Case Study
ISSN: 3051-8814
Journal homepage: https://www.harrisonacademicpress.com/index.php/FBEMD
Frontiers in Biomedical Engineering and Medical Devices

Harrison Academic Press

Design of a Soft Robotic Exoskeleton Glove for Post-Stroke Hand Rehabilitation

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ABSTRACT

Background: Impaired hand function is among the most persistent consequences of stroke, and rigid cable-driven hand exoskeletons have shown limited translation into home use owing to their mass, misalignment with finger joints, and cost. Soft robotic exoskeleton gloves, built from compliant fabric-reinforced pneumatic actuators or tendon-driven textile structures, have been proposed as a lighter, more conformal alternative. Objective: This narrative review synthesizes published engineering and clinical literature on soft robotic exoskeleton gloves for post-stroke hand rehabilitation. Methods: We reviewed studies of fabric-based pneumatic actuators, tendon-driven underactuated glove architectures, and passive spring-based hand exoskeletons, focusing on mechanical force and range-of-motion characterization and on feasibility, pilot, and randomized clinical evaluations in stroke and related paralysis populations. Findings: Fabric-reinforced pneumatic actuators generate blocked tip and grip forces from single-digit to tens of newtons while preserving near-natural finger range of motion, tendon-driven Exo-Glove designs achieve compliant multi-finger grasp with reduced actuator count, and clinical pilot studies report improved lift force, task completion time, and hand-function scores; a three-arm randomized trial found soft-glove-associated Fugl-Meyer gains statistically comparable to repetitive transcranial magnetic stimulation. Conclusions: Soft robotic exoskeleton gloves have progressed from bench-characterized prototypes to clinically tested devices with encouraging functional outcomes, though larger, longer, and more directly comparative trials across competing actuation strategies are still needed.

Keywords: *soft robotic glove; hand exoskeleton; post-stroke rehabilitation; pneumatic actuator; tendon-driven actuation*

Citation: Willemsen F, Carvalho R and Urbonas M (2025) Design of a Soft Robotic Exoskeleton Glove for Post-Stroke Hand Rehabilitation. Front Biomed Eng Med Devices, 3(2): 01-06.
DOI: 10.5281/zenodo.22642661

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Article History: *Received 2 July 2025 | Accepted 14 September 2025 | Published 27 November 2025*

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Introduction

Loss of hand function is among the most disabling and persistent consequences of stroke, with impaired finger extension and grasp release affecting the majority of survivors and remaining incompletely resolved in a substantial proportion even years after onset. Conventional rigid exoskeletons and cable-driven hand robots have demonstrated that repetitive, assisted, task-oriented practice can drive motor recovery, but their rigid linkages, misalignment with anatomical finger joint axes, and considerable mass and bulk have limited comfort, donning speed, and translation into home settings. Soft robotics has emerged over the past decade as an alternative design philosophy for hand exoskeletons, replacing rigid links and pin joints with compliant fabric-reinforced pneumatic actuators or tendon-routed textile structures that conform to the finger and require no precise joint-axis alignment, as summarized in early reviews of hand exoskeleton technology for rehabilitation and assistive engineering [1]. This narrative review synthesizes the published engineering and clinical literature on soft robotic exoskeleton gloves developed specifically for post-stroke hand rehabilitation, organizing the evidence around three themes: the actuation and mechanical design principles underlying fabric-based pneumatic gloves, the tendon-driven and underactuated architectures that constitute the principal alternative design family, and the clinical trials and feasibility studies that have evaluated these devices in stroke survivors.

The rationale for soft actuation in hand rehabilitation robotics rests on three interlinked engineering goals: minimizing the mass and profile of the device worn on an already impaired limb, achieving compliant and backdrivable interaction forces safe for a spastic or flaccid hand, and simplifying manufacturing enough to permit low-cost, personalized, and even home-deployable devices. Pneumatically actuated fabric or elastomeric bending actuators, first popularized for at-home assistive and rehabilitative gloves,

were shown to provide clinically meaningful grasp assistance while remaining lightweight and conformal to the hand [2]. In parallel, tendon-driven soft wearable robots dispensed with pneumatic pressure sources altogether, routing low-friction tendons through soft anchors sewn into a glove to transmit motor-generated tension directly to the fingers, an approach exemplified by the Exo-Glove family of devices [3,4]. Both actuation philosophies have since been carried into feasibility and pilot clinical studies in stroke and other upper-limb paralysis populations, generating a growing, if still heterogeneous, evidence base on grip force generation, range-of-motion assistance, and functional task performance that this review sets out to characterize systematically section by section.

