ASPREX Fact Sheet

Manual wheelchair

Mobility device with seating support, which relies on the occupant to provide power for the operation or may be also propelled by an assistant if equipped with push handles. Consists of a folding or rigid frame, a seat base, a backrest, two rear wheels equipped with tires, push-rims and brakes, two front castor wheels, two armrests and two detachable and swing-away height-adjustable footrests. The sizes of all components (frame, seat, backrest, rear wheels, push-rims, front wheels, armrests, footrests) can be chosen according to the individual body size, functional needs and use in various environments.

- Product Classification
  - APL (WHO Assistive Product Priority List): 46 (Wheelchairs, manual for active use)
  - ISO 9999:2022: 122203 (Bimanual handrim-drive wheelchairs)
- Possible configuration variants
  - Bimanual lever-drive (in which case the product is classifiable within ISO category 122206).
  - Double handrims on one side able to push both wheels (in which case it is classifiable within ISO 122209).
  - Low seat height allowing foot propulsion (in which case it is classifiable within ISO 122215).
  - One front wheel instead of two (as in the case of sport wheelchairs).
  - Propulsion by an assistant (featuring push handles and brakes located in a suitable position for the assistant to reach on the seat canes or under the push handles).
  - Stand-up system (to allow standing up and extending the reach ability of the user).
- Possible accessories or optional components
  - Rigid frame with solid seat base and drop in backrest.
  - Seat with a rake (a slope from front to back).
  - Cushion (to improve seating comfort).
  - Seatbelt.
  - Adjustable backrest to seat angle (to better support the sitting position).
  - Height-adjustable armrests.
  - Swing-away armrests.
  - Rear wheels with quick release mechanism.
  - Rear wheels with adjustable axle position (to alter wheelbase footprint).
  - Rear wheels with adjustable wheel camber or rake (to angle inwards and to influence wheelbase stability and ergonomics of push force).
  - Foot support made of two swing-away height adjustable foot plates.
  - Foot support made of a fixed foot bar.
  - Anti-tip bars (to avoid the wheelchair tipping over backwards).
- Product goals

  Activities or functions the product is mainly intended to support, according to WHO ICF Classification:
  - Moving around using equipment [d465].
  - Moving around in different locations [d460].
- Indicated impairments

  Difficulties the product is mainly intended to address, according to the WHO ICF Classification:
  - Walking [d450] (impossibility or severe difficulty).
  - Changing body position [d410]. *Only if used with variants: Stand-up system*
- Contraindicated impairments

  Difficulties for which the product may be inappropriate:

- Neuromuscular condition that may impact capacity to self-propel. *Unless used with variants: Propulsion by an assistant*
- Cardiovascular conditions may impact capacity to self-propel. *Unless used with variants: Propulsion by an assistant*
- Respiration conditions may impact capacity to self-propel. *Unless used with variants: Propulsion by an assistant*
- Cognitive difficulty that may impact safe use and wayfinding. *Unless used with variants: Propulsion by an assistant*
- Inability to sit well without any postural deformities or abnormalities.
- Difficulty in using both arms. *Unless used with variants: Low seat height allowing foot propulsion*
- Difficulty in using one arm. *Unless used with variants: Double handrims on one side able to push both wheels, Low seat height allowing foot propulsion*

Indicated environments

Specific environments in which the product should be used:
None specified.

Contraindicated environments

Environments in which the product may be inappropriate:

- Environments without a relatively smooth and sufficiently wide continuous path of travel.
- Environments that may impact the operability and longevity of the product (such as ice, salt, dust, heat, unless the components are made of material especially designed for those environments).

Other indicated factors

Other factors or situations the product is intended to address:

- Use in sport activity. *Only if used with variants: One front wheel instead of two*

Other contraindicated factors

Other factors or situations in which the product may be inappropriate:
None specified.

Points to be considered in product selection

- Each user has a unique set of needs; these needs can be categorized as: physical (the user's health situation and postural and functional needs), environmental (where users live and where they need to use the wheelchair), and lifestyle (the things users need to do in the wheelchair to engage in their chosen activities and participations).
- To meet the user's physical, environmental, and lifestyle factors, wheelchairs must feature proper fit and postural support; wheelchairs must be safe and durable; and should be affordable and able to be obtained and maintained locally.
- Seat width: the seat should fit the user comfortably and ensure the hips are not touching the seat rail; this prevents skin breakdown.
- Seat depth: sufficiently deep to fully support thighs but ensure there is a space of two to three finger-widths between the front seat edge and the popliteal fossa (back of the knees); this enables even weight distribution across the sitting surfaces of the body but also protects the skin and important vessels behind the knee.
- Seat height: when seated, the knees should be approximately level with the hips; this can be achieved by adjusting the footplates or foot bar height; ensure there is clearance between the footplate/ foot bar and the ground.
- Seat rake: rake refers to the angle between the front and back of the seat and also relates to the angle of the backrest. Active users may prefer an acute angle (smaller than 90 degrees) to support the pelvis and spine in an active position. An optimal seat rake angle may decrease the need for a high backrest, as the skeletal system is configured for stability. However, a strong seat rake (i.e. higher front of wheelchair) may make front transfers more effortful.
- Seat Base: a slung seat base offers some shock and vibration absorbency and provides a smoother ride. A slung seat base will however hammock or sag over time and may cause the legs to roll inwards, and impact on the supportiveness of a seat cushion. A rigid base provides a solid foundation for a cushion.
- Cushion: some slung seats contain foam padding, but if the wheelchair is used regularly a cushion with pressure relieving properties will be required.

