

Hypershell and the Tipping Point of Consumer Exoskeletons



HYPERHELL

Over the past decade, wearable technology has moved from niche gadgets into mainstream use. Smartwatches, continuous glucose monitors, wireless earbuds, and fitness sensors have transformed daily personal tech. Meanwhile, exoskeletons, once limited to medical rehabilitation, industrial logistics, and science fiction, are now emerging as the next frontier in consumer mobility enhancement.

Lightweight powertrains, compact batteries, improved motors, and sophisticated motion-prediction algorithms have accelerated the transition from lab prototypes to consumer-ready devices. This change reflects the early paths of electric scooters, drones, and hoverboards. But with rapid adoption, there is increased responsibility and scrutiny.

The consumer electronics industry has learned difficult lessons. Hoverboards caught global attention not only for their popularity but also for high-profile failures related to battery safety and testing oversight. Today's exoskeletons are entering the market at a similar inflection point. Users increasingly expect devices that meaningfully improve physical performance while meeting robust, independently verified safety, reliability, and performance standards.

International standards organizations like ASTM International, ISO, and AFNOR have been developing exoskeleton standards for about a decade, and their efforts are becoming increasingly relevant. Several years ago, the **ASTM Exo Technology Center of Excellence** conducted a survey of exoskeleton producers across the industry. The clear consensus was that the industry needs well-defined safety standards, consistent test methods, and reproducible benchmarks. However, until now, very few consumer exoskeleton companies have had their products tested through third-party, scientific testing.



Hypershell is one of the first.

The company's latest testing, independently conducted and **SGS-verified**, marks a major milestone not only for Hypershell's product line but also for the future of consumer exoskeletons as a category. The results offer solid, scientifically repeatable evidence of improvements in metabolic cost, as well as reductions in heart rate and lower-limb muscle activation (EMG) during both walking and cycling activities. These findings clearly show how the Hypershell exoskeleton makes these activities easier, similar to e-bikes, for people who need or want this kind of assistance to keep up with family members, spend time with friends, and reach goals they once thought were impossible.



The Importance of Reproducible Exoskeleton Standards

For exoskeletons to become common in the consumer market, the industry must agree on proposed standards that are:

- **Clear and technically precise**, so each producer can take a device to a standard testing lab and know what will be measured.
- **Built upon reproducible test protocols**, including testing equipment, measurement equipment, and evaluation protocols performed under comparable conditions.
- **Reported using a uniform format** analogous to how the automotive industry reports braking distance, acceleration times, skidpad performance, and efficiency metrics. Automotive publications such as Car and Driver and MotorTrend educate the market, help consumers shop for new vehicles, and build trust because their results are comparable across brands and models.

Exoskeletons could be compared to one another for specific use cases, similar to how cars are ranked by the fastest “Lightning Laps” or which trucks are best for off-road adventures.

Information like this would give consumers, media, and regulators the transparency needed for widespread trust and adoption.

Hypershell’s latest SGS-validated testing strongly aligns with these objectives and demonstrates how future standards could be modeled.

Imagine a future where exoskeletons feature standardized performance charts, with similar devices plotted together for easy comparison, providing helpful information like giving buyers the tools to make informed purchase decisions.

In such a system, each device would disclose:

VO₂ Reduction

Expected percentage reduction in oxygen consumption during walking or cycling at specific speeds, grades, cadences, and power outputs.

Muscle Activation Reduction (EMG)

Expected muscle activation (EMG) profiles for major muscle groups and exoskeleton modes.

Assistive Torque Output

Expected torque delivery profile, including peak assist, sustained assist, and torque consistency across gait cycles or cycling cadences.

Battery Performance

Expected operating duration under standardized workloads, reported at defined speeds, inclines, ambient temperatures, and assist levels.