Pneumatic and Fabric-Based Soft Actuation for Hand Exoskeleton Gloves

The archetype of the pneumatic soft robotic glove couples fiber-reinforced or fabric-reinforced elastomeric bending actuators, one per finger, to a low-pressure pneumatic control box that regulates flexion and extension independently for each digit. Polygerinos and colleagues described a soft robotic glove built from molded fiber-reinforced actuators bonded to a fabric glove substrate, engineered explicitly to combine at-home assistive grasping with a rehabilitation training mode, and demonstrated that the actuators could generate sufficient bending force and range of motion to assist functional grasp patterns while remaining compliant enough to be worn continuously [2]. Building on this fiber-reinforced actuator concept, Yap and colleagues developed and mechanically characterized a soft robotic glove using fabric-reinforced pneumatic actuators and reported that a single finger actuator produced a blocked tip force of 9.12 N at an operating pressure of 120 kPa, closely matching a theoretical model prediction of 9.47 N, and that the assembled glove generated a normal grip force of 36.2 ± 4.5 N against a 75 mm diameter cylinder and 28.1 ± 3.6 N against a 50 mm cylinder during bench testing, translating to a frictional grip force of 8.4 ± 1.8 N and 5.8 ± 1.7 N respectively once worn by a human participant [5]. In the same study, five healthy participants achieved active metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joint angles of 82.3 ± 6.8°, 84.1 ± 7.9°, and 44.8 ± 4.4° respectively during unassisted flexion, compared with 73.9 ± 10.4°, 79.9 ± 4.2°, and 46.0 ± 3.3° during glove-assisted flexion without voluntary effort, indicating that the actuator could reproduce the majority of natural finger range of motion without constraining the underlying joints [5]. A subsequent design and modeling study by Ge and colleagues advanced the mechanics of fabric-based pneumatic actuators further, developing an analytical model relating actuator geometry to blocked tip force for finger-flexion actuators and to extension torque for finger-extension actuators, validated against bench experiments, and providing a generalizable design framework for tuning fabric actuator force output to a target application [6].

Fabric-based pneumatic actuation has also been extended beyond stroke to other upper-limb paralysis populations, both broadening the evidence base for the underlying actuator technology and illustrating its versatility. Cappello and colleagues developed a fabric-based soft robotic glove for individuals with cervical spinal cord injury and evaluated it in nine participants with C4-C7 injuries, reporting that mean object lift force increased significantly from 1.76 ± 4.32 N without the glove to 2.76 ± 5.18 N with glove assistance, a mean increase of 1.00 N, and that performance on the Toronto Rehabilitation Institute Hand Function Test rose from 53.88 ± 24.20% to 87.30 ± 11.82% of the maximum test score, an overall relative improvement of 33.42 ± 15.43 percentage points [7]. Complementary evidence for a related soft robotic hand-glove device came from a pilot study in people with chronic spinal cord injury by Osuagwu and colleagues, which similarly reported functional gains in hand use following a structured home-based intervention using the device [8]. Taken together, this literature establishes that fabric-reinforced and molded pneumatic bending actuators can reliably generate forces in the single-digit-to-tens-of-newtons range appropriate for functional grasp assistance, that these forces and the accompanying range of motion can be characterized with reasonable precision on the bench and reproduced, at reduced magnitude, when the actuator is worn and coupled to human tissue, and that the resulting devices translate into measurable, though population- and device-specific, functional improvements when tested in individuals with upper-limb paralysis.

Representative soft robotic and tendon-driven hand exoskeleton glove platforms: actuation principle and reported mechanical performance.

