

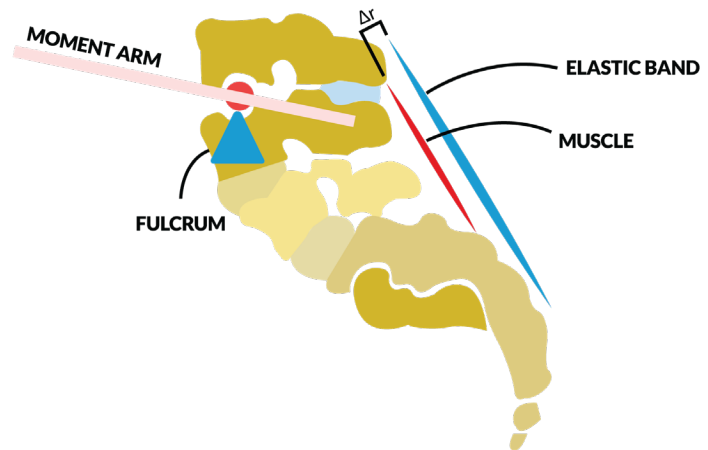


THE SCIENCE BEHIND THE EXOSUIT

Born at one of the world’s leading research institutions for biomechanics, the Apex excelled not only during initial studies (Lamers, Yang & Zelik 2019, Lamers et al. 2020) but those results have been verified by an independent, peer-reviewed scientific publication (Goršic et al 2021). More importantly, more than 150 users in real-world field studies reported reduction in discomfort and fatigue after using the Apex.

DISCOVER HOW THE APEX 2 WORKS

The Apex 2 employs passive elastic bands that act in synergy with the major muscle groups responsible for bending and lifting. The exosuit’s design uses the advantage of an extended moment arm to decrease total forces in the system, meaning the same work can be done with less total force applied. This also reduces spinal compression forces, in addition to reducing back strain and fatigue.



REDUCED RISK OF INJURY FOR WORKERS

The HeroWear Apex 2 exosuit reduces about 40% of peak muscle forces applied and reduces fatigue by up to 40%. Back pain costs industries in the USA over \$100 billion a year for medical care, workers’ compensation payments, and time lost from work. The Apex 2 offers working men and women worldwide assistance they need to sustain strength and work more safely.

APEX

E X O



The Apex 2 back-assist exosuit reduces strain on the back without getting in the way. Working men and women deserve tough gear that helps them tackle tough jobs. It's a flexible 3-pound suit that takes 100 pounds of strain off your back every time you lift an object, with no motors or batteries. For some users, it's actually closer to 125 pounds of back relief.

Reduce Strain. Reduce Fatigue.



The Challenge:

Without assistance, there's no point. Without comfort, no one will want to wear it. If it's not easy to use, it will slow workers down and hurt productivity.

The Solution:

The Apex 2 is the first exosuit on the market that not only offloads 40% of back strain, but is built as a modular system to ensure that it is comfortable for users of all sizes and shapes. The high-tech textile design with no motors or batteries means users can move naturally, including in tight spaces. All while working safer than ever before.

ASSISTIVE



- Reduces back muscle strain by 40%
- Lower risk of injuries
- Improve quality of life

COMFORTABLE



- Modular design for customized fit
- Designed to reduce heat retention
- Flexible textiles for freedom of movement

EASY TO USE



- Ready to implement at enterprise scale
- No heavy motors or batteries to charge
- Simple to learn and use

HeroWear Apex Science Overview



The Apex is one of the most heavily researched and scientifically validated exoskeletons in the world. And the results are unequivocal. There have been over a dozen academic research studies on the Apex (and the prototypes that led to it) from institutions like:

10 Things We Know

From universities, and industry studies there's a brief summary of the consistent and converging results from rigorous studies in labs and workplaces around the world, which underpin how and why we know these things.

1) Apex reduces the strain on back muscles

Back muscle activity reduced 14-43% during bending and lifting tasks (Lamers 2018), validated by independent studies: Vathing 2022, Gorsic 2021. Published field studies with international logistics & retail companies (Yandell 2020) and industry-led trials have further solidified the scientific evidence of back strain relief.

2) The Apex reduces compression force on spinal discs.

Multiple studies, including Abdoli-Eramaki 2007, have shown that exosuits like the Apex reduce spine compression force during bending and lifting. Lamers 2018 estimated a 5-10% reduction in spine compression force, and several newer studies have provided further evidence of spinal disc offloading (e.g., Lamers 2021, Yun 2021). For more, check out the "How does the HeroWear Apex work?" video on the HeroWear YouTube channel.

3) The Apex reduces muscle fatigue & increases endurance.