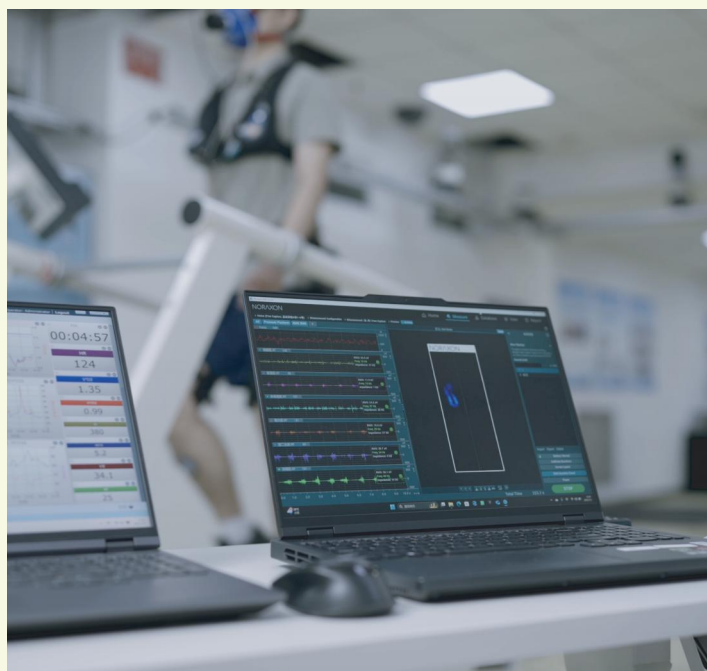
Noise Levels

Expected motor sound output (in decibels) during standardized walking and cycling tasks, measured in controlled acoustic environments.

Mode & Firmware Transparency

Clear disclosure of assistive modes, firmware versions, and configuration parameters used during performance testing.

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SGS Testing: Hypershell's Measured Performance

Hypershell submitted its Hypershell X Ultra exoskeleton (HXU-900W-TPU) for a comprehensive battery of tests independently conducted by the Experimental Center of the China Institute of Standardization and validated by SGS, a Swiss-headquartered global leader in testing, inspection, and certification with over 2,500 laboratories and facilities in more than 115 countries.

Testing Overview

- 11 subjects (9 males, 2 females; ages 21–37)
- Gait at 3.5 km/h on a 7° slope for 15 minutes for metabolic testing, and gait at 3.5 km/h on a 15° slope for 3 minutes for EMG testing.
- Metrics captured: VO₂, HR, speed, and incline for metabolic testing; EMG, speed, and incline for muscle activation testing; and user experience scores.
- EMG was recorded from six major lower-limb muscles: iliopsoas, gluteus maximus, rectus femoris, biceps femoris, tibialis anterior, and gastrocnemius.
- Testing was conducted in a controlled indoor environment (21.8° C, 46% relative humidity)

Muscle Activation (EMG) Reductions (Walking at 3.5 km/h at 15° incline)

EMG showed consistent decreases across major lower-limb muscles over the full gait cycle:

- Iliopsoas: -45.44%
- Rectus femoris: -13.22%
- Gluteus maximus: -18.59%
- Biceps femoris: -25.45%
- Tibialis anterior: small increase (+8.79%)
- Gastrocnemius: -7.47%

These results indicate that the hip and knee flexor and extensor muscle groups experience the most significant offloading, directly aligning with the assistive torque profile of Hypershell's exoskeleton.

Heart Rate Response (Walking at 3.5 km/h at 7° incline)

During uphill walking, **average HR decreased by 22.34% and maximum HR decreased by 21.60%**. This HR response to using the exoskeleton underscores genuine physiological offloading. These benefits extend beyond perceived effort and directly into reduced cardiovascular load.

Metabolic Cost (Walking at 3.5 km/h at 7° incline)

Across all 11 participants, Hypershell demonstrated statistically significant reductions in energy expenditure. **VO₂ was reduced by 20.47% on average during uphill walking with the exoskeleton, compared to not wearing the exoskeleton.** This establishes Hypershell as one of the first consumer exoskeletons to show consistent, third-party-verified metabolic reduction, an outcome historically reported only in research-grade or industrial devices. These results indicate that the body produced and used less energy to do the activity with the exoskeleton.