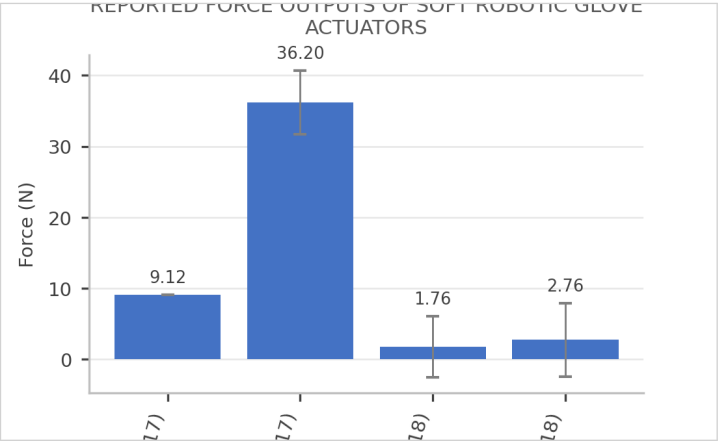
Platform	Actuation principle	Reported mechanical performance	Evidence stage
Polygerinos et al. glove	Fiber-reinforced pneumatic bending actuators	Combined at-home assistance and rehabilitation training modes	Bench/device design
Yap et al. glove	Fabric-reinforced pneumatic actuator	Blocked tip force 9.12 N at 120 kPa; grip force 36.2 N (75 mm cylinder)	Bench + pilot (n=2 stroke)
Cappello et al. glove	Fabric-based pneumatic actuator	Lift force 1.76 N (unassisted) to 2.76 N (assisted)	Clinical, n=9 cervical SCI
Ge et al. SFPA actuator	Seal-fabric pneumatic actuator (SFPA)	Analytical model of blocked tip force / extension torque vs. geometry	Bench/design model
In/Kang Exo-Glove	Underactuated soft tendon routing	Adaptive multi-finger grasp via reduced motor count	Bench/device design
Kang Exo-Glove Poly II	Tendon-driven, polymer-based structure	Improved durability and donning versus textile predecessor	Bench/device design

Tendon-Driven and Underactuated Glove Architectures

An alternative to pneumatic bending actuators routes the mechanical work of a remote motor to each finger through tendons anchored along a soft glove structure, avoiding the need for an onboard or tethered pneumatic pressure source and often permitting a lighter, more compact wearable component at the cost of a separate actuation unit. In and colleagues introduced this design philosophy with the Exo-Glove, a wearable robot for the hand employing a soft tendon-routing system in which under-actuated, adaptive tendon paths allowed a small number of motors to drive coordinated, compliant grasping across multiple fingers, explicitly targeting assistance for individuals with impaired hand function such as stroke survivors and drawing on principles of tendon-driven mechanisms already established in prosthetic and robotic hand design [3]. This concept was

subsequently advanced by Kang and colleagues with the Exo-Glove Poly II, which replaced textile glove components with a polymer-based soft wearable structure while retaining tendon-driven actuation, improving durability, ease of donning, and adaptability of the underactuated finger linkages to differing hand sizes and grasp postures without sacrificing the compliance and low profile that distinguish soft wearable robots from rigid exoskeletons [4]. The tendon-driven design family illustrates a design trade-off distinct from pneumatic actuation: mechanical power transmission through a tendon can be more energy-efficient and mechanically simpler to control with standard servo or direct-current motors than a pneumatic pump and valve manifold, but it introduces friction and routing losses along the tendon path that must be managed through careful anchor placement and low-friction sheathing, a challenge addressed explicitly in the soft-routing designs of both Exo-Glove generations [3,4].

Bench-characterized force outputs reported for representative soft robotic glove actuators and devices: blocked fingertip force and normal grip force (75 mm cylinder) of the fabric-reinforced pneumatic actuator of Yap et al. (2017), and object lift force without versus with glove assistance for the fabric-based pneumatic glove of Cappello et al. (2018) tested in cervical spinal cord injury.



