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Evidence-based Injury Prevention

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Current Problems with Workplace Injury Prevention Programs

Methods are ineffective and don't deliver ROI

Evidence has indicated that education and group training types of workplace injury prevention programs are costly and ineffective at reducing the rate of musculoskeletal injuries sustained by workers.[1, 2, 5, 17, 29, 30, 31, 33]

Limited by time and resources

Traditional injury prevention programs require EHS professionals to deliver them. The biggest threat to growth and revenue for companies in the EHS industry is the time and resource demands required to provide these services.[3, 21]

Approaches are not injury / occupation specific

Every industry, work site, work task and individual worker has unique injury risks. Therefore, generalized approaches to identifying and addressing injury risks have limited effectiveness.[4, 21]

Assessments are observation and opinion-based

Research has indicated only a moderate to fair inter-rater reliability for observation and opinion-based work task safety assessments. [37, 38] Wearable technology can remove the risk of reliability-based errors.

The Most Effective Injury Prevention Programs

Sports-based injury prevention programs are the most effective

The costs associated with high level athletes not being able to perform due to injury has driven the development of highly effective injury prevention methods using the latest technology and scientific research.

You need to measure movement *quality* and *quantity*

There is a high level of reliability and validity using accelerometers positioned on the person to collect data about their movements over long periods. This data is positively correlated with injury risk metrics (including fatigue thresholds, movement control and athlete muscle soreness). [7, 11, 23, 24, 25, 34, 35, 36]

Establishing baselines

To reduce injury risks it is essential that data is collected to establish baseline measures that are relevant and specific for that sport. Data is then collected periodically and compared to benchmarks to enable the identification of injury risks. Interventions are then provided (including feedback to the individual), to return the athlete's data to the baseline.[6, 22, 26, 36]

Measuring load to use as a baseline

Load is the process of quantifying the amount of physical training that an athlete undertakes using variables relevant for their sport (accelerometer data, GPS data, movement duration). Recent research has demonstrated that this is the most effective way to reduce injury risk across many different sports. [22, 26, 36]

1. *Internal load* = the physiological stressors imposed during training or competition. Heart rate, blood lactate and oxygen consumption are commonly used to assess internal load. (Not appropriate for the workplace)
2. *External load* = objective measures of the work performed during training or competition. Common measures of external load include power output, speed, acceleration, time–motion analysis and GPS parameters. (Very appropriate for the workplace)

Monitoring Load to Identify Risk and Prevent Injury

Simply measuring range of motion is not enough

The traditional ergonomics approach to workplace injury prevention is focused on measuring range of motion and joint angles. This is also the approach taken by most workplace wearable devices. This has limited effectiveness at identifying injury risks for physically demanding movements in dynamic environments.[28, 38]

What is load monitoring?

Measuring load is only effective when it is monitored over time and regularly compared to relevant benchmarks. Wearable technology is the perfect way to measure the load on groups of workers, establish benchmarks (relevant to their specific occupation and location) and then compare individual workers to these benchmarks. 19 articles exist for the relationship between load monitoring and injury or illness. [22, 26]

Is it relevant for workplace injury prevention?

Cyclic or repetitive ("chronic") lower back loading has been demonstrated to be a higher risk factor for the occurrence of work-related LBP than previously reported risk factors, including lifting and sustained flexion posture. [8, 10] Longitudinal studies have provided evidence demonstrating physical exposures and workload (volume of movement) and the development of shoulder complaints.[14, 16]

Establishing baselines

To reduce the unique injury risks for each occupation, task and location it is essential that data is collected from each to establish baseline measures that are relevant and specific.[6, 22, 26, 36] This can easily be done in the workplace using valid and reliable wearable technology and sports science methodology.

Movement Control Assessment to Reduce Injury Risk

Movement Control can be assessed using acceleration

Fast, jerky movements are one of the main causes of injuries in sports and the workplace. This is because when a movement is performed in a fast jerky way, there is increased mechanical stress on the joints and ligaments that are involved in the movement, and the muscles that are required to move and control the joints. Smooth, controlled movements result in less mechanical stress on these structures, resulting in reduced injury risk for specific movements. Smooth, controlled movements also result in less fatigue as the muscles are required to contract at a lower intensity over time. [25, 44]

What are high impacts through the legs?