- Slung backrest: the backrest is slung between the seat canes and may be at varying heights, but lower than the apex of the shoulder blade to ensure the shoulders are not restricted for self-propulsion.
- Push handles are optional and may be useful for users to brace the shoulder when reaching for items or when doing a pressure care lift.
- Propulsion: bimanual lever-drive. Users who do not have sufficient shoulder range of movement or wrist dexterity to propel a bimanual handrim drive wheelchair, may find it easier to use a lever-drive wheelchair, as the range of motion is decreased and the hand positioning is more linear.
- Propulsion: single side handrim drive. If users are only able to use one upper limb to propel, they will not be able to manage a bimanual handrim drive chair this is because pushing one rim will direct the wheelchair around in circles, and reaching both rims with one hand is effortful and involves significant body rotation; alternatively, a single-side set of handrims on the functional side will enable the user to grasp and push both rims at once with one hand, selecting individual rims to direct the wheelchair left and right. Note, all asymmetrical propulsion methods may affect posture and body alignment.
- Propulsion: single-side lever-drive. Users who do not have sufficient shoulder range of movement or wrist dexterity to propel a bimanual handrim drive wheelchair, may find it easier to use a single-side lever-drive wheelchair controlling both wheels. However, all asymmetrical propulsion methods may affect posture and body alignment.
- Propulsion: foot propulsion. Foot-propulsion is possible in a wheelchair with a low seat height, enabling the wheelchair to be propelled and steered by contact of the occupant's foot or feet with the floor. Note, all asymmetrical propulsion methods may affect posture and body alignment.
- Rear wheels (with push rims) various size; may be quick release wheels.
- Brakes: may be scissor action or push rod brakes, to be within mid-range of the upper limb and present on both wheels.
- Armrests are optional. Armrest height should be approximately 2.5 cm higher than the resting forearm, with a relaxed shoulder and the elbow bent to 90 degrees. The armrest length may provide a support surface which is the length of the forearm or be shorter to enable access under a table or desk. Armrests maybe detachable or swingaway to enable transfers.
- Footrest (footplates or footbar) should be adjusted to comfortably suit leg length and support the feet. Ensure the feet are approximately at right angles and there is clearance between the footrest and the ground.
- The net weight of the wheelchair (with and without accessories / disassembled) will impact the person in the short and long term. Lighter weight manual wheelchairs require less effort to propel, leading to less fatigue and preserving shoulder function in the longer term.
- The weight capacity of the wheelchair must be sufficient to bear the occupant and any accessories; postural issues can be caused when the fit between the wheelchair and the person is incorrect.
- Wheelchair and seating system too wide: inability to reach wheels to self-propel; encourages pelvic obliquity or unstable sitting base – hips and thighs tend to be abducted.
- Wheelchair and seating system too narrow: encourages pelvic obliquity and instability; leads to discomfort, increases risk of pressure sores thus decreased independent functioning.
- Wheelchair and seating system too long: pulls person forward in chair, increasing pressure on sacrum, increases slumping and instability, compromises lower limb circulation, does not support spine causing limitation in use of hands, pressure ulcer development.
- Wheelchair and seating system too short: encourages instability by reducing base of support, increases pressure on thighs and supporting area, causing pressure ulcer development, unstable sitting base impacts use of hands and dynamic balance.
- Armrests too high: elevate shoulders resulting in discomfort; encouragement of kyphosis and hyperextension of neck; reduces ability to use arms thus impacts capacity to self-propel.
- Armrests too low: encourages slumping forward or sideways to reach support, may lead to reduced respiration capacity, instability impacts functional performance.
- Footplates too high: causes discomfort in hips and knees can lead to abduction of hips or adduction and internal rotation of hips leading to increased risk of dislocation, increases pressure on buttocks and sacrum and reduces base of support.
- Footplates too low: may hit front castors or pavement curbs, pulls pelvis forward and encourage slumping and poor sitting stability.
- Wheelchair transfers: fixed footbars cannot be swung away so are not suitable for a person doing a standing transfer. Footplates which can be swung away enable the feet to reach the floor and weightbear during

standing transfers. Slideboard and hoist transfers are not affected by footplate design, but armrests must be swingaway or detachable to enable slide transfers.

