ISSN: 2692-5206
AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

THE IMPORTANCE OF NEWTON'S LAWS IN THE FIELD OF MEDICINE

Ermetov Erkinbay Yaxhivayevich, Safarov Ulug'bek Qarshiboy o'g'li, Bozarov Ulug'bek Alisherovich, Norbutayeva Malohat Qurbanovna, Ixrorova Surayexon Isroiljon qizi

Tashkent Medical Academy

Resume: The article covers Newton's laws, Newton's laws in the field of medicine in immobility and immobilization, homeostasis and physiological stability, surgery and traumatology, Orthopedic prostheses and devices use, Muscle contraction (compression), injury effects, physiotherapy and rehabilitation exercises, affecting bones and joints. gravity, weightlessness in space, gravity and blood circulation, osteoporosis and gravity are discussed.

Keywords: Newton's laws, muscle contraction, immobility and immobilization, homeostasis and physiological stability, orthopedic prostheses, physiotherapy and rehabilitation exercises.

Isaac Newton founded classical mechanics, and his laws helped explain the behavior of many physical objects and systems. Newtonian mechanics works successfully for macroscopic bodies and is mainly used at low speeds and in everyday conditions. But after Newton, classical physics was enriched with various mathematical approaches, and concepts hidden in Newton's laws were developed in a new form. These approaches have helped to describe the dynamics of the body in more detail mainly through differential equations and new algebraic methods. Cases where Newton's laws are particularly limited have been identified. A special theory of relativity is necessary for objects moving at very high speeds, because Newtonian mechanics does not take into account the effects of relativity. For very massive bodies, general relativity must be introduced, as it explains the complexities associated with gravity and space-time variation. Quantum mechanics is used for very small objects (atoms and smaller particles) because their behavior does not obey the laws of classical mechanics. Thus, Newtonian mechanics is seen as a theory that is fully applicable to specific conditions rather than a universal one.

Newton's first law, or the law of inertia, is translated from Latin as follows:
"Any body is either at rest or in straight, uniform motion unless acted upon by external forces."
This law means that an object will not change its state of motion if no external forces (such as gravity or friction) act on it. If a body is at rest, it remains at rest; if it is moving in a smooth and straight line, it will continue to do so. In the case of satellites, the Earth's gravity forces the satellite to move in a curved orbit rather than in a straight line. If there were no gravity, the moon would continue to move in a straight line. This is a practical confirmation of Newton's first law in orbit. The Earth's gravity pulls the satellite towards itself and moves it along a curved orbit, which breaks the uniform motion.
Here are a few everyday examples of Newton's first law:

1. Stopping of the car: If the car stops unexpectedly, the bodies of people sitting inside it will continue to move in the same direction as before. This can be seen when people who are

not wearing seat belts are hit in the front seat when the car stops. And the seat belt acts as an external force to stop the human body.

2. Tennis ball: If you throw a tennis ball in the air and no other forces act on it (no friction or air resistance), the ball will continue to move uniformly. But due to the effect of the Earth's gravity, the ball falls down, and this force changes the direction of motion.

3. The book remains at rest on the table: The book lying on the table remains at rest until no external forces act on it. When you push a book, it starts moving, but when an external force acts on it, such as friction, it stops.

4. Bus Stops Unexpectedly: If you are traveling in a bus and it suddenly stops, your body will continue to move at its previous speed, which will propel you forward. And the seat belt or handrails will hold you down.

5. A ball on a table: If you push a ball lying on a table, it will move uniformly, but will gradually stop due to the force of friction. If there were no friction, the ball would continue to move.

6. Cycling: If you ride a bike and stop pedaling, the bike will slow down and stop due to air resistance and frictional forces. Without these forces, the bicycle would continue to move in a straight line.

7. Airplane Flight: Once airborne, an airplane would continue to move in a straight line without any other forces acting on it. But the plane is affected by air resistance and gravity, so motion control is required.

In these examples, the fact that an external force is needed to change the position of an object shows how Newton's first law works in practice.

Newton's first law (the law of inertia) can also be related to important concepts in medicine. Below are some of its medical applications:

1. Inactivity and immobilization:

- According to Newton's first law, an object does not change its state unless acted upon by an external force. In medicine, this is observed in the case of immobilization. Patients who have been immobile for long periods of time (such as those who have been injured or have undergone surgery) may suffer from immobility. This leads to conditions such as muscle weakness (atrophy) and loss of joint mobility.

