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Exercise Induced Injuries: A Concern for Fitness Freaks

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ABSTRACT

Regular exercise has been associated with a wide range of health benefits for people with obesity, sleep apnoea and cardiovascular complications. This is achieved only when the individuals follow the physician/trainers' instructions and adhere to proper exercise regime. Even though the health benefits of exercise outweigh the negative effects, it is important to outline some of the more severe exercise-induced injuries. In this review, some of the more ignored but severer exercise-induced injuries experienced by individuals or athletes have been highlighted. Some of the causes of injury include poor posture, intensive exercise regime and lack of rest between exercise intervals leading to a muscle tear, cardiac complication, joint degeneration, decreased bone density and circulation as well as loss of muscle elasticity.The aim of this article is to highlight the exercise induced injuries and their underlying causes so that by understanding them, people may gain benefits of exercises and avoid unexpected injuries.

Introduction

Exercise is defined asan organized, repetitive physical activity which is carried out with an objective to condition the body.Generally, its purpose is to enhance or maintain the physical fitness. Other than this, it is performed for a variety of reasons like to improve strength, develop muscles, reduce weight, counteract aging, enhance athletic aptitudes, and simply for happiness or enjoyment.There are a variety of physical exercises like aerobic, anaerobic or flexibility exercises. Aerobic, anaerobic and flexibility exercises includewalking/running, weight training/sprinting and stretching respectively. Aerobicexercises enhance cardiovascular endurance while anaerobic exercises improve the muscle strength. On the other hand, flexibility exercises improve the range of muscular and jointmotions. Different types of people carry out different types ofphysical exercises as per their goals, requirements or reasons.

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The health benefits contributed by physical exercises are well known and widely reported. Some of the clinically proven benefits include the increased life expectancy,improved glycaemic control, reduction of blood pressure/cholesterol and improved muscle coordination.Aerobic endurance exercises have been reported to benefit visuospatial memory in young adults [1]. These exercises are also being advised for pregnant women [2]. These exercises provide various health benefitse.g.feto-protection, prevention of maternal weight gain or fat deposition in late pregnancy and reduction in musculoskeletal complaints [3]. Aerobic exercises havebeen reported to improve endurance and muscle strength in elderlypatients [3-6]. Exercise regime has also been used in psychiatric rehabilitation to moderate depression, schizophrenia and anxiety which improves behavioural functioning such as self-efficacy, decreased stress, increased social contact as well as improves eating disorders. In addition to improving the physical fitness, physical exercises have been reported to contribute in the prevention and management of various health-related conditions such as asthma, sleep apnoea, orthopaedic complications as well as psychosocial disorders (depression, eating disorders).A lot of people enthusiastically follow stringent exercise routines so as to fulfil their personal goals or to achieve the health benefits of exercises. Aregular exercise routine is highly recommended also, but the growing incidence of exercise induced injuries among fitness freaks or sportspersons is a serious matter of concern. The aim of this article is to highlight the exercise induced injuries and their underlying causes so that by understanding them, people may gain benefits of exercises and avoid unexpected injuries.

Exercise induced injuries

Contrary to the popular belief, exercise may be harmful in some cases and can cause injuries. Table Iand Fig. I summarize the possible injuries which may occur due to certain exercises. But there are certain reasons due to which exercise may induce injuries instead of providing benefits. To be more specific, vigorous high-intensity exercises or unsupervised exercise can cause serious muscle injuries. For example, carrying out exercises without consulting a gym trainer, maintaining an improper posture, missing warm-up and cool down before and after work out, missing stretching or cross-training, not identifying trouble spots, exercising without proper gear and improper exercise technique may lead to painful injuries.These injuries may prove to be very detrimental when they occur in teens, adults and elderly people.

