DERLEME / REVIEW

Musculoskeletal Problems in Wheelchair Users: A Review Study

Tekerlekli Sandalye Kullanıcılarında Kas İskelet Sistemi Problemleri: Bir Derleme Çalışması

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Abstract

Mobility is the basic need for functionality in human life. Physically disabled people often require mobility aids and wheelchairs are the most commonly preferred assistive mobility devices for enhancing independent functional mobility. Today, powered and manual wheelchair technology is available. Manual wheelchair propulsion necessitates more repetitive loading, but because the human body is not designed for such movement, musculoskeletal and functional issues such as pain and joint limitation may arise among manual wheelchair users. They require more support from their spine, arm, elbow, and wrist for mobility, transfer, pressure relief, and most daily activities. During these tasks, repetitive weight-bearing and mobility activities tend to increase the risk of injury, increasing dependence on helpers and a lower quality of life. Accordingly, this review synthesizes musculoskeletal problems and preventive strategies in wheelchair users. Improved understanding of risk factors can assist health professionals who assess, treat, and guide manual wheelchair users.

Keywords: Wheelchairs, musculoskeletal pain, cumulative trauma disorders.

Öz

Mobilite, insan yaşamında fonksiyonellik için temel ihtiyaçtır. Fiziksel engelli insanlar, genellikle mobilite için yardıma ihtiyaç duyarlar. Tekerlekli sandalyeler, bağımsız fonksiyonel hareketliliği artırmak için en yaygın tercih edilen yardımcı cihazlardır. Günümüzde elektrikli ve manuel tekerlekli sandalye teknolojisinden yararlanılmaktadır. Tekrarlayan yüklenmeler, manuel tekerlekli sandalyenin ilerletilmesi için gereklidir, ancak ne yazık ki insan vücudu bu hareket için özelleşmemiştir ve ağrı, eklem kısıtlaması ve ilgili fonksiyonel problemler gibi kas-iskelet sistemi sorunlarına neden olur. Manuel tekerlekli sandalye kullanıcısı, mobilite, transfer ve günlük yaşam aktivitelerinin çoğu için kollarından daha fazla destek almalıdır. Bu görevler sırasında tekrarlayan ağırlık taşıma ve hareketlilik aktiviteleri, yaralanma riskini artırır ve kişinin bir dış desteğe bağımlılığı artırarak yaşam kalitesinin azalmasına neden olur. Bu derlemenin amacı tekerlekli sandalye kullananlarda kas-iskelet sistemi problemlerini sentezlemektir. Risk faktörlerinin daha iyi anlaşılması, manuel tekerlekli sandalye kullanıcısını değerlendiren, tedavi eden ve yönlendiren sağlık uzmanlarına yardımcı olacaktır.

Anahtar Kelimeler: Tekerlekli sandalyeler, kas-iskelet ağrısı kümülatif travma bozuklukları.

1. Introduction

Mobility, in its simplest terms, refers to the ability to move oneself from one place to another (1). Given that it is the basic need for functionality in human life, persons with physical disabilities that impede functional mobility often require mobility aids. Wheelchairs are the most commonly preferred assistive mobility devices for enhancing independent functional mobility by spinal cord injuries like paraplegia, spina bifida, cerebral palsy, multiple sclerosis, stroke, and amputee (2-4). The wheelchair is not considered as seating equipment that provides the static activity; rather, it can be used for various functions while eating, exercising, recreating, working, and so forth (5).

The high risk of experiencing musculoskeletal problems due to being wheelchair-bound or having chronic neurological disorders might cause musculoskeletal pain directly associated with tonus problems. In addition , age, duration of wheelchair use, gender, body mass index, level of spinal cord injury, and the type of activity are risk factors for musculoskeletal pain (2).

Today, powered and manual wheelchair (MWC) technology is available for users (6). Repetitive loading is more required for MWC propulsion, yet human body is not specialized for this movement, resulting in musculoskeletal problems including pain, joint limitation, and related functional problems (7). Manual Wheelchair Users (MWCU) users need to take more support from their spine, arm, elbow, wrist for mobility, transfer, pressure relief, and most daily activities.

