Biomechanically-Assistive Garment Offloads Low Back During Lifting & Leaning Tasks

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Fits Like Clothes, Acts Like Exoskeleton

**Methods and Analysis**
- 8 healthy subjects (7 male, 1 female, 74 ± 9 kg, 1.8 ± 0.1 m, 23 ± 3 yrs.)
- Subjects performed lifting (13 kg & 24 kg weight) & leaning (30˚, 60˚, 90˚) tasks with & without assistive garment
- Measured kinematics, elastic band force, & erector spinae EMG
- Computed EMG envelope, normalized to max activation
- Compressive L5-S1 disc loading estimated with simple spine model
- Paired t-test to compare with vs. without assistive garment, alpha=0.05

**Societal Problem Addressed**
- 60-85% of adults will experience low back pain [Hoy et al. 2010]
- Repeated & elevated low back loading, such as occurs during leaning & lifting, increases risk of low back injury & pain [Heneweer et al. 2011]

**Assistive Garment Prototype**
- Processor
- Vest/Shirt
- Powered Clutch
- EMG Control
- Elastic Band
- Shorts

**Motivation for Design**
- Back belts don't work [Steffens et al. 2016]
- Industrial exoskeletons are too bulky & expensive for average person
- Lack of preventative solutions for non-industrial users (e.g. nurses, package handlers, caregivers, office workers, etc.)

**Estimated to Reduce Spine Loading**
- Reductions in EMG (14-43% on Avg.)

**How It Offloads Low Back**
- Elastic band:
  - Stretches during leaning & lifting
  - Offloads lumbar extensors
  - Extends moment arm relative to muscle (∆r), reducing low back loading

**How It’s Controlled**
- Elastic band can be engaged (clutched) or disengaged (unclutched) by smartphone, EMG control, or manual touch sensor
  - Engaged: Elastic band assists in parallel with low back muscles during lifting & leaning
  - Disengaged: Elastic band is slack, feels like normal clothes

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