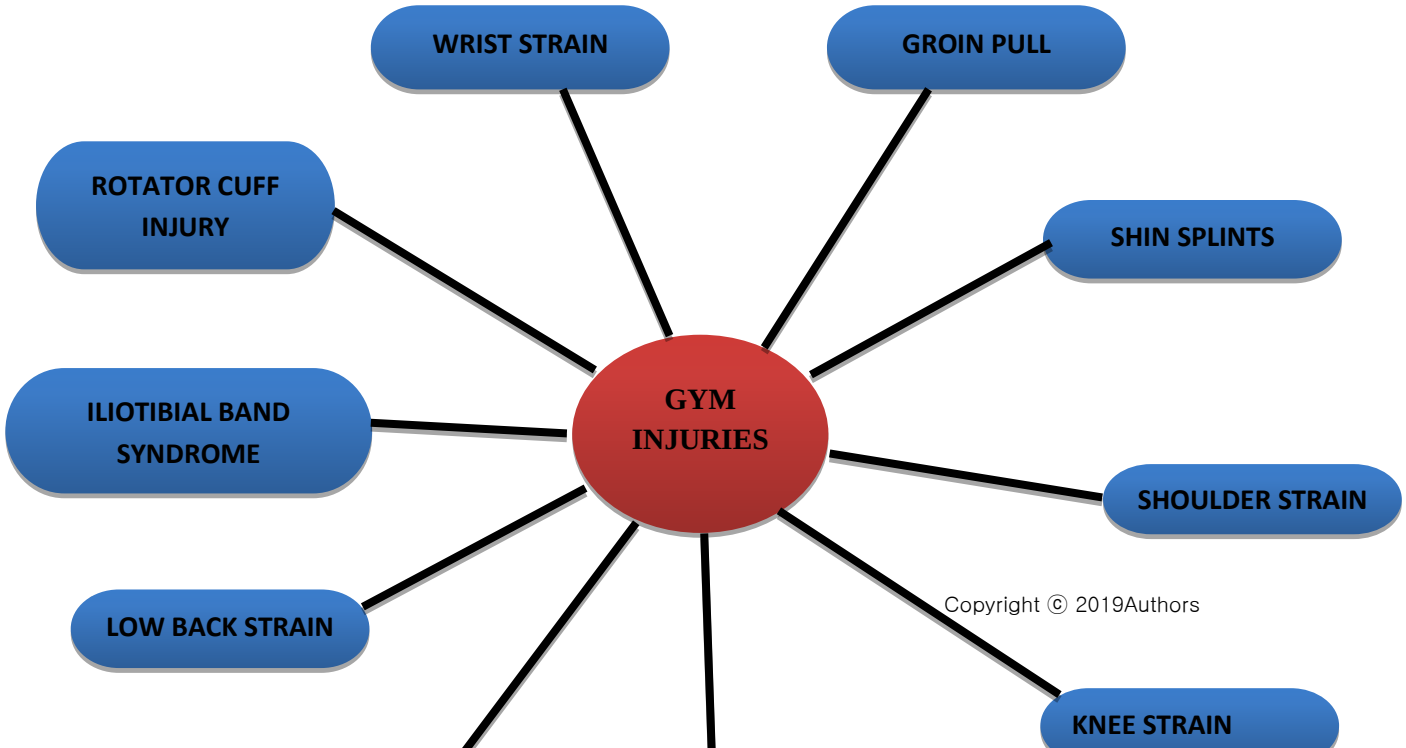
S.	Types of exercises	Possible injuries

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No.		
1	Crunches: Bicycle-style and regular	Muscle spasm and herniation
2	Head Exercises: Lat pull-downs, and shoulder presses	Stress on anterior joint capsule causing impingement and rotator cuff tears
3	The Kettlebell Swing	Rotator cuff injury and inflammation in structures in the shoulder
4	Bent Over Rows	Disc displacement and possible nerve injury
5	Deadlifts	Lumbar injuries, lower back muscle spasm and herniating of spine disc
6	Overhead Squat	The strain on the lumbar regions, shoulders, cervical and thoracic vertebrae
7	Backward Medicine Ball Rotation Tosses	Herniated disc
8	Seated Leg Extensions	Muscular incoordination, knee joint damage and cartilage wear down
9	Pull-Ups	Shoulder complications
10	Preacher Curl	Forearm complications

Table I: List of possible injuries due to certain exercises.



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Fig. I: Injuries frequently associated with gym-exercises.

i) Exercise induced musculoskeletal injuries

Commonly observed injuries affecting skeletal system are as follows:

a) **Patellar tendonitis:** This is a condition in which the tendon connecting the knee to the shinbone becomes inflamed as a result of overexertion due to leg activities. It is also prominent in people with weakened glutes and quads, tightened quads and poor ankle mobility [7-8].

b) **Lower back strain:** There are three main muscles that support the spine these are extensors (gluteal and back muscle), flexors (iliopsoas and abdominal muscle) and oblique (side muscles). The spine is responsible for weight bearing function such as moving, bending and twisting. A strain occurs when muscle fibres are abnormally torn and stretched. This can be accompanied by torn ligaments. The soft tissues become inflamed causing muscle spasms and pain [9-10].

c) **Meniscus tear:** It occurs due to forcefultwisting or rotation of the knee. It affects the C-shaped pieces of cartilage that serve as cushion between the thighbone and shinbone. It results in swelling and stiffness causing a blockage of knee movement or motion. Symptoms include popping sensation, pain and difficulty in twisting, straightening or rotating the knee, and swelling [11].