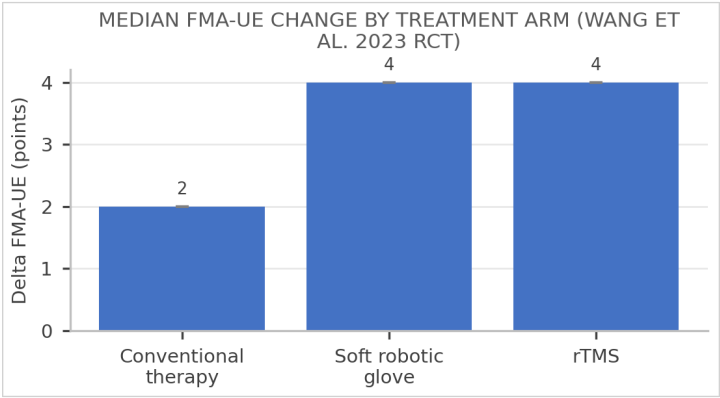
Motor-tendon actuation has also enabled a further design variant relevant to stroke rehabilitation, namely myoelectric triggering of an otherwise passive or motor-assisted glove, allowing the wearer's own residual muscle activity to initiate assisted grasp and release rather than relying on an external switch or therapist cue. Yurkewich and colleagues developed an untethered, myoelectrically controlled robotic glove and evaluated it in stroke survivors performing standardized activities of daily living, reporting that the device enhanced hand function and task performance when triggered by the user's own electromyographic signal, thereby coupling a tendon-actuated mechanical architecture to a volitional, biosignal-driven control strategy intended to promote active user engagement during assisted grasping rather than purely passive motion [9]. Considered alongside the pneumatic actuator literature, the tendon-driven and myoelectrically triggered designs demonstrate that the mechanical compliance central to soft robotic hand exoskeletons can be achieved through multiple, mechanically distinct actuation strategies, each carrying its own trade-offs in power source, control bandwidth, and integration with the user's residual voluntary motor drive, and each represented by at least one design that has progressed from bench characterization toward evaluation in the target stroke population.

Clinical Validation and Functional Outcomes in Post-Stroke Rehabilitation

Key clinical and pilot studies of soft robotic and passive spring-based hand exoskeleton gloves in stroke and related populations.

Study	Population / design	Sample size	Principal finding
Yap et al. 2017	Chronic stroke, pilot	n=2	Task completion time improved with glove assistance
Radder et al. 2018	Chronic stroke, feasibility	n=5	Extended wear feasible; task-time gains on several ADL items
Cappello et al. 2018	Cervical SCI, pre-post	n=9	TRI-HFT score 53.88% to 87.30% of maximum with glove
Casas et al. 2021 (HandSOME II)	Chronic stroke, home-based	n=15 enrolled / 10 completed	Significant ROM, ARAT, and MAL gains retained at 3 months
Wang et al. 2023 (RCT)	Severe post-stroke upper-limb dysfunction	n=69 (23 per arm)	Glove: median FMA-UE +4 vs conventional +2 ($p<0.05$); comparable to rTMS

Median change in upper-extremity Fugl-Meyer Assessment score (delta FMA-UE) by treatment arm in the three-arm randomized controlled trial of Wang et al. (2023) comparing conventional therapy, a soft robotic glove, and repetitive transcranial magnetic stimulation (rTMS) in patients with severe post-stroke upper-limb dysfunction (n=23 per arm).



Clinical evaluation of soft robotic gloves in stroke populations has so far consisted predominantly of small feasibility and pilot studies, with a smaller number of controlled comparative trials beginning to appear. Yap and colleagues complemented their actuator characterization work with a pilot test in two stroke survivors, finding that task completion times for a standardized grasp-and-release activity improved with glove assistance, including one participant who was unable to complete the task at all without the device but completed it in 12.3 ± 2.7 seconds when wearing the glove [5]. Radder and colleagues conducted a feasibility study of a wearable soft-robotic glove in five people with chronic stroke and persistent finger flexion impairment, using the upper-extremity Fugl-Meyer assessment, whose maximum attainable score is 66 points, alongside a set of standardized activities of daily living performed with and without the device, and found that while task performance times were broadly comparable between conditions, several activities showed clinically relevant time reductions when the glove assisted grasp,

supporting the feasibility of extended wear during functional tasks without adverse effects [10]. A bidirectional fabric-based soft robotic glove capable of both active flexion and active extension assistance was subsequently evaluated by Lim and colleagues in patients with chronic stroke, reporting improved hand function assistance relative to unidirectional flexion-only designs and underscoring the functional importance of actively assisting finger extension, which is frequently the more severely impaired movement direction after stroke [11].

