3 Let us identify principles of biomechanics to maintain correct postures

Maintaining a correct postures means keeping the body parts in proper positions so that minimum amount of energy is spent and no strain is caused to any part of the body during movement or remaining still. Maintaining correct postures pave the way for the development of a fine personality. It is difficult for every individual to maintain postures in the same way as others. The way that postures are maintained may differ from person to person depending on factors like body weight, body size and age. In order to maintain correct postures, it is important that you learn the principles of biomechanics.

Out of the principles of biomechanics that influence postures, you learned the two principles 'centre of gravity' and 'balance' when you were in Grade 10.

In this lesson you will learn some more principles of biomechanics that influence postures and physical activities, and how the body and equipment are manipulated using those principles.

Principles of biomechanics that influence postures

Postures are mainly of two types:

1. Static postures
   eg: sitting, standing, lying
2. Dynamic postures
   eg: running, jumping, walking

The following principles of biomechanics influence these postures.

1. Centre of gravity
2. Balance
3. Inertia
4. Force
5. Direction of force

6. Momentum

As we have already learnt about 'centre of gravity' and 'balance', let us now study the other principles of biomechanics.

Inertia

Inertia is the property of resistance of a body that remains at rest to move or the resistance of a body that is in motion to stop.

Let us consider two objects (A and B) that have been kept on the ground for lifting. If it is more difficult to lift object B than A, inertia of the object B, or the resistance of object B to move, is higher. (Figure 3.1)

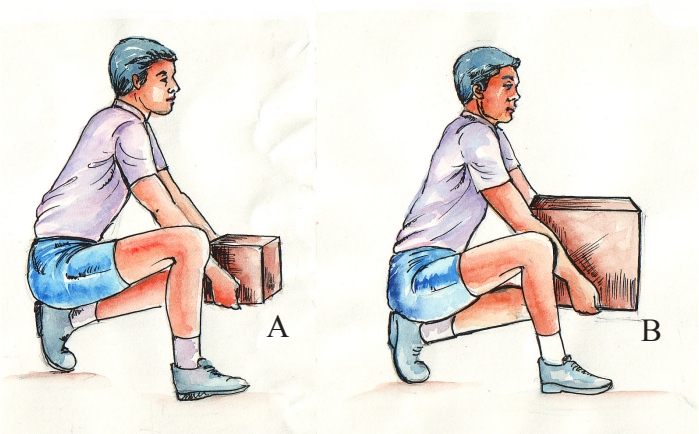


Figure 3.1

Think of a leather ball and a tennis ball that are rolling over. You will understand that it is easier to stop the tennis ball than stopping the leather ball. This means that inertia of the leather ball is higher.

Force

An effect that causes an object which remains at rest to move or which changes the nature of motion of an object in motion is called a 'force'.

When a weightlifter is lifting a barbell that is on his shoulders, he pushes it upwards. When the barbell that is on the ground is lifted, the weightlifter has to pull it upwards. We see such acts of pushing and pulling in different forms in sports. (Figure 3.2)

Actions like pulling, pushing and lifting are results of exerting force.

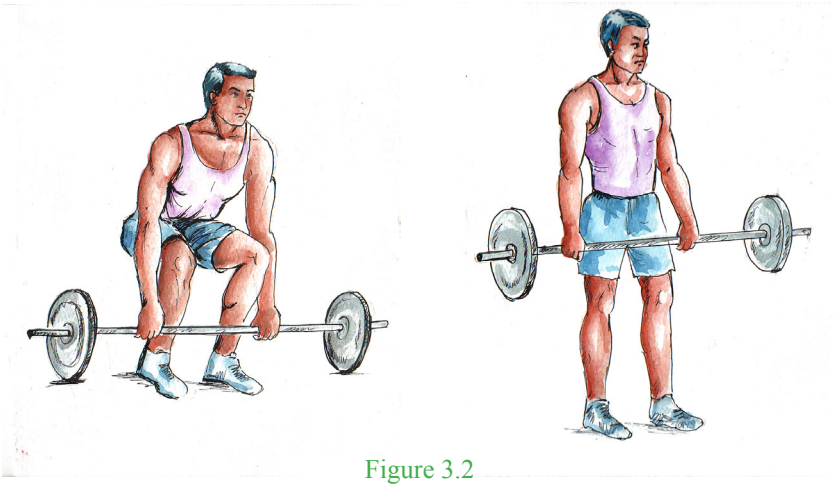


Figure 3.2

When a sprint race is about to start, a sprinter stands still bracing his feet against the starting block. In order to break this stillness, the sprinter has to exert some influence. The influence that breaks the stillness is a force. The force that breaks the stillness of the sprinter is the force of the reaction that is produced as a result of the pressure exerted against the starting block by the sprinter. (Figure 3.3)

When the ball is coming towards a batsman, he hits it with his bat in order to change the direction of motion of the ball by exerting some force on it.