During these tasks, repetitive weight-bearing and mobility activities tend to increase the risk of upper limb injury, increasing dependence on helpers and a lower quality of life (8). Joint reaction forces that lead to injury are greater in paraplegic patients than in the able-bodied population. It has also been indicated that up to 70% of MWCU report upper limb pain. Mechanical stress due to the axial load and disuse of the hip joint also accelerate the lower extremity degenerative process (7, 8).

Accordingly, providing appropriate wheelchairs does not only enhance mobility but also prevents deformity as well as provides physical and social health. The proper use of a wheelchair can help users maintain their quality of life and reduce the risk of several different health issues. This article informs readers about how to use a wheelchair properly and avoid using improper purposes. It synthesizes musculoskeletal problems (see Table 1) and preventive strategies in MWCU. Improved understanding of risk factors can have implications for health professionals who assess, treat, and guide MWCU.

1.1. Spine Injuries

When the literature is reviewed, it can be seen that earlier studies have mainly focused on shoulder and upper limb injuries. However, it must be noted that MWCU might also suffer from neck, upper back, thoracic, and lumbar back pain problems (2, 9). Most wheelchair users generally have a reduced activity capacity of the torso musculature.

Adequate motor control of the musculature surrounding the spinal column provides an upright sitting posture and a base to push against during manual wheelchair propulsion. Trunk muscular demands are increased during manual wheelchair ramp ascent and propulsion. Trunk flexion is increased during the push phase and returns upright posture during the recovery phase on a level surface. The upper body's center of mass moves forward to prevent backward tipping on-ramp ascent (10). On the other hand, prolonged sitting in wheelchairs are also associated with an anterior pelvic tilt, tight hip flexors, elongated stretched gluteal muscles, and lumbar lordosis, causing lower back pain (11). Posterior pelvic tilt and progressed kyphosis are also prevalent resulting from wheelchair-dependence. Neck, thoracic, and back pain occur as a result of poor seated posture. Boninger et al. suggested that neck pain could be of mechanical or myofascial origin (12).

1.2. Upper Extremity Injuries

Based on earlier studies, it seems evident that MWC propulsion and wheelchair-related daily life activities cause injuries in several parts of the body, particularly in shoulder, elbow, wrist, and hand (2). Repetitive trauma during indoor/outdoor wheelchair-using and transfers in daily living activities appear to be the most common reason for upper limb musculoskeletal pain in MWCU because these factors are directly related to changes in the mechanical efficiency of upper extremity joints and the amount of physical strain experienced during daily living activities. It might also be expected that the upper limb joints and the nearby soft tissues undergo overuse type of injuries (2, 12, 13). It has been reported that increased forces are seen through the shoulder joint–using primarily the shoulder flexors for wheelchair propulsion and ramp ascent and shoulder extensors for recovery (14, 15).

Shoulder

The anatomy of the shoulder, due to its inherent limited stability and small supporting musculature, is not well designed for tasks required for MWCU. Shoulder injury which results in pain has a significant effect on the range of motion, leading to functional limitation (13).

The shoulder pain in people who use a MWC is mostly experienced during activities of daily life and clearly during weight-bearing tasks such as transfers, wheelchair propulsion, and weight-relief raises. Joint intersegmental forces and moments differ in particular daily activities (5). Joint-reaction forces during these tasks are more immense in MWCU than in the healthy population, which eventually might lead to disabling shoulder pain and functional disorders following a loss of independence (16, 17). Especially, pressure relief, ramp propulsion, and the start of propulsion are the highest joint forces for MWUs (5).

Several familiar physical stressors, including force, posture, repetition, transfer, and duration, might lead to activity-related musculoskeletal pain or disabilities of the upper extremity. In addition, compensatory strategies during overhead tasks while sitting or wheelchair propulsion, such as using the other upper limb for stabilization or sitting in a "C" spinal posture, might lead to the same problems in the upper extremity, particularly in the shoulders (16).