Passive, spring-based hand exoskeletons developed in parallel with pneumatic and tendon-driven soft gloves have generated a more extended longitudinal clinical record and offer a useful comparator for the newer soft actuator literature. The Hand Spring Operated Movement Enhancer, or HandSOME, is a portable, passive exoskeleton that uses elastic elements rather than motors or pneumatics to extend the fingers against flexor hypertonia, and was first evaluated as a stroke rehabilitation device by Brokaw and colleagues, who demonstrated that the spring-based extension assistance increased active range of motion during a reaching and grasping task in chronic stroke survivors [12]. Chen and colleagues subsequently examined a structured, unsupervised, home-based therapy program built around the HandSOME device, reporting improvements in hand function that were sustained during independent home use without ongoing clinician supervision, an important precedent for the deployment of any low-cost, portable hand exoskeleton, soft or passive, outside the clinical setting [13]. Casas and colleagues extended this home-based paradigm to a redesigned HandSOME II device, recruiting fifteen chronic stroke survivors, of whom ten completed the home-based training protocol, and reporting statistically significant gains in finger range of motion and in reaching-task hand displacement at the end of training that were retained at a three-month follow-up assessment, together with significant improvements on the Action Research Arm Test, the Modified Ashworth measure of flexor tone, and the Motor Activity Log measure of real-world limb use [14].

Controlled comparative evidence for soft robotic gloves specifically has begun to emerge from randomized trial designs. Wang and colleagues conducted a three-arm randomized controlled trial in 69 patients with severe post-stroke upper-limb dysfunction, comparing conventional rehabilitation therapy, a soft robotic glove intervention, and repetitive transcranial magnetic stimulation, with 23 patients allocated to each arm, and found that the median improvement in upper-extremity Fugl-Meyer score was 4 points in both the soft robotic glove and the repetitive transcranial magnetic stimulation groups, compared with 2 points in the conventional therapy group, a difference that was statistically significant for the glove-versus-conventional comparison but not significantly different between the glove and the neurostimulation intervention, suggesting that the soft robotic glove achieved motor outcomes comparable to an established non-invasive neuromodulation therapy in this severely impaired population [15]. Synthesizing this and other evidence, several recent systematic reviews have sought to characterize the field as a whole: Bardi and colleagues systematically reviewed upper-limb soft robotic wearable devices and catalogued their actuation types, control strategies, and levels of clinical validation across a large body of engineering and clinical reports [16]; Liu and colleagues conducted a systematic review focused specifically on robotics for hand rehabilitation after stroke, situating soft and pneumatic glove designs within the broader landscape of rigid, cable-driven, and end-effector hand robots [17]; and Fardipour and Hadadi reviewed the therapeutic effects reported for wearable robotic gloves on hand function in stroke patients, concluding that while individual studies frequently report functional gains, methodological heterogeneity in outcome measures and dosage across the reviewed trials complicates direct comparison [18]. Across this converging body of feasibility studies, home-based passive-device trials, one randomized comparative trial, and multiple systematic reviews, the clinical literature indicates that soft and compliant hand exoskeletons can be worn safely for extended functional training in stroke survivors and can produce measurable gains in grip and lift force, range of motion, and standardized upper-limb outcome scores, while also revealing that sample sizes remain small, follow-up durations short, and head-to-head comparisons across the several competing actuation architectures still scarce.