The force necessary for a sportsman for motor activities is generated by the contraction of his muscles.

When an athlete is throwing the shot put, he has to exert some force on it in order to make it move. Further, that force has to be exerted in the direction in which the shot put has to be thrown.

Figure 3.3

For extra knowledge

The first law of Newton that you learnt in Science is as follows:
"Until an unbalanced force is applied on it, bodies at rest remain stationary and bodies in motion continue to move at uniform velocities."

Apply the first law of Newton to the example given above.

Direction of Force

A force has both a magnitude and a direction. Direction of force, too, has an effect on actions. When illustrating the direction of force by drawing a line, the length of the line that is drawn to scale is reflective of the magnitude of the force and the direction in which the force is acting is indicated by the direction of an arrow head.

A weightlifter exerts an upward force in order to lift a weight. Then that object moves in the direction in which the force is exerted. (Figure 3.4)

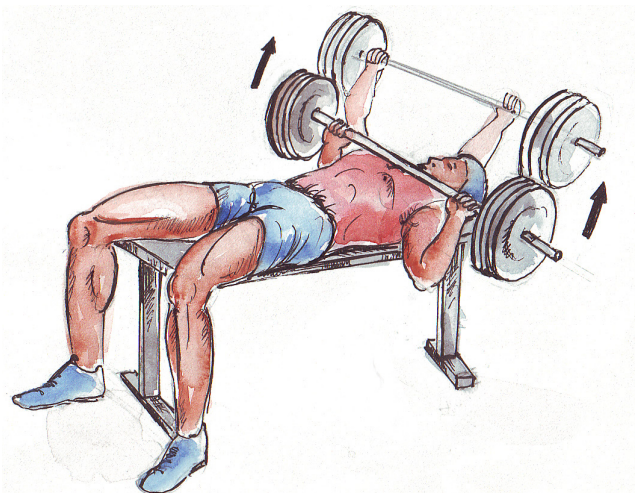


Figure 3.4

When an athlete jumps up, the ground exerts a force vertically upwards on the athlete because of the force that the athlete exerts on the ground. That means the force acts in the direction of the motion.

For extra knowledge

Recollect the third law of Newton that you learnt in Science.
"For every action, there is an equal and opposite reaction."

Apply the third law of Newton to the example given above.

Momentum

Momentum is a measure of how difficult it is to stop the motion of an object in motion.

When playing ″Elle″ it is easy for you to catch the ball that a player throws at you, but if a heavier object is thrown at you, it would be more difficult for you to catch it.

Further, even an object that is not so heavy would be difficult to be caught when it is moving very fast.

Accordingly, it is clear that momentum depends on the mass and velocity of an object.

momentum = mass x velocity

The momentum of a shot put that is rolling over fast is greater than the one that is rolling over slowly. Further, the momentum of a bigger shot put that is rolling over at a certain speed is greater than that of a smaller one that is moving at the same speed.

When a cricketer catches the ball coming towards him, he exerts some force on the ball with both his hands in order to stop the ball (Figure 3.5). Then the momentum of the ball becomes zero as its velocity becomes zero and consequently the ball stops moving.

Figure 3.5

Effects of principles of biomechanics on activities

Walking

The purpose of the activity of walking is to carry the body from one place to another. While walking, the body moves forwards or backwards and the weight of the body is shifted from foot to foot alternately. Accordingly walking is called an unceasing process in which the balance of the body is lost and regained.

While walking, the balance of the body is maintained by moving hands and legs in opposite directions.