2. Homeostasis and physiological stability:

- The body strives to maintain its internal balance (homeostasis). If the body is not affected by external factors (disease, stress), it will maintain its condition. For example, a healthy person's blood pressure and heart rate remain relatively stable. This is similar to Newton's law, which states that in the absence of an external force, the state does not change.

2. Surgery and traumatology:

• When the body is injured, tissues or organs are exposed to certain traumatic forces. For example, the sudden stop of a moving body as a result of a car accident or trauma causes injuries. In these processes, Newton's first law plays a role, that is, the body continues its previous movement, but is damaged when it suddenly stops.

2. Medical technologies and mechanics:

• Prostheses, orthopedic devices and other medical devices are also designed according to Newton's laws. For example, leg or arm prostheses are created depending on mechanical forces to mimic the natural movement of the human body.

Newton's first law helps to understand the following concepts in medicine:

1. Principle of Inertia: Understanding how an organism reacts to changes in its state or system.

• For example, as a result of prolonged immobilization of the patient, muscle atrophy or joint stiffness may occur. This means the principle of inertia - that is, the continuation of inactivity.

2. Principle of Homeostasis: The body strives to maintain its dynamic balance.

• For example, in the cardiovascular system or in the endocrine system, responses to external changes are shown. When there is no external force (disease, injury), the body returns to its previous state.

Thus, Newton's first law can be used in medicine as a general physics principle that explains the state of organisms and systems at rest or in consistent motion.

Newton's second law. The change in motion of a body is directly proportional to the force acting on it and is carried out in the direction of a straight line under the action of the force.

By "motion" Newton meant a quantity called current momentum, which depends on the amount of matter in a body, its speed, and its direction. In modern notation, the momentum of an object is the product of its mass and velocity.

$$\vec{p} = m\vec{\upsilon} \qquad (1)$$

Newton's second law, in its modern form, states that the time product of momentum is force:

$$\vec{F} = \frac{dp}{dt} \qquad (2)$$

The mass of the object does not change with time, then the derivative only affects the velocity, and therefore the force is equal to the product of the time derivative of the mass and the velocity, which is the acceleration:

$$\vec{F} = m\frac{d\upsilon}{dt} = m\vec{a} \qquad (3)$$

Since acceleration is the second derivative of position with respect to time, we can also write:

$$\vec{F} = m\frac{d^2S}{dt^2} \qquad (4)$$

In medicine, Newton's second law is used to explain many phenomena, especially in the study of human body movement and movement processes. Here are a few examples:

Muscle strength and body acceleration: In medicine, the movement of the human body depends on the force produced by the muscles. For example, when muscles act on bones, they create force and accelerate body parts. A large muscle force (for example, a strong muscle contraction) produces a large acceleration. Low muscle strength leads to slow movement. Especially in physical therapy and sports medicine, this law is used to study muscle strength.

Impact of injury: in the medical field, Newton's second law explains the causes of trauma or injuries. For example, in a car accident, when a body is stopped quickly (a sudden change in acceleration), a large force is exerted. Given the mass of the body and the stopping time, this force determines how serious the injury will be. The greater the speed and body mass, the greater the potential for injury.

Prostheses in Orthopedic Surgery: Newton's second law is used to restore movement of body parts, such as prosthetics. The design of orthopedic prostheses takes into account how they affect the body during movement. The mass of the prosthesis and the muscle strength of the patient determine the force required to move the prosthesis.

Movement Control in Rehabilitation: This law is important in the rehabilitation process, especially when re-teaching a person to move. In the training process, Newton's second law is used to increase muscle strength and thereby facilitate movements. Greater muscle strength naturally creates more movement and speed, which increases the patient's ability to move independently.

These examples show how Newton's second law is used in medicine, which is important in understanding body motion and researching the function of the musculoskeletal system.

Overly succinct expressions of the Third Law, such as "action equals reaction," could have caused confusion among generations of readers: "action" and "reaction" refer to different entities. For example, consider a book sitting still on a table. Earth's gravity pulls the book down. The "reaction" to that "motion" is not the support force from the table holding the book, but the gravitational force exerted by the book on the Earth.

