The Impact of Pre-Employment Screening and Physical Testing on Workplace Injuries

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Workplace injuries are a growing concern. Due to the many possible causes, these injuries continue to happen everyday in a wide variety of workplace settings. Kinetisense has developed a screening tool to assess injury risk that is cost-effective, accurate, and portable. The use of this tool is one way to prevent workplace injuries from occurring in the first place.

THE PROBLEM

Workplace injuries are a major public health issue around the world, with an estimated 317 million occurring each year (1). In Canada and the United States, there were approximately 1,130,245 work-related injuries that occurred in 2018 alone (2). These injuries are not only costly to workers and their families, but also employers and the broader community. According to the National Safety Council, the estimated total cost of workplace injuries in the United States in 2019 was $171 billion (this includes the cost to the nation, employers, and individual workers) (3). The cost per injury was a staggering $42,000 (3).

For employers in particular, workplace injuries come with a number of direct and indirect costs. Costs that are tied directly to the injury are referred to as direct costs, and usually include workers' compensation payments, medical expenses, and costs for legal services (4). Indirect costs on the other hand are any additional, unexpected costs associated with the injury. These include costs related to lost productivity, training replacement employees, and repairing damaged equipment and property (4).

The most commonly reported workplace injuries are strains and sprains, cuts/open

wounds, contusions, fractures, and other chronic joint or muscle conditions (5, 6, 7). Out of the many possible causes, overexertion and slips, trips, and falls have been found to account for the majority of these injuries (8).

In the case of overexertion, injuries are often the result of prolonged and repetitive movement, as well as lifting, pushing, or carrying something that is too heavy (9). The areas of the body most commonly affected by overexertion-related injuries are the back, shoulders, and knees (9). In many instances, these injuries stem from asymmetries in muscle development and imbalances in flexibility and movement patterns. If a strength or flexibility imbalance is present, the less functional side is incapable of producing the same amount of force, which can lead to muscle, ligament, and joint injuries. This is especially true for lower back injuries. When the lower back is forced to bear an excessive load, it can lead to strains and sprains of the active and passive lumbar tissues, as well as intervertebral disc degeneration or herniation (10).

Slips, trips, and falls on the other hand happen for a number of different reasons. Specific hazards in the workplace environment such as uneven flooring, cluttered walkways, and poor lighting make it much more likely someone will slip, trip, or fall (11). There are also personal factors that can play a role. Age is one such factor that cannot be overlooked. In fact, work-related falls have been shown to be more common among older workers (12). Older adults are also at the greatest risk of falling and suffering a serious fall-related injury (13). This is due in large part to balance and gait impairments that are present in older individuals (14, 15). A consequence of falls of this nature is an increased risk of fractures, specifically hip fractures (16).

THE SOLUTION

Kinetisense uses an Intel d415 sensor, which has the capability to capture anywhere from 30 to 90 frames per second (fps) and is processed in real-time. This allows the system to accurately capture and measure quick, explosive movements.

Kinetisense has been designed to provide an affordable means of acquiring 3D joint tracking. The software itself provides real-time analysis and easy to understand reporting for motion capture. The real-time representation of human motion data and the increased inter and intra-examiner reliability in assessment separate Kinetisense from other movement analysis tools.

The 3D capture of joint and body-position replaces the need for wearable sensor technology that is both difficult to place on the body and time consuming. Wearable sensors also have issues with inter and intra-examiner accuracy and reproducibility in assessment, as placement of the sensors on the skin can vary and anatomical landmarking is often subjective.

ANALYSING RISK OF INJURY THROUGH KAMS

The Kinetisense Advanced Movement Screen (KAMS) is a 12-part functional movement screen that is able to identify an individual's risk of injury. The software is able to analyse asymmetries and restrictions in range of motion for key movements such as single leg hop and posture angel. Each movement is scored on a 12 point scale, which allows for injury risk to be quantitatively represented.

The system analyzes human biomechanics and the subsequent “compensatory movement patterns” in 3 planes (sagittal, frontal, transverse). The 3-4 minute comprehensive movement screen provides invaluable information on compensations and movements that may put the employee “at-risk” of injury.

The FPM (functional planar mapping) tool “maps” the joints and respective movement planes of dysfunction from the overall findings of the 12 movements. The customized FPM outputs provide valuable insights into the risk of injury and specific strategies for injury prevention.

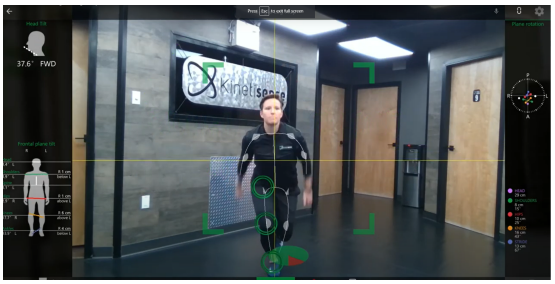

Figure 1.3. **Single Leg Hop Assessment Screen.** *In the Single Leg Hop Assessment screen, the user is able to see frontal and transverse plane information. The joints that are being assessed during the movement are highlighted with green circles.*

UNIVERSITY VALIDATION ON THE ACCURACY OF THE KINETISENSE SYSTEM

The Kinetisense markerless motion system and associated SDK have been validated for accuracy as a biomechanical analysis tool in a variety of studies. It has shown reliability in measurement and inter-reliability in assessment and reassessment.

A study by Harsted et al. entitled “The performance of two in-clinic markerless motion capture systems compared to a laboratory standard” found that Kinetisense showed good accuracy when compared to the Vicon marker-based system. This study concluded that the Kinetisense markerless system was “sufficiently similar to the laboratory standard” of the Vicon system (17).