Challenges, Evidence Gaps, and Future Directions

Several recurring limitations emerge from this literature and merit explicit attention before soft robotic exoskeleton gloves can be considered for routine post-stroke clinical deployment. First, sample sizes in device-specific clinical evaluations remain small, typically ranging from two to fifteen participants, reflecting the field's early translational stage and limiting the statistical power available to detect moderate treatment effects or to characterize responder subgroups by initial impairment severity [5,10,7,14]. Second, outcome measures are heterogeneous across studies, spanning bespoke task-completion timing protocols, the Toronto Rehabilitation Institute Hand Function Test, the upper-extremity Fugl-Meyer assessment, the Action Research Arm Test, and the Motor Activity Log, a heterogeneity that recent systematic reviews have identified as a central obstacle to meta-analytic synthesis of the soft glove literature [16,17,18]. Third, the mechanical design space itself remains only partially explored in head-to-head comparisons: pneumatic fabric actuators, tendon-driven underactuated mechanisms, and passive spring-based exoskeletons each report internally consistent engineering characterization and encouraging pilot clinical results, yet almost no published study has directly compared two or more of these actuation strategies within the same cohort using matched dosage and outcome measures, leaving open which mechanical approach, or combination of approaches, best serves particular stroke impairment profiles [2,3,4,12]. Fourth, the single identified randomized controlled trial of a soft robotic glove against an active comparator, while encouraging in showing outcomes comparable to repetitive transcranial magnetic stimulation, was likewise conducted at a single site with a modest sample and a relatively short intervention window, underscoring the need for larger, multi-site, longer-duration randomized trials with pre-registered functional and quality-of-life endpoints [15]. Addressing these gaps through larger comparative trials, standardized outcome batteries, and continued mechanical refinement building on the actuator characterization foundations established over the past decade [1,6] represents the clearest path toward establishing soft robotic exoskeleton gloves as an evidence-based component of post-stroke hand rehabilitation.

Conclusion

Soft robotic exoskeleton gloves have matured over roughly a decade from bench-characterized fabric and tendon-driven actuator prototypes into devices evaluated, albeit still on a modest scale, in stroke survivors and other upper-limb paralysis populations. Fabric-reinforced pneumatic actuators have been

shown to generate blocked tip forces and grip forces in the range of several newtons to several tens of newtons while preserving close to natural finger range of motion [5,6], tendon-driven underactuated architectures have demonstrated that compliant, adaptable grasp assistance can be achieved without pneumatic infrastructure [3,4], and passive spring-based exoskeletons have accumulated the field's longest home-based clinical track record [12,13,14]. Clinical evidence, though still dominated by small feasibility studies, now includes at least one randomized controlled trial reporting soft-glove-associated Fugl-Meyer gains statistically comparable to an established neuromodulation therapy [15], alongside consistent pilot-study signals of improved grip and lift force, task completion time, and standardized hand-function scores across pneumatic, tendon-driven, and passive device families [7,10,11,8]. Realizing the full rehabilitative potential of this technology will depend on larger and longer randomized trials, harmonized outcome reporting, and direct comparative evaluation across the several competing soft actuation strategies that this review has characterized.

Acknowledgements

The authors thank colleagues at the Department of Biomedical Engineering, Radboud University, Nijmegen, Netherlands, the Department of Rehabilitation Medicine, University of Lisbon, Lisbon, Portugal, and the Department of Mechanical Engineering, Vilnius University, Vilnius, Lithuania for helpful discussions during preparation of this review.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Willemsen F conceived the review, conducted the literature search, and drafted the manuscript. Carvalho R contributed to the literature screening and clinical framing and critically revised the manuscript for important intellectual content. Urbonas M contributed additional mechanical design context and approved the final version for submission.

Ethics Statement

Not applicable. This is a narrative review of previously published literature and did not involve new experimental data, human participants, or animal subjects.

Data Availability

No new data were generated or analyzed for this review. All sources synthesized are cited in the reference list and are available through their original publishers.

References

1. Heo P, Gu GM, Lee SJ, Rhee K, Kim J (2012) Current hand exoskeleton technologies for rehabilitation and assistive engineering. International Journal of Precision Engineering and Manufacturing, 13(5):807-824, DOI:10.1007/s12541-012-0107-2.

2. Polygerinos P, Wang Z, Galloway KC, Wood RJ, Walsh CJ (2015) Soft robotic glove for combined assistance and at-home rehabilitation. Robotics and Autonomous Systems, 73:135-143, DOI:10.1016/j.robot.2014.08.014.

3. In H, Kang BB, Sin M, Cho KJ (2015) Exo-Glove: a wearable robot for the hand with a soft tendon routing system. IEEE Robotics & Automation Magazine, 22(1):97-105, DOI:10.1109/MRA.2014.2362863.

4. Kang BB, Choi H, Lee H, Cho KJ (2019) Exo-Glove Poly II: a polymer-based soft wearable robot for the hand with a tendon-driven actuation system. Soft Robotics, 6(2):214-227, DOI:10.1089/soro.2018.0006.