Because of all these reasons, the term "weight-bearing shoulder" was coined by Bayley et al (18). The literature has reported that the prevalence ranges from 29% to 75%, and shoulder pain is associated with increasing years of manual wheelchair use (19-21).

Morrow et al. indicated that the prevalence of rotator cuff tears in both shoulders was four times higher in the MWCU than in the able-bodied group (63% and 15%, respectively) during magnetic resonance imaging (MRI) examination. At the same time, MWCU has 78 percent full-thickness tears and 22 percent partial-thickness tears. In the same population, the supraspinatus tendon tear was greater than infraspinatus and subscapularis tendon tear (61%, 19%, 12%, respectively). The prevalence of glenohumeral osteoarthritis (19%, 1%, respectively) and acromioclavicular osteoarthritis (42% and 26%, respectively) was greater among the MWCU than that among the able-bodied population. In addition to shoulder pathology, other problems frequently encountered in long-term wheelchair users including muscle strength imbalances around the shoulder, joint instability, altered scapular kinematics abnormal glenohumeral motion, and subluxation (14).

According to shoulder MRI findings, the paraplegic patients using MWCs had a tenfold higher risk of experiencing a rupture of rotator cuff (a full-thickness or partial-thickness rotator cuff tear) (19, 21). In the literature of MRI findings, MWCU have revealed a high prevalence of rotator cuff tears (partial thickness, full-thickness or complete tear), labral tears, coracoacromial ligament thickening, and edema, acromioclavicular degenerative joint disease (joint spurs and edema) and tendinopathy in the long head of the biceps, the subscapularis muscle, subacromial bursitis (12, 22).

Elbow

Various studies conducted with MWCU revealed that shoulder pain is the most common problem suffered from while using the device. Other problems such as elbow joint effusion, triceps tendon thickness, and lateral epicondylitis were also observed. . However, there are limited data on the prevalence of elbow pain in MWCU, especially in paraplegic patients, where the prevalence varied between 5-33%. Elbow joint pain often occurs after forceful and repetitive activities (22, 23).

Lateral epicondylitis is one of the common problems in elbow joint, characterized by pain in the round of lateral epicondyle and forearm, especially wrist extensors and the extensor muscle surface of the forearm. This problem may develop with any prolonged repetitive motion at the wrist, and manual wheelchair use is a known risk factor. Row et al. showed that for every ten years of wheelchair use, the risk of developing lateral epicondylitis increases by 79% (24).

Wrist and Hand

The prevalence of wrist pain in MWCU has focused on carpal tunnel syndrome (CTS) and other related factors. It has been reported in earlier studies on MWCU that the prevalence of CTS ranges between 40% and 78%. Overuse of the wrist flexor tendons causes inflammation and repetitive strain (25-27).

In addition to carpal tunnel, wrist, and trapeziometacarpal osteoarthritis are mostly seen because of degenerative changes (22).

1.3. Lower Extremity Injuries

In contrast with upper extremity musculoskeletal pain/ injuries/disabilities, the lower extremity problems are mainly caused by neurological damage. Problems caused by tonus changes (hypotonus or hypertonus) may vary from subluxation to contracture (28).

Due to muscle imbalance, weakness or paralysis, and immobilization, there is a kinetic chain that negatively affects each other in the lower extremity and spine. Poor seated posture or sacral sitting because of weakness or paralysis can cause pelvic obliquity and posterior pelvic tilt. An asymmetry in muscle strength leads to an unstable base for the trunk in an upright position. This imbalance also increases the risk for musculoskeletal pain, overloading to upper limb joints during daily living activities (29).

