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# Walking on Your Hands

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***Using arms as legs can have painful results, especially after many years. What options do manual-wheelchair users have?***

Pushing a wheelchair is an unnatural phenomenon. The chair is neither the result of a lengthy evolutionary process nor the outgrowth of the human need to expand horizons. It's a practical tool that has developed out of necessity. This does not mean that the mobility device is not useful, as it is indeed. The basic problem stems from arm function.

Several problems are related to using manual wheelchairs. Prolonged chair use can lead to pressure sores, deconditioning of the heart and lungs, arm and back pain, and postural deformities. Although this is not an exhaustive list, it does raise possible concerns. Fortunately, legislation and advances in medicine have improved the lives of wheelchair users within the United States. Also, improvements in wheelchairs have been tremendous over the past two decades.

## Arm Pain and Degeneration

Most people experience arm pain and degeneration after prolonged manual-wheelchair use. Shoulders and wrists are the most common areas for pain and repetitive strain injury. Studies have shown that 30-70% of manual wheelchair users will experience *carpal tunnel syndrome* (CTS) or some form of shoulder-joint degeneration.

CTS is commonly described as "a painful tingling sensation in the hands that is often worse at night." It is usually diagnosed by physical examination and *clinical electromyography* (EMG). EMG can help physicians determine the health of a nerve or nerves.

The most common shoulder injuries due to repetitive motion are damage to the tendons and the shoulders' connective tissue. These are related to overuse-and possibly unnatural use.

The most common means of diagnosing repetitive strain disorders for the shoulders is *magnetic resonance imaging* (MRI). These types of injuries experienced by wheelchair users have been investigated for several years. However, study into cause and prevention has only recently begun.

## Repetitive Strain Injuries

The exact causes of repetitive strain injuries among manual wheelchair users are not known. CTS may result from a combination of high repetitions and repeated forces applied to the hand. The damaging effects are thought to be higher when wrists are in extreme or awkward positions; i.e., when transferring into a car, wheelchair users commonly use high forces (near body weight) and awkward hand postures. Pushing a wheelchair may require high hand forces as well as frequent repetitions.

Among able-bodied people, shoulder injuries most often occur during overhead activities. However, this is unlikely to be the cause of injury among manual-wheelchair users.

The human shoulder is a complex joint that possesses a great degree of flexibility while being capable of generating considerable force. A novel feature of the shoulder is that much of the joint motion is a result of its reliance on tendons (cords of fibrous tissue connecting muscle and bone) and ligaments (bands of fibrous tissue connecting bones).

The trade-off for increased flexibility is less stability. The shoulder is one of the body's most easily dislocated joints. Repetitive activities such as pushing wheelchairs or transferring stress the shoulders in several ways. Most activities performed by wheelchair users rely primarily on the anterior muscles (those in front of the body), sometimes allowing the shoulder musculature to have an imbalance. This can lead to instability and injury. For example, transferring into a bathtub may initiate tendinitis or a tear. Wheelchair propulsion is also likely to lead to some shoulder injuries.

While propelling wheelchairs, users are likely to generate a high downward force that has been recorded as high as 25 pounds for each arm. The amount of force varies with the person's body weight, speed, wheelchair setup, and terrain. This vertical force has a tendency to push the humerus (arm bone) into the acromion (shoulder bone). This can have a mortar-and-pestle effect (e.g., like mashing the connective tissue of the shoulder between the bones of the arm and the shoulder) and possibly lead to shoulder degeneration (tendinitis or osteolysis).

## Prevention

Wrist and shoulder degenerative disorders can have severe consequences. The most conservative treatments start with resting the joint, splinting, and medication. If symptoms remain intolerable or worsen, doctors may recommend surgery. In some cases a power wheelchair may be the only viable solution. Because of medical and quality-of-life implications associated with repetitive strain disorders, prevention should be paramount.

Fitness is important for wheelchair users' mobility and cardiorespiratory health. However, the risk of developing a degenerative joint disorder and the apparent lack of cardiorespiratory benefits suggest that an alternative to standard wheelchair propulsion should be used for exercise.