Lamers 2020 found back muscle fatigue rate was reduced by 29-47% during sustained bending. A field study on heavy lifting found that U.S. Army Soldiers increased their endurance by 25-75% when wearing an exosuit similar to the Apex. Gorsic 2021 "confirm[ed] that the HeroWear Apex could reduce muscle demand and fatigue". HeroWear field study data found reductions in lifting effort of 20-30% (n=154). Apex trial results from the Construction Scotland Innovation Centre suggested reduced downtime and fatigue of workers during typical construction tasks (CSIC 2022).

4) The Apex reduces bodily discomfort on the back as well as legs and shoulders.

Workers participating in HeroWear fields studies consistently report less work-related discomfort in their lower and upper backs, shoulders, knees, hips and thighs. Field study data indicates, on average, 35% reductions in low back discomfort and 40% reduction in knee discomfort (n=154). Similar results have been replicated in independently-run field studies, including one by SAIF (insurance company) which reported a 73% reduction in low back discomfort.

5) The Apex reduces overexertion injury risk factors

Ergonomic assessment tools provide quantitative insight on how much injury risks are reduced by an intervention that alleviates peak forces on the lower back. Zelik 2022, using the Exo-LiFFT ergonomics assessment tool, estimated to reduce back injury incidence by 20-60%. Also, reductions in bodily discomfort (see #4 above) are a leading indicator of reduced injury risk due to overexertion.

6) The Apex makes lifting easier

Yandell 2020, a field study on logistics and retail workers, found >90% of the workers reported that the exosuit made lifting feel easier. In a Vanderbilt-led study with the U.S. Army, 100% of Soldiers reported that they were satisfied with the lifting assistance (Slaughter & Rodzak, In Review). In Gorsic 2021 participants reported that lifting and lowering tasks were mildly or moderately easier to perform. Workers in HeroWear field studies (n=154) reported an average of 26% reduction in effort for a typical lift and 32% reduction in effort required for their heaviest lifts. An independent field study conducted by SAIF insurance company found similar numbers (SAIF 2022).

7) The Apex is comfortable for daily work

We spent years researching how and where to comfortably apply exosuit forces to the body. Our team was the first to publish a peer-reviewed study characterizing the comfort limits of exosuit forces (Yandell 2020B) and to comprehensively characterize interface dynamics during the transmission of mechanical power from an exosuit to a user (Yandell 2019). In a recent Vanderbilt-led study, 82% of US Army Soldiers reported that they were satisfied with the comfort of an exosuit prototype and the remaining 18% were neutral in their opinion of comfort (Slaughter & Rodzak, In Review). HeroWear has observed similar outcomes across dozens of field studies: when properly fit, the vast majority of users find the Apex to be comfortable to wear for their daily work.

8) The Apex doesn't increase muscle demands on other parts of the body

Independent studies Lamers 2020, Gorsic 2021, and Vathing 2022 all found that abdominal muscle activity does not increase when wearing the Apex. Gorsic 2021 also concluded that when wearing the Apex “no adverse effects on other muscles or during non-lifting tasks were noted.” Yun 2022 found that the Apex had no adverse effects on walking stability (balance), for both assisted or non-assisted modes. This conclusion is further bolstered by HeroWear field data (N=154) showing reductions in discomfort across a wide range of body parts (see #4 above).

9) The Apex fits into work & is well-accepted by workers

In our peer-reviewed field study with international logistics and retail companies, 100% of workers reported that the exosuit could fit into their daily work without interfering with other aspects of their job (Yandell 2020). Slavin 2021 found the Apex fit well into work at a foundry. A series of field studies led by SAIF insurance company concluded that the Apex was a good fit for jobs involving prolonged bending or ground-level work, and heavy or repetitive lifting.

10) The Apex is preferred over rigid exoskeletons in various jobs & industries

While rigid exoskeletons and soft exosuits have each repeatedly been proven to provide back relief and musculoskeletal offloading (Kermavnar 2020; Lamers 2021; Schwartz 2021), it is now evident in the scientific literature and in industry feedback that soft exosuits like the Apex are perceived by most users to be more comfortable and less restrictive to movement.

Slavin 2021 (foundry) and Frixen 2022 (agriculture) tested the Apex against rigid exoskeletons and both studies concluded that there was better usability and user acceptance for the Apex. The main reasons cited were because the Apex was more flexible to move in, more comfortable, and because its modular design could be better adapted to fit the different body proportions of users. In a recent keynote presentation on occupational exoskeletons (CRE-MSD UW 2022), Dr. Maury Nussbaum from Virginia Tech remarked, “I also think the future is soft. We do lots of demos for people in different occupational sectors (construction, mining, etc.) and a clear message I hear is that [for] these exosuits that are mainly soft materials, people are much more receptive to them... [they're] much more comfortable over time.”