

A short History of Goldilocks Work

Goldilocks Work is a conceptual framework that was developed through a collaboration of Professors Leon Straker (Curtin University, Perth, Australia), Svend Erik Mathiassen (University of Gävle, Sweden) and Andreas Holtermann (National Research Centre for the Working Environment, Copenhagen, Denmark). They drew on their diverse professional backgrounds and research experience to bring together key concepts, including rehabilitation, variation, and physical activity paradox, to provide a paradigm for the conundrum of how work should be designed to enhance health and capacity.

Rehabilitation - physical loading is good, no physical loading is not good

Prior to 2000, Straker had been working clinically as a physiotherapist, where the dominant strategy to improve health was through the prescription of physical loading (exercises) to help improve physical capacity in terms of fitness and coordination. The rapid loss of physical capacity when physical loading was substantially reduced was recognised as a major health risk. For example, when patients were bed-bound or arms were kept still in splints, a major aim of rehabilitation was to increase capacity as quickly as possible through increasing appropriate physical loading.

In the 2000s, Straker became increasingly aware of the contrasting approaches to health, especially musculoskeletal disorders, of physiotherapy clinical management and occupational risk management. Where clinical management was prescribing increasing physical loading to patients, occupational management was recommending reducing physical loading as much as possible for workers. This reduction of physical load paradigm was prevalent in examination of musculoskeletal risks associated with a range of activities including use of computers (Straker, Burgess-Limerick et al. 2008) and manual handling (Straker 2002) and formed the basis of occupational health and safety policy and regulations in many jurisdictions. These contrasting approaches were evidence not only for adult workers, but also for children (Straker, Burgess-Limerick et al. 2008, Straker, Pollock et al. 2009).

Variation - time pattern is an important aspect of physical loading

Prior to 2000 Mathiassen, having a background in exercise physiology, had been researching physical variation in an occupational context, addressing issues such as how to measure variation, how to obtain variation at work, and what physiologic effects could be expected from different initiatives promoting variation, such as introducing breaks or changing tasks (Mathiassen 1993, Mathiassen and Winkel 1996). He also developed the now widely used Exposure Variation Analysis method to simultaneously express time and intensity of loading (Mathiassen and Winkel 1991). The dominant

concept at that time was that risk could be minimised by reducing the physical loading as much as possible, including having substantial periods of no muscle activity. In a challenge to this “less is better” concept, Mathiassen proposed that variation of the physical loading, i.e. its change over time, was a major determinant of health and capacity (Mathiassen 2006). Thus, in some occupations, increases in physical loading could be just as helpful as decreases in physical loading would be in others, and workers with an ability to perform a repetitive task with more variation would be less at risk than workers with a more stereotyped motor behaviour (Mathiassen, Moller et al. 2003).

In the 2000s, Straker and Mathiassen started collaborations based around variation in physical loads for adults and children using computers. This consolidated their developing views around the flaws in the dominant concept of risk reduction being best obtained by physical load exposure reduction and led to their publication of a seminal paper arguing for a need to increase physical loading in many modern work situations (Straker and Mathiassen 2009).

Physical Activity Paradox - other aspects of physical loading are also important

During the 2000s, Holtermann moved from research primarily on exercise science and leisure time physical loading (activity) to occupational physical load (activity) research. He developed a fascination for the question: “how can blue collar workers (e.g. construction, cleaners and elder care) with very high physical activity at work have such poor fitness and health?”

The dominant concept in physical activity and cardiovascular and all-cause mortality research was that physical activity was universally a good thing for health. Indeed many international and national guidelines had been developed and promoted since the early evidence from studies in the 1950s (Morris, Heady et al. 1953) and 1970s (Paffenbarger, Laughlin et al. 1970). He then started researching the impact of physical loading at work and mortality and cardiovascular disease outcomes. The evidence from several of his studies was shocking, suggesting physical loading at work may have a negative impact on health (Holtermann, Mortensen et al. 2009, Holtermann, Burr et al. 2012, Holtermann, Marott et al. 2012), rather than a positive impact as had been consistently seen in the studies of leisure-time physical activity. He coined the term ‘physical activity paradox’ to capture this (Holtermann, Hansen et al. 2012).

In the 2010s, Straker, Mathiassen and Holtermann began collaborations based on a common conviction that the nature of physical loading (including the time pattern, intensity and type of activity) is a key issue in understanding the contrasting effects on health and capacity observed in different rehabilitation practices, in different jobs, and at work versus during leisure.

Replacing one type of physical loading with another does not necessarily improve health

Concurrently during the 2010s, there was a rapid increase in research on sedentary behaviour with a particular focus on societal and technological trends facilitating increased sitting at leisure, during commuting and at work. Concepts developed for leisure-time physical activity were repurposed to also focus on sitting at work, with substantial evidence quickly amassed to support replacing sitting with standing (Straker, Coenen et al. 2016). Interestingly, this contrasted the occupational policies and regulations developed prior to the 1990s when prolonged occupational standing was seen as a major risk and strategies to promote sitting at work were developed (Coenen, Gilson et al. 2017). This reversal of what was considered a desirable occupational physical load illustrated the fallacy of simply replacing one exposure entirely with another exposure as it may just replace one set of negative outcomes with other negative outcomes (Coenen, Willenberg et al. 2018).

A 'just right' balance is needed

Thus, the diverse perspectives Straker, Mathiassen and Holtermann brought to their collaboration fostered the realisation that a new paradigm was needed, to replace the previous concepts which were proving to be ineffective such as “less is better” and “exercise around work”. The new paradigm says that a ‘just right’ balance is needed in physical loading during productive tasks to enhance health and capacity; physical loads need to be sufficient to stimulate cardiometabolic and/or neuromusculoskeletal responses *and* opportunities for recovery need to be adequate. This was contrasted to the limited sustainability of interventions developed to encourage “exercise around work”, such as walking during breaks from productive work tasks.