Newton's third law is more about the fundamental principle, conservation of momentum. The latter is true even in cases where Newton's statement is not, such as in quantum mechanics, when force fields and material bodies have momentum and the momentum is well defined. In Newtonian mechanics, if two bodies have momenta $\vec{p}_1$ and $\vec{p}_2$ respectively, then the total momentum of the pair is $\vec{p} = \vec{p}_1 + \vec{p}_2$, and the rate of change is $\vec{p}$:

ISSN: 2692-5206
AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

$$\frac{dp}{dt} = \frac{d\vec{p}_1}{dt} + \frac{d\vec{p}_2}{dt} \qquad (5)$$

In medicine, Newton's third law, that is, "For every motion, there is an equal and opposite reaction," is widely used to explain human body movements and the effects of forces. Here are some medical examples:

1. Walking and running: In the process of walking or running, human feet press on the ground with force. And the earth gives back an equal and opposite reaction to this force, this reaction force propels the human body forward. The movement of the musculoskeletal system depends on the interaction of these forces. Also, during the rehabilitation process, this law helps to teach a person the correct walking technique.
2. Orthopedic prostheses and devices: When using prostheses or orthopedic devices, the patient's body exerts force on the prosthesis, and the prosthesis responds with an equal and opposite force. This is important, for example, when calculating the force and resistance required to move an artificial leg or arm. Prosthetics are designed based on Newton's third law, as they must respond to the body's natural forces during movement.
3. Muscle contraction: Muscles contract and apply force to the bones, which make the body move. As the muscle exerts a force on the bones during movement, the bones also respond with force in an equal and opposite direction. This law helps to understand the balance of forces in the musculoskeletal system.
4. Impact of trauma: Newton's third law is important in the analysis of trauma in medicine. For example, in a car accident, when a large force is applied to the body, the body reacts with force against this force. This process leads to injuries, broken bones or other damage. The interaction between the body and external forces determines the degree of injury.
5. Physiotherapy and Rehabilitation Exercises: During rehabilitation and physiotherapy exercises, movements targeting muscles and joints follow Newton's third law. For example, a force applied to a human muscle during exercise will cause the muscle to respond with an equal and opposite force, resulting in movement. Each exercise movement is based on learning the balance between force and reaction force.

These examples explain how Newton's third law is used in medicine and are important in studying the mechanical movements of the human body.

Candidates for Bylaws. Various sources have proposed to elevate other ideas used in classical mechanics to the status of Newton's laws. For example, in Newtonian mechanics, the total mass of an object formed by combining two smaller objects is the sum of their individual masses. Frank Wilczek proposed to draw attention to this hypothesis by labeling it "Newton's Zeroth Law". Another candidate for the "zeroth law" is the body's response at any given moment to the forces acting on it at that moment. Similarly, the idea that forces add like vectors (or, in other words, obey the principle of superposition) and that forces change the energy of a body are both described as the "fourth law". The same can be said about the universal law of gravitation.

The whole universe is the law of gravity. The universal law of gravitation, Newton's law of gravitation - the law of mutual attraction of material particles; a universal law of nature. The force of mutual attraction between material particles with masses m_1 and m_2 and located at a distance r from each other is found from this expression:

$$F = G\frac{m_1 m_2}{r^2} \qquad (6)$$

in this: G – gravitational constant and $G = 6{,}67 \cdot 10^{-11}\frac{N \cdot m^2}{kg^2} = \frac{2}{3} \cdot 10^{-10}\frac{N \cdot m^2}{kg^2}$. Material particles mean objects whose size is much smaller than the distance between these particles, i.e. material points. In order to determine the mutual attraction force of real bodies (taking into account their sizes, shapes and densities), it is necessary to find the geometric sum of the forces of interaction between pairs of individual small particles, which these bodies conditionally disintegrate. So, the force of mutual attraction between two spheres can be found from the above expression (for this, the distance between the centers of the spheres should be taken as g).

Here are some examples of the application of this law in medicine:

1. Gravity affecting bones and joints: The human body moves under the influence of the Earth's gravity. This force is especially important when loading bones and joints. Gravity affects every part of the human body, especially the legs and spine. In orthopedics and physiotherapy, the effect of this force is taken into account, and treatment and exercises are planned.

2. Weightlessness in space: When astronauts are in space for long periods of time, their body structure and physiology changes. Bones and muscles become weak due to the lack of Earth's gravity, because gravity is the force that forces the bones and muscles in the body to work. This is of great importance for medicine, because by studying how long-term living and working in space affects the human body, therapeutic methods are developed against weakening of bones and muscles.

