Forward bending of the trunk during work and leisure using Exposure Variation Analysis (EVA) among male manufacturing workers in Denmark

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1. Introduction
The quantification of variation in relation to exposure is important in the analysis of occupational biomechanics (Mathiassen & Winkel, 1991) and should be considered for both work and leisure (Villumsen et al., 2014). For this purpose Exposure Variation Analysis (EVA) has been suggested as a computational framework to quantify variation at work (Mathiassen & Winkel, 1991). The purpose of this study was to develop and apply EVA on diurnal recordings of physical activity focusing on forward bending during both work and leisure.

2. Practice innovation
This studied population is based on a subsample of male manufacturing workers (n=32 males, mean age ±SD 26.1±4.0 years) with similar duration of working (7.9±0.9 h) and leisure hours (6.1±0.8 h) during a working day from the field study called ‘Danish Physical ACTivity cohort with Objective measurements (Dphacto)’ (Jørgensen et al., 2013). Two triaxial accelerometers (ActiGraph GT3X+, ActiGraph LLC, Pensacola, FL, USA) were used to detect trunk inclination and body posture.

In this study all samples of the selected periods of trunk inclination, with respect to upright standing posture as the reference position, were categorized in intervals of [<5, 5-10, 10-20, 20-40, 40-80> and >80 deg.] and time categories of [0-3, 3-7, 7-15, 15-31, ≥31 s]. This resulted in matrices in which each element represents an accumulated elapsed time that the trunk inclination lies uninterruptedly in an interval for a determined time category shown above. Thus, 5 levels along the time axis and six levels along the amplitude axis were generated. The centroid of the map 5x6 plane was extracted, providing information about the general tendency towards a displacement of exposure into the determined intervals and time categories (Samani, Holtermann, Sogaard, & Madeleine, 2009). Additionally, the standard deviation of the elements of EVA matrix was calculated (EVA_SD) and the elements of EVA matrix were divided by their total sum and then Shannon entropy of the obtained array was computed (EVA_ENT).

A repeated measured ANOVA (RM) was used to reveal the difference of exposure profiles in work and leisure time activity of the manufacturing workers in terms of i) (EVA_ENT), ii) (EVA_SD) matrix, iii) the centroid (EVA_centroid) of the EVA layout along the time (EVA_CTm) and the amplitude (EVA_Cam).

3. Findings
The EVA_SD during work was significantly larger than during leisure, 510.4±201.4 s vs. 158.7±79.8 s, respectively (\(F=78.966, p<0.001\)). Furthermore, the EVA_CTm was significantly smaller during leisure compared to work, 2.2±0.3 vs. 2.4±0.4, respectively (\(F=13.023, p=0.001\)). No significant differences between work and leisure was found in the EVA_ENT or in the EVA_CGAm.

4. Discussion
This study showed larger values in the EVA_SD of forward bending during work compared to leisure. This indicates that the manufacturing workers had a more variable trunk inclination pattern during leisure compared to work. Similarly, the EVA_CGTm was smaller during leisure compared to work, indicating that the workers stayed with the trunk forward bended for shorter duration of time during leisure.

This study revealed for the first time that the EVA enables detection of differences in physical exposure during work and leisure. That is, the physical exposure pattern in leisure time is more variable than the exposure pattern at work. Having the contrasting health outcomes of physical activity (i.e. forward
bending) at work and leisure in mind, this supports previous suggestions that a more variable pattern of exposure may be beneficial when addressing forward bending in relation to the intensity of low back pain (Villumsen et al., 2014).

References