d) **Subacromial impingement:** This injury occurs due to irritation and inflammation of the rotator cuff tendons. It results in pain, reduced range of motion within the shoulder and weakness[12-13].

e) **Plantar fasciitis:** The plantar fascia is present on the bottom surface of the calcaneus (heel bone) and extends along the sole of the foot towards the toes. This injury occurs when there are micro tear and inflammation in the plantar fascia. This happens due to two reasons: traction (repeatedly overstretching due to elongated arch resulting from

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the weakness of foot arch muscles and poor foot biomechanics e.g.overpronation) and compression (when a person lands on sharp a object that leads to bruises) [14].

The effects of excessive or wrong exercise have been reported to produce a damaging long-term effect on the muscles (Table II). Intensive eccentric exercise has been the cause of muscle damage for athletes and people. Several changes occur within the muscle indicating muscle damagelikeswelling, impaired excitation-contraction coupling, damage to the muscle cell membrane, loss of calcium homeostasis or muscle soreness.The extent of this can be examined through the study of the function, ultrastructural and molecular features of the muscles. This further shows that overstretching of the sarcomeres and aggressive contraction leads to their disruption. In weak sarcomere, desmin, dystrophinand cytoskeletonshow a wide range of damages (e.g. disrupted I-bands, extracellular matrix disturbances, autophagicvacuoles, A-band filament disturbances, autophagicvacuoles, swollen or missing mitochondria,randomly orientated myofilaments and capillary disruption) thereby affecting the integrity and structure of the muscle. Muscle damage can occur during exercise and asafter injury, it may remain undetected, the person tends to continue overworking of muscle. This results in soreness and stiffness which generally occurs in elbow flexors and arm flexor muscle. Loss of contractile ability and soreness aggravates the injury [15-16].

S. No.	**Muscle injuries**	**Causes**	**Symptoms**	**Clinical signs**	**Location**
1	Fatigue-induced muscle disorder	Muscles absorb less energy during exercise causing stiffness	Aching muscle, stiffness during activity or after	Muscle pain which is characterized as dull,diffuse and tolerable	Entire muscle
2	Delayedonset muscle soreness	Eccentric deceleration movements	Aching muscle, stiff muscles and pain at rest after activity	Limited motion on adjacent joints, pain on isometric contraction, and oedematous swelling	Entire muscle
3	Spine-related neuromuscular muscle disorder	Caused by irritation on a spinal nerve which results in increased muscle tone(leading	Aching muscle, firmness with increased regular activity characteracteriesd by no pain at rest	Limitation in flexibility, increased muscle longitudinally,oedema between muscle, oedematous swelling between muscle and fascia	Tendon junction or large muscle bundles on the entire muscle

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		to lumbar spine hamstring or calf pain)			
4	Musclerelated meuromuscular-muscle disorder	Caused by increased muscle toneand firmness	Cramp-like pain and aching	Oedematous swelling and increased muscle pain	Entire muscle belly
5	Partial muscle tear	Overworking of the muscles or due to injury	Localised pain, stabbing and sharp pain	Palpable defect and stretch induced pain	Tendon junction
6	Contusion/ Laceration	Caused by a blunt external force which may result ina haematoma	Weakness in tendons, swelling, bruising or redness, increased haematoma characterized by pain at rest and inability to use muscle	Decreased motion,tenderness palpation,pain on movement and diffuse pain	Vastusintermedius and rectus femoris but any muscle is susceptible tothis injury

Table II: Classification of exercise induced muscle injuries.

ii) Exercise induced cardiovascular injuries

Physical exercise has been associated with a number of cardiovascular benefits likeimproved the functioning ability of theheart, lungs and circulatory system[16-18].But it has become evident now that extreme endurance training may actually cause damage to the cardiovascular system (Table III). The athletes are likely to have complications such as cardiac malfunction, altered diastolic filling and reduced left ventricular contractility.Elevated catecholamines, accumulation of free fatty acids causing reduced inotropic state and altered Ca^{2+} sequestration and uptake are being considered as the attributing factors for this [19].Increased cardiac fatigue has been related to cardiac ultra endurance exercises lasting for more than 10hrs [16-18].Increased cardiac fatigue decreases diastolic and systolic functions of heart[20]. Excessive exercise causes cardiomyopathy leading to physiological changes like increase in oxygen demand, increase in preload and afterload, left ventricular hypertrophy and cardiac fibrosiseventually leading to sudden cardiac death [21].