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- Frame: a folding frame will flex slightly during use, this may offer some shock and vibration absorbency and provide smoother ride but also absorbs some of the propulsion force of the user. A rigid frame is sturdier as it has fewer moving parts and effectively translates propulsion force. The mechanisms of dismantling for transportation are different and the capacities of different users must be considered.
- Wheelbase: the wheelbase (footprint of the wheelchair) impacts maneuverability and stability. The wheelbase with must be sufficiently wide to fit the occupant but sufficiently compact to fit in the environment e.g. through doorways. Wheelchair width: Very wide users may need the wheelchair to be reconfigured internally (e.g. maximize space between the wheels) rather than making the wheelchair wider. Wheelchair length: some models have adjustable axle positions to enable the front to rear wheelbase length adjustment and alter the position of the weight of the user in relation to the center of gravity. Consider whether the trunk is positioned above, outside or inside the wheelchair footprint, when evaluating wheelchair stability. A shorter wheelbase (with the user's trunk positioned above or slightly forward of the rear axle) will enable the user to tip the front castors more easily and do a 'wheelie'. This is both more maneuverable and less stable and is a feature to be matched to user experience and developing competence. Users with an altered center of gravity for example, with lower limb amputation, will require a longer wheelbase to provide stability (that is, with the user's trunk positioned slightly behind the rear axle). Novice wheelchair users will require a longer (more stable) wheelbase but may move to a shorter wheelbase which enables more maneuverability, as they gain wheelchair skills.
- Moving parts such as removable armrests and footrests have some disadvantages: removable components can get lost; and mounting locations can become bent or damaged, making them difficult to put on and take off.
- Rear wheels: they may come in different sizes. The rear wheel should be in a position that allows the user to have the best push stroke as possible and keeps the user safely balanced according to his or her skill level and ability. The position of the rear wheels should allow the user to have a good push stroke and provide the necessary stability.
- Tires: Harder tires (which deform less) have lower rolling resistance on smooth ground than softer tires, all other factors being equal. Solid tires cannot be punctured, but harder/solid tires provide little shock absorption.
- Wheel camber (rear wheels): camber brings the wheels closer to the user and more in line with the user's forward push stroke, thus making it easier to push. Camber may be adjustable to influence wheelbase stability and ergonomics of push force.
- Front castor wheels: smaller castors are more maneuverable but will be impacted by obstacles such as small stones or uneven terrain. Large castors (these may be solid or pneumatic) will overcome obstacles and uneven terrain but require a larger turning circle.
- Anti-tip bars are options to prevent the wheelchair tipping backwards on steep slopes or where the front wheels come off the ground. They will prevent the wheelchair being tilted e.g. to get up a kerb.
- A lap belt is optional for security.
- Reaching and moving objects requires the wheelchair to pull up close to surfaces and objects: How close users can get to surfaces and objects they cannot roll under, such as toilets, low tables, counter tops, center-post tables and bathtubs, is determined by how far the wheelchair extends both forwards and to the side of the seat. A user can get closer to surfaces and objects if the wheelchair is shorter in height.
- Working at a work surface requires the wheelchair to fit under surfaces. The user's ability to pull up to a table is determined by the height of the user's knees (the length of the user's lower leg plus the minimum safe height of the footrest above the ground). Some types of fixed armrest also prevent users from pulling up to tables and counters.

Points to be considered in product fitting

- Trained personnel prepare the wheelchair for the initial fitting; depending on the product and service facilities, this may include assembly and possible modification of products supplied by manufacturers or production of products in the service workshop.
- During fitting, the user and competent personnel together check that: the wheelchair is the correct size; the wheelchair is correctly adjusted for the user; any modifications or postural support components are fitting correctly; and the wheelchair meets the user's mobility and postural support needs and minimizes the risk of the user developing secondary deformities or complications.