Straker proposed the use of the Goldilocks fairytale as a way of capturing the essence of this emerging concept and together they refined the concept through discussion papers. They drew together the threads of rehabilitation, variation and physical activity paradox, creating a paradigm to enhance health and capacity through productive work (Straker, Mathiassen et al. 2018). Whilst their initial focus was on physical aspects of work, they recognised that the Goldilocks paradigm could also be applied to other aspects of job design such as mental demands and social conditions. They postulated that use of this new paradigm could address several of the major societal challenges of our time, such as socioeconomic inequities, occupational health burden, and the impact of multi-morbidity and an ageing population on productivity (Holtermann, Mathiassen et al. 2019).

References

- Coenen, P., N. Gilson, G. Healy, D. Dunstan and L. Straker (2017). "A qualitative review of existing national and international occupational safety and health policies relating to occupational sedentary behaviour." *Applied Ergonomics* **60**: 320-333.
- Coenen, P., L. Willenberg, S. Parry, J. Shi, L. Romero, D. Blackwood, C. Maher, G. Healy, D. Dunstan and L. Straker (2018). "Associations of occupational standing with musculoskeletal symptoms - a systematic review with meta-analysis." *British Journal of Sports Medicine* **52**(3): 176-183.
- Holtermann, A., H. Burr, J. Hansen, N. Krause, K. Sogaard and O. Mortensen (2012). "Occupational physical activity and mortality among Danish workers." *International Archives of Occupational and Environmental Health* **85**(3): 305-310.
- Holtermann, A., J. Hansen, H. Burr, K. Sogaard and G. Sjogaard (2012). "The health paradox of occupational and leisure-time physical activity." *British Journal of Sports Medicine* **46**(4): 291-295.
- Holtermann, A., J. Marott, K. Gyntelberg, K. Sogaard, P. Suadicani, O. Mortensen, E. Prescott and P. Schnohr (2012). "Occupational and leisure time physical activity: risk of all-cause mortality and myocardial infarction in the Copenhagen City Heart Study." *BMJ Open* **2**(1): e000556.
- Holtermann, A., S. Mathiassen and L. Straker (2019). "Promoting health and physical capacity during productive work: The Goldilocks Principle." *Scandinavian Journal of Work, Environment and Health* **45**(1): 90-97.
- Holtermann, A., O. Mortensen, H. Burr, K. Sogaard, K. Gyntelberg and P. Suadicani (2009). "The interplay between physical activity at work and during leisure time--risk of ischemic heart disease and all-cause mortality in middle-aged Caucasian men." *Scandinavian Journal of Work, Environment and Health* **35**(6): 466-474.
- Mathiassen, S. (1993). "The influence of exercise/rest-schedule on the physiological and psychophysical response to isometric shoulder-neck exercise." *European Journal of Applied Physiology* **67**: 528-539.
- Mathiassen, S. (2006). "Diversity and variation in biomechanical exposure: what is it, and why would we like to know?" *Applied Ergonomics* **37**: 419-427.
- Mathiassen, S., T. Moller and M. Forsman (2003). "Variability in mechanical exposure within and between individuals performing a highly constrained industrial work task." *Ergonomics* **46**: 800-824.

Mathiassen, S. and J. Winkel (1991). "Quantifying variation in musculoskeletal load using exposure-vs-time data." *Ergonomics* **34**: 1455-1468.

Mathiassen, S. and J. Winkel (1996). "Physiologic comparison of three interventions in light assembly work: reduced work pace, increased break allowance and shortened working days." *International Archives of Occupational and Environmental Health* **68**: 94-108.

Morris, J., J. Heady, P. Raffle, C. Roberts and J. Parks (1953). "Coronary heart-disease and physical activity of work." *Lancet* **265**(6796): 1111-1120.

Paffenbarger, R., M. Laughlin, A. Gima and R. Black (1970). "Work activity of Longshoremen as related to death from coronary Heart disease and stroke." *New England Journal of Medicine* **282**: 1109-1114.

Straker, L., R. Burgess-Limerick, C. Pollock, J. Coleman, R. Skoss and B. Maslen (2008). "Children's posture and muscle activity at different computer display heights and during paper information technology use." *Human Factors* **50**(1): 49-61.

Straker, L., R. Burgess-Limerick, C. Pollock, K. Murray, K. Netto, J. Coleman and R. Skoss (2008). "The impact of computer display height and desk design on 3D posture during information technology work by young adults." *Journal of Electromyography and Kinesiology* **18**(2): 336-349.

Straker, L., P. Coenen, D. Dunstan, N. Gilson and G. Healy (2016). *Sedentary Work - Evidence on an Emergent Work Health and Safety Issue*. Canberra, Safe Work Australia.

Straker, L., S. Mathiassen and A. Holtermann (2018). "The 'Goldilocks Principle': designing physical activity at work to be 'just right' for promoting health." *British Journal of Sports Medicine* **52**(13): 818-819.

Straker, L. and S. E. Mathiassen (2009). "Increased physical workloads in modern work - a necessity for better health and performance?" *Ergonomics* **52**(10): 1215-1225.

Straker, L., C. Pollock, J. Piek, R. Abbott, R. Skoss and J. Coleman (2009). "Active-input provides more movement and muscle activity during electronic game playing by children." *International Journal of Human-Computer Interaction* **25**(8): 713-728.

Straker, L. M. (2002). "A review of research on techniques for lifting low-lying objects: 1 - Criteria for evaluation." *Work* **19**(1): 9-18.