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A new approach to consider 3D angles in eva

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A NEW APPROACH TO CONSIDER 3D ANGLES IN EVA

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INTRODUCTION

The development of new wireless sensors such as IMUs now allows the monitoring of workers' posture in the field giving precious information on their postural exposure. Time series of postural angles can be recorded in 3D with unprecedented accuracy [1]. Exposure Variation Analysis (EVA) adds information on how much time is spent within a given range of angle and duration. In the case of the trunk, it is widely accepted that trunk asymmetry combined with flexion increases risk of injury to the spine. However current methods such as EVA consider only one angle at the time, while the three angle time series provide the 3D posture at each instant. Therefore, the question raised in this abstract is: how can we better represent the 3D postural exposure of workers, and create summary indices of postural exposure that take into account coupling between angles.

METHODS

Data were collected from 14 daycare workers, looking after infants or toddlers, during the morning of their shift (~3 hours). A dosimeter with two IMU sensors located on the spine at T1 and S1(sacrum) levels was used and the three relative angles between these two levels –flexion-extension, lateral bending and torsion- were calculated for the duration of the collection[2].

Illustration of asymmetry: Asymmetry was considered to exist when either trunk lateral bending or torsion were larger than a given threshold. After considering several EVA options, the consensus went to the following. A modified EVA flexion graph was created in which: a) the classes for posture (angles) and duration were taken from the flexion EVA graph, b) the bars height was split into two colours, the upper part of which representing the percent time spent in asymmetry for the data in this bar, the lower part the time spent in symmetric posture (Fig. 1).

Postural exposures indices. Our reflection was based on the following considerations: a) the range of trunk flexion is large, and its magnitude directly related to spinal loads, b) static postures, particularly awkward ones, increase risk of spinal damage, c) asymmetric postures also increase risk of damage, but c) ranges of lateral bending and torsion are smaller and more difficult to measure than range of flexion and there are no accepted thresholds for them.

We chose to summarize postural exposure using three dimensions: amplitude of flexion, duration that postures are maintained, and percentage of time spent in asymmetry. Thus we propose the following measures: Pos and Dur indices (X and Y coordinates of the "center of mass" of the EVA) for Flexion with or without asymmetry (lateral bending or torsion > 20º), and percent time spent in asymmetry.

RESULTS AND DISCUSSION

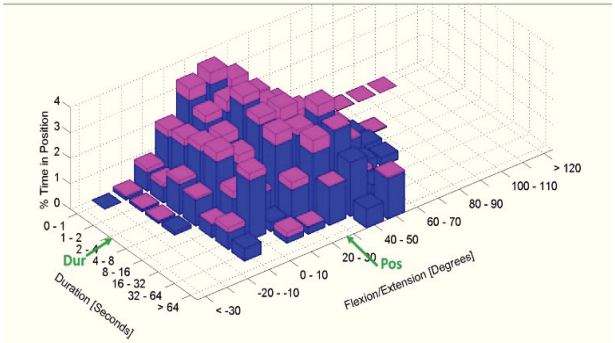

Figure 1: Percent of total time with (pink) or without (blue) asymmetry (lateral bending or torsion > 20º) at various flexion angles and durations for one subject (infants), Pos =6.7 (20º - 30º), Dur =3.0 (2 - 4 s) and 12% of total time spent in asymmetry.

Pos and Dur indices were used by previous studies for postural data and showed they could discriminate between conditions [3]. Here, percent of time spent in asymmetry had mean values of 7.7% (SD 4.5%) for the infant group (n=5) and of 18.9% (SD 16.5%) for the toddler group (n=7). This suggests that workers looking after toddlers spend a larger percentage of their time in asymmetric posture than those working with infants, and should be confirmed on more subjects. Results also showed that time spent in torsion > 20º was smaller than time spent in lateral bending > 20º for most subjects.

CONCLUSIONS

This paper proposes a novel approach to take asymmetry and coupling of angles in different planes in consideration in evaluating postural exposure. More field research is necessary to determine meaningful thresholds of risk for these indices.

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