Running

Running is to be pushed forwards by the force that is exerted on the ground by the feet. When running, a runner exerts some force on the ground and consequently an equal and opposite force acts on the runner. The runner moves forwards because of the reactive force that is generated. (Figure 3.6)

Figure 3.6

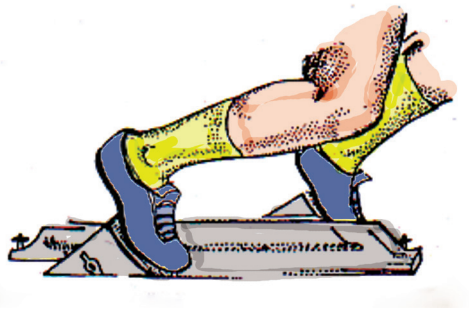


Figure 3.7

At the start of a 100-metre race, a sprinter remains at rest on the starting block. He exerts some force on the block using his feet. As the reactive force generated by the block in response to the athletes force, acts back on him, he is pushed forwards. If that reactive force does not act on him, he remains at rest on the block. (Figure 3.7)

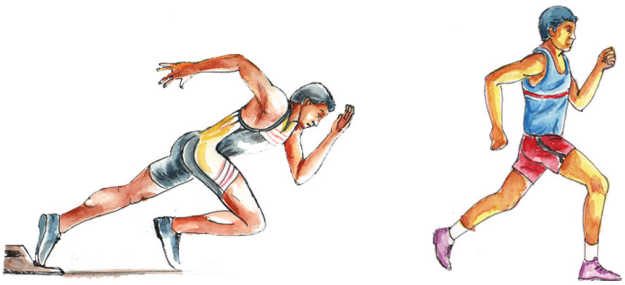
For extra knowledge

Apply the second law of Newton that you learnt in Science to the example given above.

"The acceleration of a body is directly proportional to the unbalanced force acting on it, while it is inversely proportional to its mass."

According to this law, acceleration of an object or an athlete can be increased by increasing the force that acts upon that object or the athlete (a higher rate of velocity change).

The acceleration produced when a sprinter of a 100-metre race takes off at starting block is directly proportional to the force that he exerts on the block. If the force he exerts on the block is greater, the acceleration of taking off the block is greater, too.



3.8 Figure

Jumping and throwing

Releasing an object to the air by throwing or shooting forward, is called a projection and the object that is projected is called the projectile.

In sports and in physical education activities, there are various events in which objects are thrown forwards.
eg: javelin, shot put, discus

Moreover, various pieces of sports equipment are thrown forwards using various techniques.
eg: hitting the ball, kicking the ball

In events like long jump, high jump, triple jump and hurdles, the body of the athlete becomes the projectile.

For extra knowledge

The centre of gravity of a piece of sports equipment or that of an athlete that is taken-off into the air moves along a circular path in the air. This path is called the trajectory.

The following figure shows the path of the centre of gravity of a long-jumper from the time he takes off until he lands.

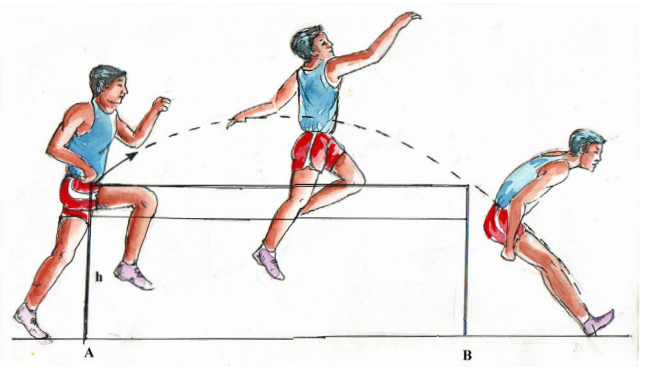


Figure 3.9

A = Point of taking off
B = Landing point
A-B = Distance of the jump
h = Take-off height

Factors affecting the distance or the height of the jump of an athlete

1. Velocity of take-off
2. Angle of take-off
3. Height of take-off

The height or the distance of the jump determined on the above factors cannot be changed by the movements that the athlete makes while he is in the air. In an event like long jump, such movements are only useful in preparing the body for a successful landing. (Figure 3.10)

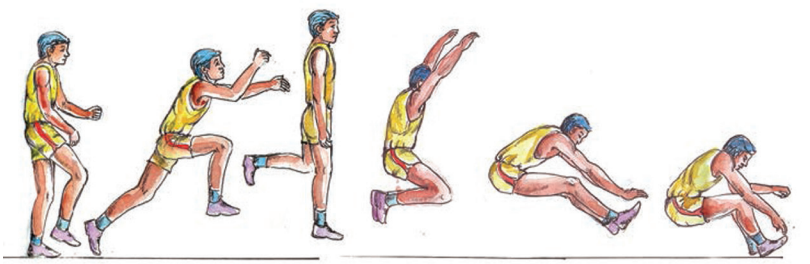


Figure 3.10

The velosity of the take-off is the most important one of the above factors. In jumping events, the approach run is used to increase the take-off speed.
The optimum take-off angle differs according to the event.