Metabolic Cost (Cycling at 100W at 60 +/- 5 rpm)

Along with walking on an incline, the exoskeleton was tested during a cycling activity. Measurements of metabolic cost and heart rate were taken using the same system as in the treadmill assessments.

Across all participants, the exoskeleton demonstrated robust performance-enhancing effects:



- **Average VO₂ reduced by 39.20%**



- **Average heart rate reduced by 42.68%**



User Experience Scores

Participants rated their **mean user satisfaction**, including the overall wearability, comfort, assistive effect, and fatigue reduction, as **4.3 / 5**. This is a critical metric for consumer products, where comfort and usability are often as important, and in some cases more important than raw performance.

These results indicate that Hypershell's assistive effects go beyond activities like walking, hiking, or uphill climbing. They showcase the exoskeleton's capacity to significantly reduce physical effort and physiological load during cycling, which was previously only achievable for those who could ride e-bikes. This marks a major step forward for consumer exoskeletons designed for multi-modal outdoor use.

Safety & Compliance Certification

Hypershell has invested heavily in meeting established international standards, understanding that safety and compliance are crucial for the future of consumer exoskeletons and their global adoption. It's not enough for Hypershell to claim that its products are safe and durable; a third party must verify this. Some additional certifications include, but are not limited to:

Electrical & Radio Safety

- **CE – EMC Directive (Electromagnetic Compatibility)**

Verifies that the device tolerates external electromagnetic interference and does not generate harmful emissions.

- **IEC 60335 (Household Appliance Safety, with CB Scheme Certification)**

Provides protection against electric shock, overheating, fire, and other hazards under normal and foreseeable use; recognized internationally through the IECEE CB Scheme.

- **FCC (U.S. Federal Communications Commission)**

Certifies compliance with U.S. electromagnetic emission and RF communication regulations for electronic and wireless products.

- **IC/ISED (Innovation, Science and Economic Development Canada)**

Ensures electronic and wireless devices meet Canada's mandatory EMC and RF performance requirements.

- **CB Scheme (IECEE Mutual Recognition System)**

Allows one globally recognized safety test report to be accepted by multiple national certification bodies, simplifying global market access.

- **CCC (China Compulsory Certification)**

China's mandatory safety certification for electrical and electronic products to enter the Chinese market.

- **PSE (Japan Product Safety Electrical Appliance & Materials)**

Japan's mandatory certification verifying electrical safety, insulation, and overheating protection for consumer electronics.

- **MIC (Japan Ministry of Internal Affairs and Communications)**

Regulates radio frequency and telecommunications compliance for wireless devices sold in Japan.

- **SRRC (China State Radio Regulatory Commission)**

Mandates RF compliance—including frequency, bandwidth, and output power—for wireless devices such as Bluetooth and IoT products.

- **Bluetooth SIG Certification**

Validates Bluetooth performance, RF behavior, and interoperability; required to legally use the Bluetooth trademark worldwide.

Materials, Environmental & Disposal Compliance

• **ClimatePartner Certification**

Enables carbon-neutral product labeling through validated carbon footprint accounting, reduction strategies, and offsetting.

• **RoHS (Restriction of Hazardous Substances)**

Limits toxic substances such as lead, cadmium, and mercury in electronics to protect users and reduce environmental harm.

• **REACH / REACH SVHC (Registration, Evaluation, Authorization of Chemicals)**

Ensures identification, control, and communication of high-concern chemical substances used in manufacturing.

• **WEEE (Waste Electrical and Electronic Equipment Directive)**

Ensures proper end-of-life recycling and recovery for electronic devices placed on the EU market.

• **California Proposition 65 (CA65)**

Requires consumer warnings and chemical controls for substances linked to cancer or reproductive harm.

• **POPs Regulation (Persistent Organic Pollutants)**

Restricts toxic, persistent pollutants such as PCBs and certain flame retardants in alignment with the Stockholm Convention.