1.4. Preventative Strategies

Among the most common musculoskeletal injury preventive actions/steps are wheelchair personalization, education of proper transfer and propulsion technique, seating and movement optimization, therapeutic exercise, and increasing physical capacity (5, 9, 11, 32). Many wheelchair users wish to be physically active, but upper limb overuse injuries restrict them. The primary cause of these injuries is wheelchair propulsion pathomechanics due to incorrect chair adjustment and limited cardiorespiratory fitness (33). Musculoskeletal injury prevention strategies for MWUs are discussed below.

Wheelchair selection

Poor sitting posture, weight-bearing on the upper extremity, improper wheelchair configuration are predisposing factors for injury for wheelchair users. Seating and positioning systems significantly affect vital and functional abilities (34, 35). Therefore, the wheelchair should meet users' needs and be ergonomically compatible (36).

Nowadays, a wide range of wheelchair options are available, and wheelchair types, control mechanisms, features, and accessories are the important variables for functional mobility. Samuelsson et al. reported that more than 90% of wheelchair users who attended a seating clinic primarily complaint about seating discomfort or pain (37). Appropriate wheelchair system selection process generally begins with an evaluation of user needs by a group of team consisting of patients, primary care providers, physiotherapists, occupational therapists and speech therapists. In this process, interviews, observations, and examinations should be administered in a very detailed way. If a prognosis is changeable, chair seating and control systems that are adjustable must be chosen (38-40).

The seated posture is a functional posture. A person who is independent or dependent in propulsion has different needs. Users should be properly fitted as their needs and bodies. Among the common causes of slouched posture are improper seat dimensions (5). Seat width, seat depth, seat back height, armrest height, seat angle are the most critical dimensions. The measure of the wheelchair must be compatible with the user. Proper seat-back angle adjustment and cushion shape stabilize the pelvis. Effective seating provides postural control, optimizes functional access, enhances social acceptability with appearance, prevents deformities, protects skin, and makes respiration, speaking, and swallowing processes much easier (34, 41). The seat angle which is between the seat and horizontal line is not recommended to be at zero degrees.

Table 1. Most common musculoskeletal problems in wheelchair users

Spine	
	Neck pain (mechanical or myofascial origin) (12), Low back pain (29), Kyphosis, lordosis, scoliosis (11, 28)
Upper Extremity	
Shoulder	
	Rotator cuff tear, glenohumeral osteoarthritis, acromioclavicular osteoarthritis, biceps tendinitis, subscapularis tendinitis, subacromial bursitis (28, 30), glenohumeral instability (14), impingement syndrome (31)
Elbow	
	Lateral epicondilitis (24)
Wrist	
	Carpal tunnel syndrome, osteoarthritis (27)
Lower Extremity	
	Contracture, hypotonus or hypertonus (28)

Positive angles provide greater pelvis stability whereas negative angles provide easier transfer. Pelvis stabilization and upper body position are primary factors in arranging seat angle. Daily transfer needs and activities must also be considered while arranging angles (35, 40).

The process of choosing a wheelchair system involves multiple factors: Users' medical needs, physical and cognitive status, anticipated course of impairments, goals related to activities, and participation are essential components that should be taken into consideration. Accordingly, injury level, user weight, accessories, individual's lifestyle, and environment must be considered while the selected weight of the wheelchair. Furthermore, door width, outdoor-indoor terrain, climate, transportability at home, work, recreational spaces, and other community environments in daily routines should be evaluated, too. Besides all these factors, there is a wide range of costs for products based on technology, appearance, durability, so financial and community resources are the other important factors during selection processes (38, 40).

The lightest weight and the high-strength wheelchair should be preferred as much as possible because it? can allow users to move faster and travel farther by spending less energy. Given that increased weight causes more force on the upper extremity during functional tasks while shifting and transferring, hightech materials like carbon fiber, titanium, alloy, magnesium, and aluminum alloy are generally preferred for the lighter frame. In addition to this durability, vibration dampening and configurability should be considered while selecting a frame (42, 43).

