Journal of Biomechanics 44 (2011) 2369–2375

Contents lists available at ScienceDirect

Journal of Biomechanics

journal homepage: www.elsevier.com/locate/jbiomech
www.JBiomech.com

Estimation of low back moments from video analysis: A validation study

Pieter Coenen [a,b], Idsart Kingma [a,b], Cécile R.L. Boot [b,c], Gert S. Faber [a,d,e], Xu Xu [e], Paulien M. Bongers [b,f], Jaap H. van Dieën [a,*]

[a] Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, Van der Boechorststraat 9, 1081 BT Amsterdam, The Netherlands
[b] Body@Work, Research Center on Physical Activity, Work and Health, The Netherlands
[c] EMGO Institute for Health and Care Research, Department of Public and Occupational Health, VU University Medical Center, Amsterdam, The Netherlands
[d] Department of Environmental Health, Harvard School of Public Health, 665 Huntington Avenue, Boston, MA 02115, USA
[e] Liberty Mutual Research Institute for Safety, 71 Frankland Road, Hopkinton, MA 01748, USA
[f] TNO Healthy Living, Hoofddorp, The Netherlands

ARTICLE INFO

Article history:
Accepted 4 July 2011

Keywords:
Low back loading
Lifting
Low back pain
Video analysis
Posture matching

ABSTRACT

This study aimed to develop, compare and validate two versions of a video analysis method for assessment of low back moments during occupational lifting tasks since for epidemiological studies and ergonomic practice relatively cheap and easily applicable methods to assess low back loads are needed. Ten healthy subjects participated in a protocol comprising 12 lifting conditions. Low back moments were assessed using two variants of a video analysis method and a lab-based reference method. Repeated measures ANOVAs showed no overall differences in peak moments between the two versions of the video analysis method and the reference method. However, two conditions showed a minor overestimation of one of the video analysis method moments. Standard deviations were considerable suggesting that errors in the video analysis were random. Furthermore, there was a small underestimation of dynamic components and overestimation of the static components of the moments. Intraclass correlations coefficients for peak moments showed high correspondence (>0.85) of the video analyses with the reference method. It is concluded that, when a sufficient number of measurements can be taken, the video analysis method for assessment of low back loads during lifting tasks provides valid estimates of low back moments in ergonomic practice and epidemiological studies for lifts up to a moderate level of asymmetry.

1. Introduction

As low back pain (LBP) in society is associated with high social suffering and costs (Lambeek et al., 2011), it is important to consider risk factors involved. Associations between physical risk factors and the occurrence of LBP have been reported extensively with lifting, twisting, bending and whole body vibrations being the most commonly reported ones (Lotters et al., 2003; Wai et al., 2010).

Although posture and force measurements and subsequent biomechanical analyses can provide valid and reliable estimates of back load during occupational handling (Kingma et al., 1996), such measurements are time and money consuming and can hardly be used outside the laboratory setting for epidemiological studies. Accordingly, research has focused on less costly (with respect to time and money) low back load assessment methods, which can be brought into the work place easily. Direct observation combined with simple measurements (i.e. load distances) was shown to provide reasonable estimates of low back loads during lifting, although systematic underestimation of loads occurred, possibly due to neglecting segment dynamics (van Dieen et al., 2010). Other efforts focused on video analysis methods (Hsiang et al., 1998; Chang et al., 2003; Sutherland et al., 2008; Xu et al., in press) by assessing body orientations based on observations of selected key video frames. These methods provided acceptable kinematic accuracy (Neumann et al., 2001; Chang et al., 2010; Xu et al., in press). Furthermore, quasi-static biomechanical calculation using these kind of models showed small but significant errors in peak (Hsiang et al., 1998; Chang et al., 2003) and cumulative (Sutherland et al., 2008) lumbar compression forces.

Although promising, these methods suffer from some shortcomings. Segment orientations were based on crude categorizations (Hsiang et al., 1998; Sutherland et al., 2008), segment dynamics were not taken into account (Sutherland et al., 2008) or only movements in the sagittal plane could be determined (Chang et al., 2003; 2010). Therefore, better posture matching strategies should be investigated.

The aim of the present study was thus to develop, compare and validate (against a reference laboratory-based 3D inverse dynamics method) two versions of a video analysis method for estimation of mechanical back load (expressed in peak and mean moments) during occupational lifting tasks. With this method, we aim to

* Corresponding author. Tel.: +31 20 5988501; fax: +31 20 5988529.
E-mail address: j.vandieen@fbw.vu.nl (J.H. van Dieën).

0021-9290/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jbiomech.2011.07.005