• **PAHs (Polycyclic Aromatic Hydrocarbons) Limits**

Controls 18 harmful PAHs commonly found in plastics and rubber components to reduce carcinogenic exposure.

• **TSCA (Toxic Substances Control Act, U.S. EPA)**

Regulates production, use, and reporting of hazardous chemicals, including persistent, bioaccumulative, and toxic substances.

• **TPCH (Toxics in Packaging Clearinghouse Model)**

Limits total heavy metals and PFAS in packaging materials to less than 100 ppm to protect consumers and supply-chain workers.

• **EU Battery Regulation (EU 2023/1542)**

Mandates carbon-footprint labeling, recycling content thresholds (cobalt, lithium, nickel), and due-diligence obligations for portable and industrial batteries.

• **France “Arrêté du 13 avril 2022” (Mineral Oil Restrictions)**

Restricts MOAH/MOSH mineral oils in packaging and printing inks, with phased limits beginning 2025 to reduce environmental contamination.

Cybersecurity & Data Protection

- **Delegated Regulation (EU) 2022/30 + EN 18031**

Imposes cybersecurity requirements for connected radio equipment sold in the EU, including protections against network intrusion, data breaches, and device manipulation.

- **PSTI Act (Product Security and Telecommunications Infrastructure Act, UK)**

Establishes baseline cybersecurity safeguards for consumer-connectable devices, including secure defaults, vulnerability disclosure, and protection against common cyber threats.

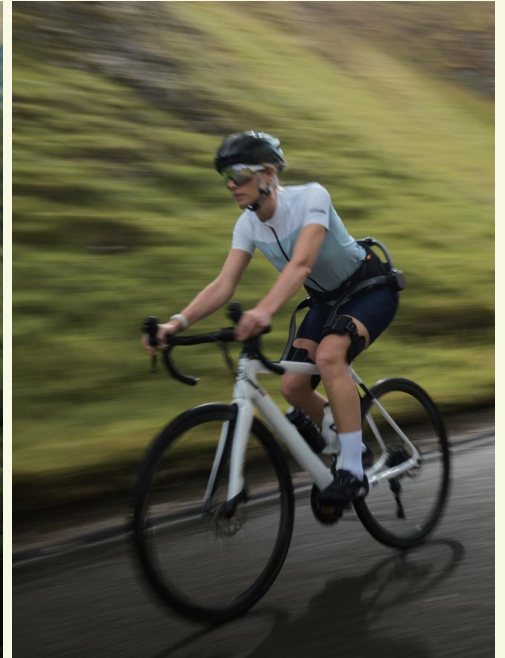


The Significance of Disclosure and Transparency

Advancing exoskeleton industry standards requires full transparency. Hypershell is committed to responsible disclosure of the following:

- Firmware and software versions used during testing
- Assistive-mode configuration
- Device serial numbers and hardware versions
- Subject demographics and test methods
- Statistical treatment (ANOVA, Z-score filtering, steady-state selection)
- Measurement uncertainties, limitations, and potential sources of bias

Such transparency is crucial for the reproducibility of test methods and for building trust with the media, regulators, and consumers who will use these products.



Collaborating to Advance the Future of Consumer Exoskeletons

Hypershell's SGS-validated testing is a significant advancement, but it should not be the final step. To build a thriving ecosystem where exoskeletons are safe, trusted, and transformative for everyday mobility, the community, including producers, standards bodies, regulators, academia, and consumers, must collaborate to:

- Pass standardized test methods and certify labs
- Establish standardized reporting frameworks
- Develop meaningful safety benchmarks
- Encourage and participate in third-party testing for all exoskeletons
- Promote transparent data sharing and reproducibility

Hypershell invites stakeholders across the sector to join this effort. By adopting and continually refining unified standards, the industry can accelerate innovation while safeguarding consumers. Together, we can define the future of wearable mobility and enhance the quality of life for millions of users worldwide.



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