



Personal Exoskeletons

In 2024, Medicare began covering personal exoskeletons for eligible beneficiaries. This was a huge step in helping those with spinal cord injuries (SCI) access this technology for home and the community.

Unfortunately, there has been very little research completed on personal exoskeletons in a home or community setting. Research has been completed on the devices themselves, but mostly these are in research settings, with a specific number of sessions per week over a specified period of time and under the supervision of a medical professional. This is different from how a personal device would be used. In the home and community, personal exoskeleton users in the United States must be accompanied by a trained support person. This may be a spouse, family member, or caregiver, but is likely not a medical professional. Also, we expect home and community use to vary week to week. Both of these factors could change the effectiveness of using a personal exoskeleton.

In this paper, we examine the handful of papers that examine robotics at home and in the community. All of these utilize the ReWalk exoskeleton.

Decisions to Use an Exoskeleton

Besides diagnostic and physical characteristics that indicate someone as safe to use an exoskeleton at home, there are other factors that play into whether a person is a good candidate to use an exoskeleton in this setting. One paper suggested an algorithm to help determine this appropriateness, that takes into account device inclusion and exclusion criteria, commitment to training, goals, capacity for ambulation with traditional orthotics, and ability to regain functional ambulation capacity without a device.¹ Another paper interviewed two persons on two occasions about their use of an exoskeleton at home. It was determined that the way in which the technology was used differed between persons, and that those differences were tied to their dispositions, social and cultural contexts.² It was also important for users to understand that using an exoskeleton is not equivalent to relearning to walk, and that this process of re-embodiment takes physical and mental effort to accomplish.² The need to have a support person also forces some collaboration between user and the support person, and being dependent on that support person for use of the exoskeleton can present challenges.²

Health Benefits

Two articles look at actual home use and outcomes. These differed significantly in their length of intervention. One randomized 161 veterans to standard of care wheelchair use or standard of care plus at-will use of an exoskeleton over four months. While many results were similar between groups, the exoskeleton group reported a significant global impression of improvement and a reduction in sleep disturbance.³ However, in this study, the exoskeleton group averaged 86 minutes of use per week and between 4321 and 6192 steps per month, which is low usage, especially when compared to the research based studies which usually require 180-300 minutes of use per week.³ Therefore it could be possible that this usage was not enough to cause significant change. The second followed 14 persons with complete SCI who used the ReWalk over two to three weeks and recorded this use in a logbook. Median use was 9 days out of 16,



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with a total of 3226 steps.⁴ Most users' goal in using the exoskeleton was for exercise, and biggest reasons for non-use were weather related.⁴ Out of the 14, five participants reported positive effects on social and mental health, while three reported decrease in spasticity, and one reported reduced neuropathic pain and improved range of motion.⁴

Considerations for Home Devices

When compared to traditional means of achieving standing and walking for persons with SCI like knee ankle foot orthoses (KAFOs) and reciprocating gait orthoses (RGOs), exoskeletons require less energy to use and allow users to walk faster.⁵ However, these orthoses can be used by a greater amount of people, as limitations including physical characteristics exist that prevent certain users from being exoskeleton candidates.⁵ Exoskeletons can be used to achieve physical exertion and exercise, which can help individuals with SCI achieve the recommended dose of exercise per week.⁵ Additional health benefits including improved bone health, decreased pain, improvements in bowel and bladder function, and increased quality of life may also be expected from using an exoskeleton in the home setting.⁵

There are a number of factors to consider when deciding if an exoskeleton is a good fit for home and community use. Some of these include ease of donning, transportability, battery life, and need for a stability aid. Other important considerations include cost and amount of training required.⁵ All of these factors will be important for exoskeleton manufacturers to keep in mind as these technologies advance.

Conclusion

While we would expect many of the clinical research outcomes to be applicable to home use of a personal exoskeleton, the actual amount that the device is used at home likely dictates if we see these improvements. From the small numbers of studies that exist, these have shown that personal use devices are underutilized, and therefore this likely is why we are not seeing identical outcomes to clinical studies with fixed dosage. With Medicare coverage for exoskeletons beginning in 2024 and the hope that more insurance companies follow suit, it is anticipated that studies examining personal exoskeleton use and their effect on health and function will become available in the future.

References

1. Onate D, Hogan C, Fitzgerald K, White KT, Tansey K. Recommendations for clinical decision-making when offering exoskeletons for community use in individuals with spinal cord injury. *Front Rehabil Sci*. 2024;5:1428708. doi:10.3389/fresc.2024.1428708
2. Lusardi R, Tomelleri S, Wherton J. Living With Assistive Robotics: Exploring the Everyday Use of Exoskeleton for Persons With Spinal Cord Injury. *Front Med Technol*. 2021;3:747632. doi:10.3389/fmedt.2021.747632
3. Spungen AM, Dematt EJ, Biswas K, et al. Exoskeletal-Assisted Walking in Veterans With Paralysis: A Randomized Clinical Trial. *JAMA Netw Open*. 2024;7(9):e2431501. doi:10.1001/jamanetworkopen.2024.31501
4. Van Dijksseldonk RB, Van Nes IJW, Geurts ACH, Keijsers NLW. Exoskeleton home and community use in people with complete spinal cord injury. *Sci Rep*. 2020;10(1):15600. doi:10.1038/s41598-020-72397-6
5. Kandilakis C, Sasso-Lance E. Exoskeletons for Personal Use After Spinal Cord Injury. *Arch Phys Med Rehabil*. 2021;102(2):331-337. doi:10.1016/j.apmr.2019.05.028

All known articles assessing personal exoskeletons

Title	Authors	Journal	Device	Diagnosis
Exoskeletal-Assisted Walking in Veterans With Paralysis: A Randomized Clinical Trial	Spungen AM, Dematt, EJ, Biswas K, Jones KM, Mi Z, Snodgrass AJ, Morin K, Asselin PK, Cirnigliaro C, Kirshblum S, Gorman PH, Goetz LL, Stenson K, White KT, Hon A, Sabharwal S, Kiratli BJ, Ota D, Bennett B, Berman JE, Castillo D, Lee KK, Eddy BW, Henzel MK, Trbovich M, Holmes SA, Skelton F, Priebe M, Kornfeld SL, Huang GC, Bauman WA	JAMA Netw Open. 2024 Sep 3;7(9):e2431501	ReWalk	SCI
Recommendations for clinical decision-making when offering exoskeletons for community use in individuals with spinal cord injury	Onate D, Hogan C, Fitzgerald K, White KT, Tansey K	Front Rehabil Sci. 2024 Aug 14;5:1428708	ReWalk	SCI
Living with assistive robotics: exploring the everyday use of exoskeleton for persons with spinal cord injury	Lusardi R, Tomelleri S, Wherton J	Front Med Technol. 2021 Oct 8;3:747632	ReWalk	SCI
Exoskeletons for Personal Use After Spinal Cord Injury	Kandilakis C, Sasso-Lance E	Arch Phys Med Rehabil. 2021 Feb;102(2):331-337	ReWalk	SCI
Exoskeleton home and community use in people with complete spinal cord injury	van Dijksseldonk RB, van Nes IJW, Geurts ACH, Keijsers NLW	Sci Rep. 2020 Sep 24;10(1):15600	ReWalk	SCI

SCI = spinal cord injury