CHOOSING AND DESIGNING: Ultralight Manual Wheelchairs

Helping clients decide on the correct and properly configured ultralight wheelchair can be challenging. In addition to choosing a specific style of wheelchair, as many as 20 to 30 additional choices are required when designing the chair. The specifications work together with the frame chosen to allow the person to function at their highest level.

It is important to note that there is no perfect set-up or formula. Every person who uses a wheelchair is an individual and should be seen as such. Finding the perfect balance of stability and mobility is important, as each person has his or her own unique needs. When a chair fits a person properly, it should feel like an extension of their body, not a device. This should be the goal of wheelchair provision.

Risk and history of pain or injury in wheelchair users is also important to understand when choosing a wheelchair. This directly affects a person’s positioning, support and wheelchair set-up needs. Reports of pain are very common in wheelchair users, including carpal tunnel syndrome, rotator cuff tears, and upper extremity pain. These conditions reduce function, reduce quality of life, and can cause wheelchair users to require power wheelchairs or other expensive interventions to maintain some level of independence. The wheelchair that is properly designed and set-up can lessen a person’s risk of developing pain and injury.

wheelchair set-up

The first issue when choosing a wheelchair is deciding what type of chair the client needs. Multiple research articles show the benefits of a chair that is as lightweight and adjustable as possible. For most people who are full time wheelchair propellers, that means a rigid, ultralight weight wheelchair (see Figure 1). Folding frames tend to be heavier, have less available adjustments, and generally are less efficient to propel due to the moving parts on the chair (see Figure 2). Rigid chairs are light, adjustable, and are the most efficient to propel. There are times when each chair can be the most appropriate style for an individual. However, either chair will be inefficient and can cause injury if they are not designed and set up properly.

There are general measurements that determine the exact frame configuration, but that list is too long to include here. Some of the most important measurements are discussed below. All recommendations are made with consideration for the best propulsion biomechanics possible. This allows a person to obtain the highest skill level possible for their function and needs.
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when discussing wheelchair provision. This paper was published in March 2012 and can currently be found on the RESNA website at www.resna.org/resources/position_papers.dot. References for all of the research provided here are in this position paper. The paper does not give the specific applications listed here. Those come from this author and her interpretation of the available research and best clinical practice.

seat width

The first measurement that is frequently determined is seat width. Assuring the seat width is as narrow as possible without compressing the person too much is recommended. A chair that is too wide causes increased shoulder abduction and wrist flexion, which can make the chair more difficult to propel and can cause upper extremity injury. Many people were taught chairs should be approximately two inches wider than the client. In most cases, following that “rule” results in seats that are too wide and limit function.

seat depth

Seat depth is similarly important. A seat that is too short can increase the load on the buttocks and cause pressure ulcers. A seat that is too long can put pressure behind the knees and frequently causes people to slide forward in the chair to relieve the pressure. This can also limit the person’s ability to tuck their feet underneath them, which causes the chair to be longer and can limit maneuverability. Ideally, the seat depth in a manual wheelchair is at least 2 inches shorter than the person’s sitting depth to assure good leg position.

front frame bend

Depending on manufacturer, the front frame bend is either the angle the front frame makes relative to the floor or the angle the front frame makes relative to the seat. It is important to realize that on chairs where the angle is relative to the seat, the angle changes if the seat slope is larger or smaller. Tighter or larger angles make the chair shorter, which improves maneuverability and also accommodates tight hamstrings better, allowing a person to sit upright and propel. Generally, the larger a front frame angle a person can tolerate, the easier it is for them to function throughout the day (see Figures 3 and 4).

seat height

The desired sitting height should be discussed before making final decisions about the overall sitting height in the wheelchair. Seat height is usually determined by the length of the lower legs. It is important the legs be supported and the footplates are off the ground enough for safe propulsion. The height a person sits in their wheelchair affects their access to tables and desks. For taller individuals, it can be difficult to both properly support the lower legs and to get under surfaces. Increasing the front frame bend can sometimes improve the clearance without raising the seat height too much.
Shorter stature people can have the opposite problem. If the chair is simply designed around their height and lower leg length, then the chair may be too low and they may feel like a kid at the adult’s table.

**seat slope**

Seat slope is the difference between the front seat height and the rear seat height. Finding the perfect amount of seat slope for each person is important, as it affects sitting balance, transfers, and wheel access. People with less trunk control may need larger seat slopes to maintain their balance. However, if the slope is too large and the upper extremities are weak, the person may not be able to transfer out of the chair because they have to slide uphill. Additionally, if the slope is large, the person may sit too low relative to their wheels and have difficulty propelling. In most cases, a minimum of 2 inches of seat slope is used.

**center of gravity**

The position of the rear wheels is very important and affects a person’s ability to propel a wheelchair. Moving the center of gravity as far forward as possible without compromising stability improves function in many individuals. This forward position can reduce rolling resistance and make it easier for the person to perform wheelies. It also positions the wheels for improved general propulsion and minimizes the risks of developing repetitive stress injuries. Finding the perfect spot for each person is important, as a center of gravity that is too far forward will cause the chair to be tippy and may result in falls.

**rear wheel camber**

Increased camber can bring the wheels closer to a person, improving propulsion. Increasing camber can also increase the overall lateral stability of the chair. However, there is a trade-off in that camber makes the chair wider so access through doors can be difficult if the overall width of the chair is too great.

**pediatrics**

People frequently follow a completely different set of rules for children who are wheelchair users. Chairs are often not lightweight, may be significantly wider than the child, and frequently have swing-away legrests with decreased legrest angles (see Figure 5). This scenario frequently leaves children with chairs that are too large, too heavy, and with legrest angles that cause them to sit poorly in their wheelchairs. With the invention of true pediatric frames designed more for function than growth, it is easy to follow a similar pattern for children as for adults (see Figure 6).

**conclusion**

Taking extra time to learn about each client and their needs is an important first step to determining the proper wheelchair and the correct set-up for it. Competent wheelchair providers should not rely on specific rules or formulas in which every wheelchair is set-up a certain way. The RESNA Position Paper on the Application of Ultralight Wheelchairs can help guide choices and enable our clients to reach their highest level of function.

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