The process of evaluating and choosing a wheelchair

The system involves the user, an interdisciplinary team, and equipment suppliers or vendors. Also, family members, primary care providers, and others from the user's work and leisure environments may provide useful information while choosing an appropriate wheelchair system to meet needs for mobility within and between environments. Such information could affect choices regarding seating and positioning, controls used, and supports for engagement in activities at home as well as mobility and transport in community settings. Wheelchair selection has a functional orientation and involves multiple factors including the user's (1) needs and goals; (2) home, work, recreational, and other community environments; (3) physical and cognitive status and anticipated course of impairments; (4) financial and community resources; (5) views about appearance, maintenance, and social acceptability; and (6) needs for the interface of the wheelchair system with other assistive technology and care provider or assistant requirements.

Wheelchair equipment

Proper wheelchair type, component selection, its configuration predispose wheelchair users to functionality and comfort. Push handle, backrest, frame, cushion, armrest, footplate, wheels (rear, caster), seat, brake are the main components of a wheelchair. Wheels are made up of a tire, rim, spokes, and hub. Tray, head, neck, thoracic, calf supports, pads for hand or forearm, straps, belts, power-assisted rolling systems are the most preferred accessories (44). Body mass is mostly transmitted through the pelvis and then from the backrest and footrest. Proper distribution of forces over the contact areas saves tissue integrity, by also preventing poor biomechanical posture and overuse injuries (11, 36).

MWCU push an average of 2000 to 3000 in a day. Ergonomic design handrail and power-assisted rolling system reduce stress on wrist and hands. Ergonomic rims reduce the pincer grasp and prevent fatigue with extended use also provide the easy-rolling user who has upper extremity weakness. There are several types with different materials and styles, and they must accordingly be selected based on their benefit (45).

The alignment of the wheels is a significant factor in configuration. It should be configured to optimize stability and maneuverability. Stability is necessary for safety and maneuverability affects access to narrow space. The rear wheel position should be placed as far forward as possible without compromising the stability. It also impacts maneuverability. Long wheelbase reduces maneuverability. However, a very maneuverable wheelchair may be insufficiently stable, so the user's balance is the main factor while real wheel positioning. In addition, when alignment is properly adjusted, they provide spinal stabilization and support weak trunk musculature during functional and static sitting positions. Devices that support trunk, pelvis, and extremities must be adjusted to meet the need of the user (11, 40, 46). The cushion is the other important part for alignment, it is used to stabilize the pelvis, protect the skin, and position the body. There are many options for cushions made with different materials and shapes. In sum, a variety of factors affect the selection processes, including how much time you spend, how stable one's posture is, or how much it costs. Nevertheless, it must also be noted that a wheelchair cushion may not overcome a poorly fitted wheelchair to save skin integrity (11, 47).

MWCU should attach importance to seated posture to reduce anterior/posterior pelvic tilt and thoracic kyphosis. For this reason, they can consider anterior/posterior pelvic support or seat tilt with a contoured backrest. They should decrease the frequency, force of repetitive upper extremity daily living activities tasks, and avoid extremes of position at the wrist and shoulder. Padded gloves can also be attached to the wheelchair arm (44, 48).

Wheel size and tire type impact rolling resistance. Wheel sizes must be chosen according to the size of the wheelchair since wheel size -if incompatible- affects comfort and requires more effort to move the wheelchair. Air-filled, solid, flat-free tires can be chosen and the choice should depend on primary use for indoor or outdoor activity. Air-filled tires for the rear wheel are preferred for soft terrain and provide a better ride than solid tires, but underinflated tires make the wheelchair hard to push and can also be punctured. Air tires need to be replaced more frequently? than solid tires. Solid tires are almost maintenance-free, they do not go flat, but their advantage is absorbing less shock in outdoor activity. In other words, wheelchair users ride less comfortably when compare to other types of tires. Flat-free tires are pneumatic tires that are filled with semi-solid material and give a softer ride than a solid tire. Tires may be affected by extreme temperatures, so they should be checked out based on manufacturer recommendations. Hand rims are also another components that affect weather of the wheels?(43, 44).