Wheelchair racing and similar sports in which seating position and stroke technique are substantially different may be helpful forms of exercise. Activities such as swimming, handcycling, rowing, or arm-cycle ergometry may be beneficial.

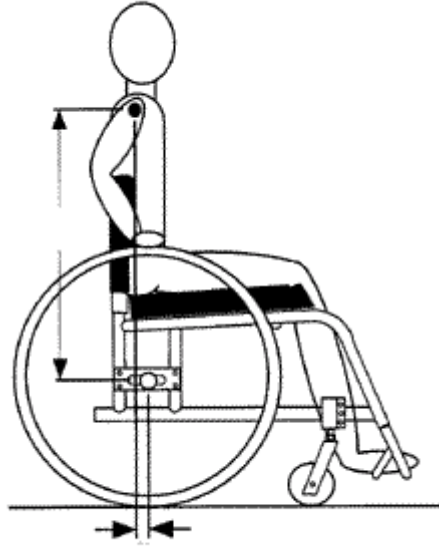
Body weight is a key factor for risk of CTS and shoulder-joint degeneration. Being overweight increases your risk significantly.

Wheelchair choice and how it is set up may affect whether the rider will develop arm pain. Recent studies have shown that an adjustable ultralight chair may help reduce this risk. As stated previously, avoid high force and repetitions.

Higher quality wheelchairs tend to roll straighter and have lower rolling resistance. This can mean lower and less frequent forces for the arms. An adjustable rear-axle position is also important. Moving the axle forward (up to several inches) of the shoulder reduces the cadence (strokes per minute) and forces on the push rims. This is likely due to positioning the push rim better for a longer, more efficient stroke. Using a vinyl-coated push rim can reduce forces and cadence.

A lighter wheelchair will also help reduce stresses on the body while going up- or downhill, starting or stopping, and transferring the wheelchair into a car. The chair's width should be as narrow as is comfortable in order to keep the arms close to the body for a stable shoulder position.

***Moving the axle farther forward of the shoulder in the x-direction lowers peak push-rim forces and reduces the number of strokes per minute required to propel the wheelchair. Lowering the shoulder with respect to the axle also reduces push-rim peak forces and lowers the cadence. The optimal position depends on the individual user.***



## Advances in Wheelchair Design

Wheelchair selection and setup may prevent some forms of arm pain and injury. However, it is unlikely that an ultralight chair is the solution for everyone. Some people will need more assistance. Wheelchairs now in development will help reduce arm stress while providing performance equal to or better than that of ultralight models.

One promising technology is the push-rim-activated wheelchair wheel with an integrated electric motor. Two manufacturers (Yamaha and E-fix) are developing such devices, which attach to nearly any ultralight-wheelchair frame. When users apply force to the push rims, the motors engage and provide assistance.

Small onboard computers determine the amount and duration of assistance. The computer program attempts to provide a smooth natural feeling of rolling across a flat surface, regardless of the actual terrain. The wheels are quick-release and only add about 15 pounds (including battery) to the wheelchair. As this type of technology evolves, many wheelchair users could benefit.

***New technology: a Yamaha JWII wheel mounted to a manual wheelchair. When users apply force to the push rims, the motors***



***engage and provide propulsion assistance.***

For some people, power chairs may be a full- or part-time alternative. Unfortunately, this is a major decision not appropriate for everyone. These chairs improve each year and offer greater performance, more flexibility, and fewer accommodations. They provide the possibility of traveling farther over more varied terrain. Of course, the greatest obstacles are cost and the possible implications for home and vehicle modifications. In addition, your self-image may be impacted. But products are advancing at a steady pace and may become more attractive in the future.

## **Summary Thoughts**

It is extremely important to obtain the best chair possible and have it set up properly. Most people get new chairs every three to five years, and the appropriate choice may go a long way toward reducing the risk of repetitive strain injury. In some cases, obtaining funding for the most appropriate wheelchair may be challenging. It is important to advocate for your needs and to seek expert advice.

## **About the Authors**

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