3. Gravity and Circulation: Gravity also affects blood circulation. For example, the heart ensures the return of blood from the lower parts of the body (legs) to the head and heart. When gravity is absent or reduced (eg, in space), the return and distribution of blood changes, which can affect the cardiovascular system.

4. Spine and Gravity: The spine and discs are constantly under the influence of gravity. Gravity increases the pressure on the discs of the spine, which over time can cause problems such as back pain and herniated discs. For this reason, medicine has developed special exercises and treatments to relieve or balance gravity.

5. Osteoporosis and Gravity: Gravity plays an important role in maintaining bone strength and density. Movement and exercise load the bones through gravity, which makes them stronger. When movement is limited or gravity is reduced (for example, in bedridden patients for long periods of time or in spaceflight), the bones become weaker and the risk of developing osteoporosis increases.

In medicine, Newton's law of universal gravitation is important in understanding how gravity affects the human body and in developing appropriate treatments and rehabilitation programs.

Reference:

1. See, for example, Zain.[4]: 1-2 David Tong observes, "A particle is defined to be an object of insignificant size: e.g. an electron, a tennis ball or a planet. Obviously the validity of this statement depends on the context..."[5]
2. Negative acceleration includes both slowing down (when the current velocity is positive) and speeding up (when the current velocity is negative). For this and other points that students have often found difficult, see McDermott et al.[8]
3. Per Cohen and Whitman.[2] For other phrasings, see Eddington[13] and Frautschi et al.[14]: 114 Andrew Motte's 1729 translation rendered Newton's "nisi quatenus" as unless instead of except insofar, which Hoek argues was erroneous.[15][16]
4. One textbook observes that a block sliding down an inclined plane is what "some cynics view as the dullest problem in all of physics".[23]: 70 Another quips, "Nobody will ever know how many minds, eager to learn the secrets of the universe, found themselves studying inclined planes and pulleys instead, and decided to switch to some more interesting profession."[14]: 173
5. For example, José and Saletan (following Mach and Eisenbud[24]) take the conservation of momentum as a fundamental physical principle and treat F=ma as a definition of "force".[18]: 9 See also Frautschi et al.,[14]: 134 as well as Feynman, Leighton and Sands,[25]: 12-1 who argue that the second law is incomplete without a specification of a force by another law, like the law of gravity. Kleppner and Kolenkow argue that the second law is incomplete without the third law: an observer who sees one body accelerate without a matching acceleration of some other body to compensate would conclude, not that a force is acting, but that they are not an inertial observer.[23]: 60 Landau and Lifshitz bypass the question by starting with the Lagrangian formalism rather than the Newtonian.[26]
6. See, for instance, Moebs et al.,[27] Gonick and Huffman,[28] Low and Wilson,[29] Stocklmayer et al.,[30] Hellingman,[31] and Hodanbosi.[32]
7. See, for example, Frautschi et al.14: 356
8. For the former, see Greiner,35 or Wachter and Hoeber.36 For the latter, see Tait 37 and Heaviside.38
9. Among the many textbook explanations of this are Frautschi et al.14: 104 and Boas.42: 287
10. Among the many textbook treatments of this point are Hand and Finch 45: 81 and also Kleppner and Kolenkow.23: 103
11. Treatments can be found in, e.g., Chabay et al.47 and McCallum et al.48: 449
12. Discussions can be found in, for example, Frautschi et al.,14: 215 Panofsky and Phillips,77: 272 Goldstein, Poole and Safko,79: 277 and Werner.80
13. Details can be found in the textbooks by, e.g., Cohen-Tannoudji et al.93: 242 and Peres.94. 302
14. As one physicist writes, "Physical theory is possible because we are immersed and included in the whole process – because we can act on objects around us. Our ability to intervene in nature clarifies even the motion of the planets around the sun – masses so great and distances so vast that our roles as participants seem insignificant. Newton was able to transform Kepler's kinematical description of the solar system into a far more powerful dynamical theory because he added concepts from Galileo's experimental methods – force, mass, momentum, and gravitation. The truly external observer will only get as far as Kepler. Dynamical concepts are formulated on the basis of what we can set up, control, and measure."95 See, for example, Caspar and Hellman.96
15. Aristotelian physics also had difficulty explaining buoyancy, a point that Galileo tried to resolve without complete success.98