Propulsion

The upper extremity is the most common injury location in MWCU. Repetitive, extreme positions of the wrist, hand (above shoulder tasks), maximum shoulder extension when combined with internal rotation and abduction positions while propelling, and maximum extension of the wrist when weight-bearing during transfers cause injury. Carpal tunnel syndrome, rotator cuff tear, impingement syndrome of the shoulder, bicep tendonitis, and tennis elbow are the most common repetitive strain (30).

Most MWCU have upper extremity overuse injuries caused by high physical demand and the repetitive nature of wheelchair propulsion. High force requirements (peak force), repetitive motion (cadence), and extreme joint postures (contact angle) are three biomechanical factors associated with upper arm pathology. These quantities influence mechanical efficiency, joint moments, electromyographic activity, and nerve conduction (49).

Minimizing the frequency of repetitive upper limb tasks, the force required to complete upper limb tasks, and extreme or potentially injurious positions at all joints are critical prevention methods. Ideal seat height is the point at which the angle between the upper arm and forearm is between 100 and 120 degrees and when the hand is resting on the top dead center of the push rim. Propulsion patterns classify as single loop over, double loop over, semicircular, and arc. The semicircular pattern in which the user's hand drops below the push rim during the recovery phase is the most efficient. The use of this propulsion style reduces repetition and causes less trauma to the upper extremities. Velocity, stroke length, and stroke frequency must be optimized for effective wheeling. Wheelchair users who push with long and smooth strokes via slower cadence that limit high forces on the hand rim minimize the frequency of repetitive upper limb tasks andforces required to complete upper limb. The ideal frequency should be one stroke per second or less. If the patient needs greater functional velocity push, rim-activated power assist wheels can be alternative for safer achievement (1, 30, 40).

Exercise Training Advice for Manuel Wheelchair Users

MWCU is a common population who depend on increased use of body parts especially their upper extremities for activity and mobility. This population is predisposed to chronic progressive musculoskeletal injury. Also, because of inactive lifestyle, they suffer from high cardiometabolic diseases risk with high body mass index and decreased body lean body mass (50). Regular aerobic, flexibility, and strengthening exercises should be lifestyle habits for manual wheelchair users. Preventative strength training and activity modification may provide a slow progression of injury development and associated pain in MWCU (31). Clinical studies have shown that strengthening and stretching interventions in persons without disabilities prevent the improvement of shoulder pain (5). Haubert et al. stressed the importance of exercise adherence and shoulder pain prevention programs to reduce shoulder pain (51). In sum, therapeutic exercise is an effective, feasible, and conservative approach to prevent musculoskeletal problems or reduce pain (5).

Studies put forward that people with low aerobic capacity sustain more injury risk than those who have high aerobic capacity. Inactivity causes greater pain with an injury. Wheelchair use and daily activity patterns may cause strain, fatigue, and even pain. Sedentary wheelchair users have poor cardiometabolic risk profiles (33). Inactivity deteriorates physical work capacity, and this downward spiral may lead to general health problems in the long term, such as overweight, obesity, diabetes, metabolic syndrome, and cardiovascular health issues (52-54).

Aerobic exercises enhance cardiorespiratory fitness, decrease cardiometabolic risk, and increase physical capacity (1). The World Health Organization (WHO) in 2020 recommended regular exercise to adults with disabilities: For substantial health benefits, they should engage in at least 150 to 300 minutes of moderate-intensity aerobic physical activity, or at least 75 to 150 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate and vigorous-intensity activity throughout the week. Cardiorespiratory fitness can be made by regular aerobic training, circuit training, applying manual wheelchair propulsion, arm cranking, and swimming (33). In the literature, it was previously reported that circuit training exercises also improve muscle strength and endurance in spinal cord injury (55). Moreover, home-based circuit training is a safe and an affordable alternative. Elastic bands are mostly preffered because they are cheap and easy to use (37, 56).