In sports that require athletes to jump, the ability to absorb the shock, or impact when they land is directly correlated with their risk of knee or ankle injury. Athletes with a poor ability to absorb (or control) the impact when they land have a significantly higher injury risk compared to athletes who are able to absorb the impact. Accelerometers placed on the upper back of athletes are used by the Sports Medicine teams working in sports that involve jumping (eg. Volleyball, Basketball, Track and Field) to identify which athletes are not absorbing the impact, and therefore have a higher risk of leg injuries. [45, 46, 47]

When is an impact considered high, or hazardous?

For over two decades, the accelerometer data has been used by Sports Medicine teams to establish thresholds for what’s considered a low, moderate and high injury risk risks for vertical impacts. These thresholds have been used by the Bardavon technology platform for the same purpose – to identify when individual workers have high impacts through their legs during their shift, which correlates with a high risk of injury to their knees and ankles.

Evidence-Based Product Development

UNIVERSITY OF CANBERRA

Wearable Technology Validation

The University of Canberra validated Bardavon's IMU against the Vicon Motion Capture System (considered the gold standard for research). The IMU positioned on the back recorded a MAD (mean average difference) of 10.7° ± 4.2°and the IMU on the arm recorded a MAD of 9.4° ± 2.8°. This is considered excellent when compared to peer reviewed IMU validation research.

Biomechanical risk factor analysis

The most effective and accurate way to identify which movements increase the injury risk for workers is to:

1. Measure their movements whilst performing the work tasks and compare this data to the established biomechanics injury risk factors [18, 19]
2. Measure their movements over a prolonged period to gain a true understanding of the mechanical risk factors involved when they are performing their work tasks throughout a shift. [15, 16]

Trunk and lower back biomechanics

The primary biomechanical low back pain risk factors include lifting frequency, load moment, trunk lateral velocity, trunk twisting velocity, and trunk sagittal angle.[13, 16] All of these variables have been integrated into our algorithms to be reflected in the load calculation.

Shoulder and upper limb biomechanics

The primary biomechanical shoulder pain risk factors include lifting frequency, shoulder joint moment, upper limb movement acceleration in all three planes.[12, 14, 19] All of these variables have been integrated into our algorithms to be reflected in the load calculation.

High load threshold validation

ISO 11226 and all three parts of ISO 11228 were at the core of Bardavon's algorithm development and testing over a five year period. The recommended limits provided by ISO are "based on the integration of data derived from four major research approaches, namely the epidemiological, the biomechanical, the physiological and the psychophysical approach" [9]

EHS Professional: Addressing the Needs

Measuring the specific physical demands of work tasks

Whilst the traditional work task risk assessments are necessary for the identification of environmental risks, there is a need to measure and assess physical demands in an easy and cost-effective way. By using valid and reliable wearable technology, these measurements can be taken from any worker at any time.[43]