S. No.	**Cardiovascular injuries**	**Causes**	**Location**

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1	Arrhythmias, cardiac remodelling of the right ventricle, chronic structural changes, reduced right ventricle function	Intense endurance exercise(marathon)	Right ventricle
2	Coronary artery plaque formation, cardiac fibrosis, right ventricle/ right atriumhypokinesis, diastolic dysfunction,ventricular and arterial arrhythmias, patchy areas of fibrosis	Marathon running	Right ventricle, right atrium or left ventricle
3	Cardiac failure, acute pulmonary oedema, cardiac dysfunction	Swimming, bicycling and running	Left ventricle
4	Leftventricular hypokinesia	Ironman triathlon	Left ventricle
5	Coronary vasospasm, endothelial injury,catecholamine elevations	Ultra marathons	Heart, right ventricular area
6	Left ventricular hypertrophy, increased preload and afterload	Marathons, long bicycling, swimming races	Left ventricle

Table III: Differenttypes of exercise induced cardiovascular injuries.

iii) Exercise induced respiratory injuries

Exercise induced bronchoconstriction (EIB) and asthma (EIA**)**are most commonly diagnosed respiratory disorders in athletes (Table IV).EIB is a term used to describe acute, sudden, transient airway narrowing that may unintentionally develop as a result of aggressive as well as regular exercise. It is common in asthmatic patients (90%)however it may occur in non-asthmatic patients(> 10%)also. It is well documented that bronchospasm may occur due to exercise provocation. EIA is characterized by airway obstruction which leads to shortness of breath, chest tightness and wheezing during aggressive and prolonged exercise [22]. Asthma may cause sudden death and many deaths have been associated directly to EIB.A study has reported that activation of sensory nerves contributes to occurrence of EIB, which may likely lead to mucus release in the airway after exercise[23-25].

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S. No.	Respiratory injuries	Causes	Mechanism of injuries
1	Bronchoconstriction and Asthma	Ultra endurance exercises in adults or children (age 9-12), ice rink exercises	- Inflammation the airway results in water loss - Hyperpnoea develops due to the release of inflammatory mediators and drying of airway surface

Table IV: Exercise induced respiratory injuries.

iv) Exercise induced vascular injuries

Exercise-induced vasculitisis a condition in which erythematous, pruriginous and purpuric flare up on the legsmostly in long-distance runners especially in hot weather. This condition is mostly ignored or undiagnosed due to its disappearance in 3-10 days (Table V). Thermoregulation overload during exercise in high-temperature areas may cause tissue damage particularly calf muscles [26].Reduction in the performance of the muscular pump on the venous return leads to drainage of veins causing venous stasis. Hot weather activities stimulate the formation and aggregation of immune complexes leading to unwanted activation accompanied venous drainage as well as muscle fatigue [27]. This is prominent on the lower legs in individuals after long runs or walks [26].This type of injury is common in women as compared to men. However it can be prevented to some extent by manual lymphatic drainage, compression hosiery, intake of oedema protective agents, or steroids (local or systemic).

S. No.	Exercise induced vascular injuries		Causes	Mechanism of injuries

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1	**Exercise induced vasculitis injury** characterized by urticarial vasculitis or leukocytoclasticvasculitis	Itching, pain, burning sensation, petechial skin rush, small degree of oedema,purpuric exanthema /eruption on the lower leg	Long distance running, long walks, hiking in hot weather, strenuous hiking	- Thermoregulation overload during exercise in high-temperature areas causing tissue damage - Reduction in the performance of the muscular pump on the venous return leading to drainage of veins causing venous stasis - Stimulation of the formation and aggregation of immune complexes leading to unwanted activation

Table V: Exercise induced vascular injuries.

Prevention of exercise induced injuries

Various approaches are being implicated for prevention and treatment of exercise induced injuries. However there are certain strategies which one can consider so as to avoid the negative effects of exercises. Firstly, exercise should be carried out under supervision of an experienced trainer in adequate environmental conditions, ensuring proper posture andadherence to an exercise training programmei.e. warming-up and cooling down before and after work out. Secondlyproper gear, nutritional supplementationand diet regimen should be followed. Thirdly, trouble spots, pre-existing risk factors or disease conditions should be identified so as to avoid aggravation of disease. Lastly, in case of exercise induced injuries timely medical intervention should be sought.

Conclusion

Exercise-induced injuries may result in serious health complications. Injury can occur at any point of time i.e. during or after exercise and may lead to sudden death in certain conditions. However in order to achieve positive benefits of exercise, one should take proper precautions

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while carrying out exercise and seek timely medical intervention in case of an injury or complication.

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