Accessibility or ergonomic problems associated with the built environment may be barriers for sports centers. Exergames have the potential to enable persons with disabilities to take part in exercises. Exergaming has various game controllers for disabled people like wheelchair rollers, arm crank cycles, and bikes. It may be an alternative physical activity and traditional exercise for wheelchair users in the convenience of their home environment. It is enjoyable to achieve recommended physical activity level proposed by American College of Sports Medicine (ACSM) or WHO. Exergames such as Wii Jogging, Bicycling, Boxing, DDR, and GameCycle have the potential to provide moderate-intensity exercises (57).

Muscle-strengthening exercise, especially upper extremity exercise, is fundamental for daily living activities, transfers, and wheelchair mobility. Flexibility exercises improve the balance between shortened anterior and lengthened posterior muscles arising from protracted shoulders, thereby maintaining normal glenohumeral motion and pectoral muscle mobility. Flexibility exercises of the neck, upper trunk, and extremity should be performed a minimum of 2 to 3 times per week (33, 40, 58). Resistance exercises should be individualized and progressive, with adequate intensity and repetition. WHO 2020 guidelines recommend regular muscle-strengthening exercises at moderate or greater intensity that involve all major muscle groups on 2 or more days a week for adults living with disabilities. Studies mostly focus on shoulder strengthening exercises (59). A study by Wellisch et al. summarises the resistance FITT (frequency, intensity, type, and time) principle for wheelchair users from earlier studies. Frequency was prescribed one to two times daily or three times weekly. A number of 8 or 15 repetitions maximum for 3 sets was the intensity of the dose. Types of exercises included strengthening and stretching exercises, consisting of some or all of the following exercise types: shoulder abduction, shoulder external rotation scapular retraction, and scapular plane elevation. The duration of the exercise intervention ranged from 4 weeks to 6 months (9).

Telerehabilitation, exergaming are popular treatments for pain management, exercise training and transfer education besides conservative therapy (60). Transfers that provide functionality are the frequent activity skills for wheelchair users. Wheelchair's set up and flight/landing position are necessary for proper transfers. This unoptimized repetitive processing is the cause of overuse injury. Better transfer techniques exhibit less injury and less self-reported pain. Many wheelchair users do not receive adequate transfer education because of decreasing length of inpatient stay or additional barriers for outpatient visits. Rigotti et al. evaluated the effectiveness of web-based direct user transfer training in improving transfer quality and reported an increase in wheelchair users' self-assessment transfer quality in their home environment after one 1-month of training. This kind of intervention has also the potential to decrease injury risk (61).

2. Conclusion

A wheelchair is a portable/mobile chair mounted on wheels, enabling the transportation of the people who are incapable of walking. It provides seating, mobility, and functionality on a single device. Most people who are unable to walk spend their day on a wheelchair. Therefore, wheelchair-dependent people are at high risk in terms of experiencing pain of musculoskeletal origin, and the most common symptoms are experienced in shoulder, neck, wrist, hand, and lower back. Chronic overuse, repetitive traumas with poor posture, wrong propulsion, transfer techniques, and improper wheelchair selection might also predispose musculoskeletal injury. The wheelchair should be chosen according to users' needs and should ergonomically be regulated with its components. Appropriate seating, propulsion technique, and lightweight wheelchairs with stronger components provide easy rolling. Management of musculoskeletal pain in wheelchair users are personalization of wheelchair, transfer and propulsion education, and exercise. Wheelchair users must be encouraged to adhere to regular aerobic, muscle strength, and flexibility exercises to prevent cardiometabolic and musculoskeletal problems. There are some studies and guidelines for wheelchair users and the management of musculoskeletal pain.

However, wheelchair technology develops, and additional studies are correspondingly needed to extend preventive strategies to increase the quality of life of the users, to eliminate or decrease musculoskeletal pain. Specific interventions like virtual reality-based exercises and telerehabilitation for the management of wheelchair user injury are required. Most importantly, interventions, customized wheelchairs, and counseling from healthcare professionals should be achievable.

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