Combining data with video

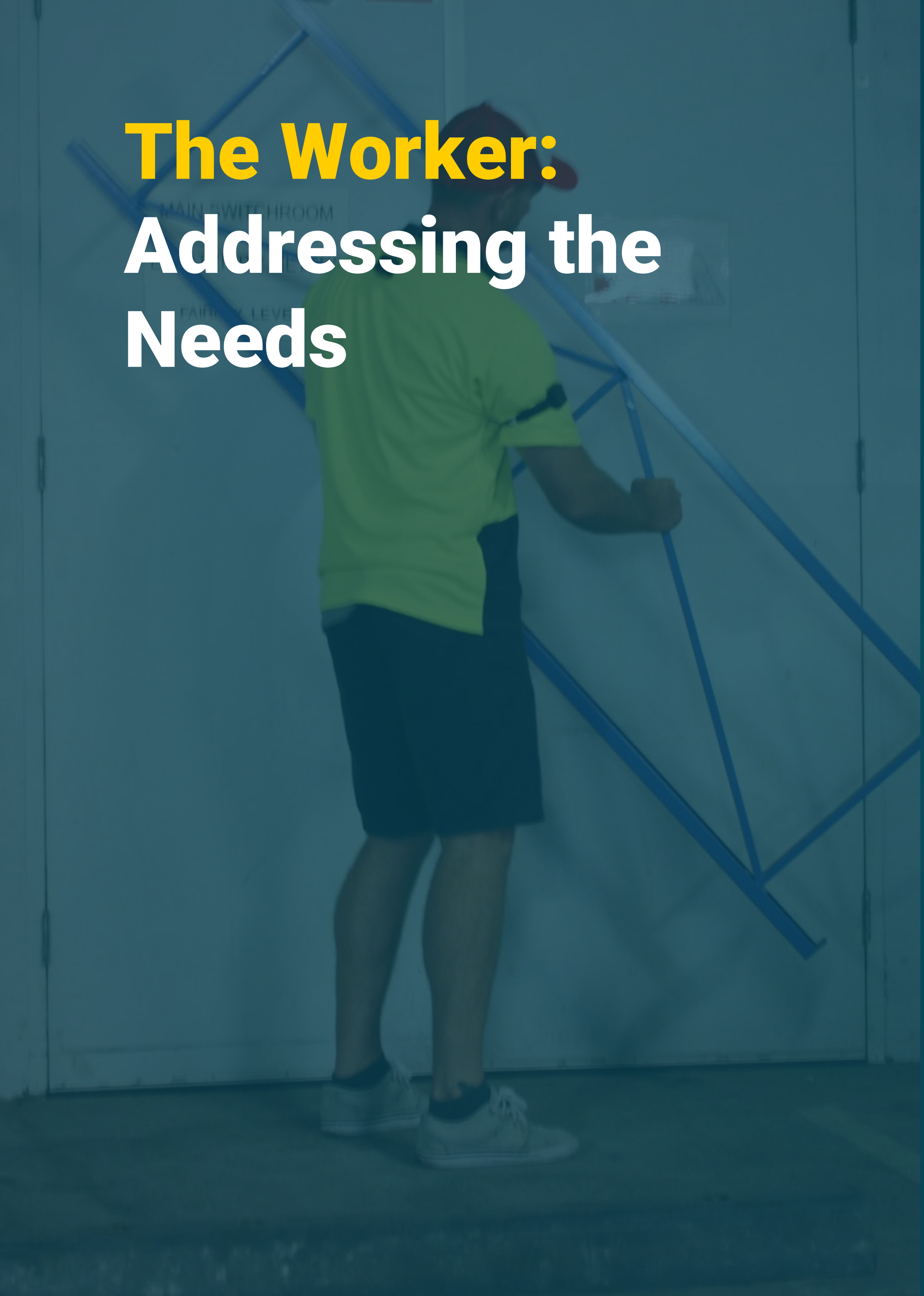
Research involving 1745 workers concluded that cumulative back loads assessed by video and force measurements are the most effective and identifying and reducing risk factors for low back pain. [28] Whilst the data collected from wearable tech is valuable at identifying the high load movements, it is of no use if you don't know what the worker was doing at that time. Therefore, we paired the data with video to enable the EHS professional to analyze the data in the most effective way.

Removing assumptions about injury risks

The most commonly reported biomechanical injury risk factors with the least reasonable evidence for causing work related musculoskeletal injuries include excessive repetition, awkward postures, and heavy lifting. [27] Data removes assumptions about injury risks. Different methods of performing tasks (with different manual handling aids) can be compared in an unbiased way using reliable data.

Establishing benchmarks

The method of performing a task with the lowest load can easily be established as the benchmark.[6, 22, 26, 36] This benchmark can then be used for training purposes (using the video for feedback), pre-employment screening, returning injured workers to full duties.



The Worker: Addressing the Needs

Worker engagement is key

Providing feedback to workers about the "risks" or "hazards" associated with their work tasks has a negative impact on workers. However, providing them with feedback using the same data, technology and terminology (load) as used with elite athletes increases their engagement. The data can also be used to gamify the injury prevention process through a points and rewards system. A "Participatory Ergonomics" approach (actively involving workers at identifying and reducing injury risks) has been proven to be effective at reducing the number of musculoskeletal injuries. [32]

Providing live feedback

The most effective way to change worker behavior is to provide them with feedback at the most relevant time - when they are performing their work tasks. This has been supported by research [40, 41] and through Bardavon trials with over 50 workers across 10 different industries (supported by AusIndustry).

Avoiding information overload

Behavior change theory outlines the need for information to be delivered in a timely way in appropriate amounts.[40, 41, 42] Constant feedback (live high load alerts) is only effective at changing worker behavior if it is delivered in appropriate amounts, which is why we recommend a maximum of 5 consecutive days before the live alerts become less effective.

Delivering safety training using Nudge Theory

Research has indicated that group education and training is ineffective at reducing injury risks. However, using Nudge Theory by sending through small amounts of training and educational content (modules) through a medium the workers regularly use (smartphones) is more effective at changing worker behaviour.[40, 41, 42] It's also more time and resource efficient compared to delivering face-to-face training.

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