, perhaps the first to use the term *biomechanics*
- Posse and Skarstrom: first use of the term *kinesiology* in the U.S. in late 1800s

(continued)
History of Biomechanics (continued)

• 1920s-1930s: Ruth Glassow (film analysis, classifying)
• 1960s: conferences, organizations, graduate-level programs, kinesiology section (1965)
• 1970s: rapid expansion, sport medicine, dance kinesiology (biomechanics)
• Late 20th century: continued expansion of university programs and organizations, switch from the term kinesiology to biomechanics to identify this subdiscipline
Research Methods for Biomechanics

- Motion measurement devices (cameras, motion-detection technology (mocap), video, sensors on sporting equipment, smartphones)
- Force measurement devices (transducers, platforms, EMG)
- Computer simulations
Overview of Knowledge in Biomechanics

• How external forces (gravity, ground reaction forces, friction, fluid resistance) act on performers.

• How internal forces act on performers.

• How biomechanical laws of nature shape our movements (law of inertia, law of action–reaction, torque or moment, propulsive forces, fluid forces, and so on).

• Why do we move in certain ways and not others?

• Is there such a thing as the perfect movement technique?
Balancing Performance Effectiveness and Safety

• Biomechanists as well as other physical activity specialists can apply the principles of mechanical laws to do the following:
  • Enhance performance
  • Reduce injury
  • Evaluate the effectiveness of a movement
  • Select the proper sport equipment, tool, or occupational equipment
Wrap-Up

• The physical laws of nature shape our movements and our body tissues.

• When we understand how mechanical principles influence our body functioning, movement, and structure, we can apply that knowledge to work, leisure activities, sport, exercise, dance, daily tasks, rehabilitation – indeed, to any action involving movement or forces acting on or within the body.