A third party University study conducted at the University of Calgary compared the accuracy of the Kinetisense system to the Vicon research system. The study compared the accuracy of the Kinetisense markerless system to the Vicon research system and force plate technology.

This study concluded that “Kinetisense may be a valid alternative to expensive and cumbersome force plate or multi-camera motion analysis systems for clinical assessment. The objective scoring provided by the 3D tool improves upon current

clinical standards that rely on scoring sheets or subjective interpretation of 2D video. The ease of set-up and the quick turnaround of objective balance data allow the clinician to fully dedicate themselves to interacting with and assessing the patient. Instead of calibrating cameras, placing markers, and processing data the clinician can spend their time working with the patient to interpret the results, discuss their progress, and develop training plans."

A third party validation study conducted by Dr. Jon Doan from the University of Lethbridge compared the accuracy of the Kinetisense system to the Vicon research system. In this study, 24 healthy young adults performed 8 different actions, each to two different levels (specific normal range deflection, maximal deflection) and at one of two different clinically relevant camera-subject distances, inside the shared calibration volume of the Kinetisense and VICON Peak motion capture systems. Bland-Altman agreement analysis was used to compare perceived and maximum joint angles from the Kinetisense system and the VICON Peak.

The results of this study showed that the "Kinetisense measures are valid compared to VICON-Peak measures, based on Bland-Altman agreement analysis."

THE CONCLUSION

Given what is known about workplace injuries and the negative effects they can have, it is crucial that preventative measures such as pre-employment screening be implemented. Utilizing a tool such as KAMS will not only help prevent workplace injuries from occurring, it will also allow employers to ensure workers are fit to perform the tasks required of them while on the job. The Kinetisense system is also portable and easy to use, making it perfect for use in any workplace.

REFERENCES

1. Abdalla, S., Apramian, S. S., Cantley, L. F., & Cullen, M. R. (2017). Occupation and risk for injuries. In C. N. Mock, R. Nugent, O. Kobusingye, & K. R. Smith (Eds.), *Injury prevention and environmental health* (3rd ed., pp. 97–132). The World Bank.
2. National Safety Council. (n.d.). *Work-related nonfatal injuries around the world*. https://injuryfacts.nsc.org/international/work-related-injuries-around-the-world/work-related-nonfatal-injuries-around-the-world/
3. National Safety Council. (n.d.). *Work injury costs*. Retrieved November 17, 2021, from https://injuryfacts.nsc.org/work/costs/work-injury-costs/
4. Occupational Safety and Health Administration. (n.d.). *Business case for safety and health: Costs*. Retrieved November 17, 2021, from https://www.osha.gov/businesscase/costs
5. Government of Alberta. (2021). *Workplace injury, illness and fatality statistics: Provincial summary 2019*. Retrieved from https://open.alberta.ca/dataset/4fb90b70-7660-4553-98fc-a59574f8fd5a/resource/5e959e64-50f5-41d4-b5a7-c5db093835f1/download/lbr-2019-workplace-injury-illness-fatality-provincial-summary-2019.pdf
6. U.S. Bureau of Labor Statistics. (2020). *Employer-reported workplace injuries and illnesses: 2019*. Retrieved from https://www.bls.gov/news.release/archives/osh_11042020.pdf
7. Australian Bureau of Statistics. (2018, October 30). *Work-related injuries*. Retrieved November 17, 2021, from https://www.abs.gov.au/statistics/labour/earnings-and-work-hours/work-related-injuries/jul2017-jun2018
8. National Safety Council. (n.d.). *Top work-related injury causes*. Retrieved November 17, 2021, from https://injuryfacts.nsc.org/work/work-overview/top-work-related-injury-causes/
9. National Safety Council. (n.d.). *Overexertion and bodily reaction*. Retrieved November 17, 2021, from https://injuryfacts.nsc.org/work/safety-topics/overexertion-and-bodily-reaction/
10. Lamers, E. P., Yang, A. J., & Zelik, K. E. (2017). Feasibility of a biomechanically-assistive garment to reduce low back loading during leaning and lifting. *IEEE Transactions on Biomedical Engineering*, *65*(8), 1674-1680. https://doi.org/10.1109/tbme.2017.2761455
11. Canadian Centre for Occupational Health and Safety. (2018, June 4).

Prevention of slips, trips and falls. Retrieved November 17, 2021, from https://www.ccohs.ca/oshanswers/safety_haz/falls.html

12. Socias-Morales, C. M., Chaumont Menéndez, C. K., & Marsh, S. M. (2018). Fatal work-related falls in the United States, 2003-2014. *American Journal of Industrial Medicine*, *61*(3), 204–215. https://doi.org/10.1002/ajim.22810
13. World Health Organization. (2021, April 26). *Falls*. https://www.who.int/news-room/fact-sheets/detail/falls
14. Salzman, B. (2010). Gait and balance disorders in older adults. *American Family Physician*, *82*(1), 61-68. https://www.aafp.org/afp/2010/0701/p61.html
15. Black S.E., Maki B.E., & Fernie G.R. (1993). Aging, imbalance and falls. In J.A. Sharpe & H.O. Barber (Eds.), *The vestibulo-ocular reflex and vertigo* (pp. 317-335). Raven Press.
16. Fuller, G. F. (2000). Falls in the elderly. *American Family Physician*, *61*(7), 2159-2168. https://www.aafp.org/afp/2000/0401/p2159.html#afp20000401p2159-b15
17. Harsted, S., Kawchuk, G., Guan, R., Skallgård, T., Hesby, B. B., Boyle, E., & Kjaer, P. (2019). *The performance of two in-clinic markerless motion capture systems compared to a laboratory standard*. In *WFC/ECU Conference: Global Opportunities in Spine Care*.