- The user tries the wheelchair; final adjustments are made to ensure the wheelchair is correctly assembled and set up; if modifications or postural support components are required, additional fittings may be necessary.
- Maneuverability around obstacles determines the user's ability to maneuver in an environment with confined spaces, such as a toilet with a narrow door and very limited space. The narrowest space through which a wheelchair can pass is determined by its width, measured from the outermost point on each side and considering position of user's hands during propulsion.
- Turning around in confined spaces: the smallest area in which a wheelchair can turn around is determined by its maximum diagonal measurement, and this measurement should be taken in fitting the wheelchair to the person and their environment
- Mobilizing on soft terrain (soft ground) such as mud, sand, grass, gravel, and snow, depends on the area of contact that the wheels have with the ground and the amount of weight on the wheel. Increasing the width, diameter and softness of the castor wheel will increase the contact area and prevent the wheelchair from sinking into soft ground. This requires a wide wheel with a raised point on the center of its tread can combine low rolling resistance on hard surfaces with good flotation over soft ground. Less weight on the front wheels will reduce the rolling resistance of the front wheels, allowing the wheelchair to roll more easily. However, increasing the contact area of the castor wheel with the ground can make turning more difficult, especially in tight, slow turns.
- Moving the front caster wheel(s) forward will reduce the weight they carry, and prevent the wheelchair from digging into soft ground, but making the overall wheelchair length longer will make it harder to maneuver in confined spaces.
- Increasing the width, diameter and softness of the rear wheels will increase the contact area, preventing the wheelchair from sinking into soft ground. However, wider and softer rear wheels can make it more difficult to turn, especially in tight, slow turns. Larger-diameter rear wheels make the wheelchair more difficult to transport. Moving the rear wheels forward in relation to the user to reduce the weight on the front castor wheel(s) and make it less likely to sink into soft ground. More of the user's weight on the rear wheels will provide more traction to the rear wheels to drive through soft ground. This will reduce the tendency to turn downhill on side slope, which requires less energy from the user to correct for downhill turning. The user will have better access to the hand rim and a longer push stroke, making it easier to push the wheelchair with the upper extremities. It is also easier to perform "wheelies" to negotiate obstacles, and the wheelchair is easier to maneuver in confined spaces. However, the wheelchair will have reduced rearward stability.
- Castor size: Maneuvering over raised obstacles, such as bumps, curbs or rocks is impacted by the size of the castor wheel, the distance of the castor wheel from the user's center of gravity and the springiness of the castor wheel. Castor flutter is also a result of hitting bumps at speed.
- The user should try the wheelchair in real environments of use as an important step in troubleshooting and verifying the wheelchair choice and setup.

- Points to be considered in product use
  - A wheelchair without a cushion or with an inadequate cushion can cause pressure sores; this in turn may require the user to spend many months in bed; without appropriate care and treatment this often leads to bedsores, secondary complications and even premature death.
  - Unstable wheelchairs can tip and lead to users falling and injuring themselves.
  - Wheelchairs that are too wide or are unduly heavy can cause shoulder injuries.
  - Sharp edges on surfaces can cause cuts that in turn can lead to infection.
  - Poor design can result in places on the wheelchair where fingers or skin of users or others may be pinched on moving parts, or between wheelchair and environment
  - Wheelchairs that cannot endure daily use in the user's environment may fail prematurely and can injure the user.
  - Users with central nervous system disturbance such as stroke, may find the tone or tightness of their affected side is increased with effortful propulsion through their more functional side; if this is the case, a powered wheelchair may be more appropriate.
  - Wheelchairs with incorrectly calibrated center of gravity may leave the user at risk of tipping
- Points to be considered in product maintenance / follow-up
  - The user and caregivers are instructed on how to safely and effectively use and maintain the wheelchair.
  - Key areas of user training include: how to transfer in and out of the wheelchair, how to handle the wheelchair; basic wheelchair mobility; how to stay healthy in the wheelchair – for example prevention of

pressure sores; how to look after the wheelchair and cushion and, if appropriate, dismantle and reassemble the wheelchair; and who to contact in case of problems.
    - Follow-up appointments are an opportunity to check wheelchair fit and provide further training and support.
    - Follow-up should include a review of: how well the wheelchair has worked for the user; if they are experiencing muscle soreness or pain related to posture or wheelchair propulsion; any problems the user has had in using the wheelchair; the wheelchair's fit, in particular checking that the wheelchair is providing good postural support for the user; the user's skills, and whether further training is required; the condition of the wheelchair and whether any adjustments or repairs are required; and the user's ability to care for and maintain the wheelchair, and whether any further training is required.
    - The frequency of follow-up will depend on the individual needs of the user. Some users should be followed up more frequently than others should. As a guide, follow-up appointments are usually made within six months of receiving a wheelchair. It is appropriate to carry out follow-up activities at the community level as much as possible. If the wheelchair is found to be no longer appropriate, a new wheelchair needs to be assessed for and supplied.
- Examples of products available on the market
    - Live product search in the EASTIN website https://www.eastin.eu/en/searches/products/list?iso=122203

Source

This Fact Sheet was compiled in 2021 by an international team of experts, to provide the initial knowledge base for a project ("An online system to assist the selection of assistive product") supported by the World Health Organization in 2020-2021 within the GATE Initiative (Global collaboration on Assistive Product). Fact Sheets were compiled for each of the 50 types of products included in the WHO APL (Assistive Product Priority List).

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The project led to a prototype online tool called ASPREX (ASsistive PRoduct EXplorer). At the end of the project, it was transferred to a WHO collaborating center (the Global Disability Hub in the UK), in view of possible future developments.