5. Yap HK, Lim JH, Nasrallah F, Yeow CH (2017) Design and preliminary feasibility study of a soft robotic glove for hand function assistance in stroke survivors. Frontiers in Neuroscience, 11:547, DOI:10.3389/fnins.2017.00547.

6. Ge L, Chen F, Wang D, Zhang Y, Han D, Wang T, Gu G (2020) Design, modeling, and evaluation of fabric-based pneumatic actuators for soft wearable assistive gloves. Soft Robotics, 7(5):583-596, DOI:10.1089/soro.2019.0105.

7. Cappello L, Meyer JT, Galloway KC, Peisner JD, Granberry R, Wagner DA, Engelhardt S, Paganoni S, Walsh CJ (2018) Assisting hand function after spinal cord injury with a fabric-based soft robotic glove. Journal of NeuroEngineering and Rehabilitation, 15:59, DOI:10.1186/s12984-018-0391-x.

8. Osuagwu BAC, Timms S, Peachment R, Dowie S, Thrussell H, Cross S, Shirley R, Segura-Fragoso A, Taylor J (2020) Home-based rehabilitation using a soft robotic hand glove device leads to improvement in hand function in people with chronic spinal cord injury: a pilot study. Journal of NeuroEngineering and Rehabilitation, 17, DOI:10.1186/s12984-020-00660-y.

9. Yurkewich A, Kozak IJ, Ivanovic A, Rossos D, Wang RH, Hebert D, Mihailidis A (2020) Myoelectric untethered robotic glove enhances hand function and performance on daily living tasks after stroke. Journal of Rehabilitation and Assistive Technologies Engineering, 7, DOI:10.1177/2055668320964050.

10. Radder B, Prange-Lasonder G, Kottink A, Melendez-Calderon A, Buurke J, Rietman J (2018) Feasibility of a wearable soft-robotic glove to support impaired hand function in stroke patients. Journal of Rehabilitation Medicine, 50(7):598-606, DOI:10.2340/16501977-2357.

11. Lim DYL, Lai HS, Yeow RCH (2023) A bidirectional fabric-based soft robotic glove for hand function assistance in patients with chronic stroke. Journal of NeuroEngineering and Rehabilitation, 20:120, DOI:10.1186/s12984-023-01250-4.

12. Brokaw EB, Black I, Holley RJ, Lum PS (2011) Hand Spring Operated Movement Enhancer (HandSOME): a portable, passive hand exoskeleton for stroke rehabilitation. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 19(4):391-399, DOI:10.1109/TNSRE.2011.2157705.

13. Chen J, Nichols D, Brokaw EB, Lum PS (2017) Home-based therapy after stroke using the Hand Spring Operated Movement Enhancer (HandSOME). IEEE Transactions on Neural Systems and Rehabilitation Engineering, 25(12):2305-2312, DOI:10.1109/TNSRE.2017.2695379.

14. Casas R, Sandison M, Nichols D, Martin K, Phan K, Chen T, Lum PS (2021) Home-based therapy after stroke using the Hand Spring Operated Movement Enhancer (HandSOME II).

Frontiers in Neurorobotics, 15:773477, DOI:10.3389/fnbot.2021.773477.

15. Wang T, Liu Z, Gu J, Tan J, Hu T (2023) Effectiveness of soft robotic glove versus repetitive transcranial magnetic stimulation in post-stroke patients with severe upper limb dysfunction: a randomised controlled trial. Frontiers in Neurology, 13, DOI:10.3389/fneur.2022.887205.

16. Bardi E, Gandolla M, Braghin F, Resta F, Pedrocchi ALG, Ambrosini E (2022) Upper limb soft robotic wearable devices: a systematic review. Journal of NeuroEngineering and Rehabilitation, 19:87, DOI:10.1186/s12984-022-01065-9.

17. Liu C, Lu J, Yang H, Guo K (2022) Current state of robotics in hand rehabilitation after stroke: a systematic review. Applied Sciences, 12(9):4540, DOI:10.3390/app12094540.

18. Fardipour S, Hadadi M (2022) Investigation of therapeutic effects of wearable robotic gloves on improving hand function in stroke patients: a systematic review. Current Journal of Neurology, 21(2):125-132, DOI:10.18502/cjn.v21i2.10496.