The height at take-off differs according to the height of the body of the jumper and the position of the body of the jumper at the take-off.

Factors that determine the distance of the throw are;

1. velocity of release
2. angle of release
3. height of release

In throwing events like throwing the shot put, discus throw, javelin throw and hammer throw, the distance that the shot put, discus, javelin and the hammer will travel depends on the above factors.

Velocity of release of the equipment
In a throwing event the key factor that determines the distance of the throw of the equipment is the velocity of release of that equipment. The magnitude of the force exerted on the equipment depends on the direction of force, the distance and duration of exerting the force and the speed of release of the equipment.

In order to attain the maximum speed of the propellers, the thrower uses different techniques. A discus or shot put thrower by rotating the body and a javelin thrower by running fast, gets the speed. (Figure 3.11)

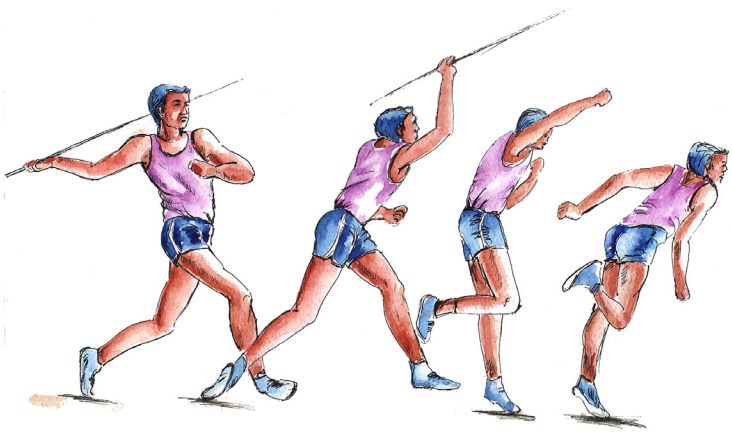


Figure 3.11

Angle of releases of the equipment

The next important factor is the angle of release of the equipment. In throwing events, the optimum release angle differs from event to event.

When a piece of equipment is released in the proper angle, it can be thrown further and when that equipment is thrown at angles greater or lesser in magnitude to the proper angle, the equipment lands at shorter distances.

Figure 3.12

Height of release of the equipment

In a throwing event, the height of release of the equipment is a factor that depends on the height of the athlete. An athlete who is taller than another can release the equipment at a greater height when compared to the shorter one. If all the other factors are equal, the athlete who releases the equipment at a greater height is in a slightly advantageous position. (Figure 3.13)

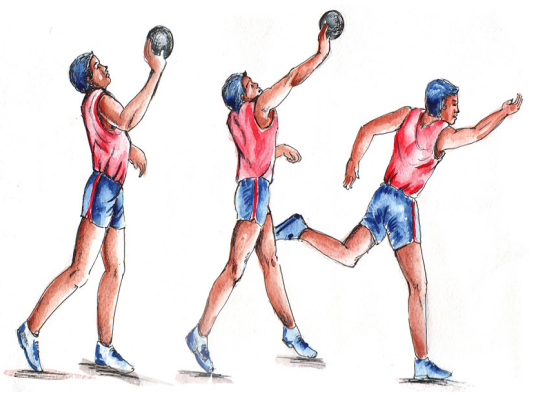


Figure 3.13

Summary

It is important to maintain correct postures in order to live a healthy life.

The centre of gravity and balance, inertia, force, direction of force and momentum, are also included in the principles of biomechanics that influence postures.

Inertia is the property of resistance of a body that remains at rest to move or that of a body that is in motion to stop.

An effect that causes an object that remains at rest to move or that changes the nature of motion of an object in motion is called a 'force'. A force has both a magnitude and a direction.

Momentum is a measure of how difficult it is to stop the motion of an object that is in motion.

These principles of biomechanics influence in dynamic postures like walking, running, throwing, and also in sports activities.

In jumping, the path that the centre of gravity of the athlete takes depends on the take-off velocity, take-off angle, and take-off height. In throwing, the path that the equipment takes depends on the velocity of release, angle of release, and the height of release.

Exercise

1. Name six principles of biomechanics that influence postures.
2. What are the three factors that determine the height and the distance that an athlete would jump in a jumping event?
3. What are the three factors that determine the path that a sports equipment takes in a throwing event?