ELSEVIER

CrossMark

The Spine Journal 14 (2014) 2373–2383

THE SPINE JOURNAL

Clinical Study

Individual and contextual characteristics as determinants of sagittal standing posture: a population-based study of adults

Fábio Araújo, MSc[a,b,*], Raquel Lucas, PhD[a,b], Nuno Alegrete, MD[c,d], Ana Azevedo, MD, PhD[a,b,c], Henrique Barros, MD, PhD[a,b]

[a]*Institute of Public Health – University of Porto (ISPUP), Rua das Taipas, 135-139, 4050-600 Porto, Portugal*

[b]*Department of Clinical Epidemiology, Predictive Medicine and Public Health, University of Porto Medical School, Al. Prof. Hernâni Monteiro, 4200-319 Porto, Portugal*

[c]*Centro Hospitalar São João, Al. Prof. Hernâni Monteiro, 4200-319 Porto, Portugal*

[d]*Department of Surgery, University of Porto Medical School, Al. Prof. Hernâni Monteiro, 4200-319 Porto, Portugal*

Received 6 June 2013; revised 29 October 2013; accepted 17 January 2014

Abstract

BACKGROUND CONTEXT: Sagittal standing posture is associated with musculoskeletal symptoms and quality of life. However, the frequency and determinants of suboptimal sagittal alignment outside the clinical context remain to be clarified.

PURPOSE: To estimate the association of sociodemographic, anthropometric, and behavioral characteristics with sagittal standing posture among adults from the general population.

STUDY DESIGN: Cross-sectional evaluation of a population-based sample.

PATIENT SAMPLE: As part of the EPIPorto study, 489 adults were assessed during 2005 to 2008.

OUTCOME MEASURES: Individual spinopelvic parameters were measured. Additionally, participants were classified into one of four types of sagittal postural patterns (Roussouly classification: Types 1, 2, and 4 corresponding to nonneutral postures and Type 3 to a neutral posture).

METHODS: Spinopelvic parameters were recorded from 36-inch sagittal radiographs obtained in free-standing posture. Age, sex, education, occupation, body mass index (BMI), waist circumference, total physical activity, leisure time physical activity, time spent in sitting position, smoking status, and tobacco cumulative exposure were collected. Individual parameters and patterns of sagittal posture were compared across categories of participants' characteristics.

RESULTS: Older age, lower educational level, blue collar occupation, and overall and central obesity were associated with increased sagittal vertical axis and pelvic tilt/pelvic incidence ratio. Taking the neutral postural pattern (Type 3) as reference for the outcome in a multinomial regression model, independently of age, sex, education, total physical activity, and smoking status, overweight adults had higher odds of Type 2 (odds ratio [OR]=1.92; 95% confidence interval [CI]: 1.13–3.27) and Type 4 (OR=2.13; 95% CI: 1.16–3.91) postural patterns in comparison with normal weight subjects. Overall and central obesity were positively related with Type 1 postural pattern (OR=6.10, 95% CI: 1.52–24.57 and OR=3.54, 95% CI: 1.13–11.11, respectively). There was also a weak direct association between female sex and Type 1 postural pattern. Regarding behavioral factors, subjects with total physical activity above the first third exhibited all nonneutral postural patterns less frequently, and current smokers were more likely to present a Type 4 postural pattern.

CONCLUSIONS: Higher BMI and central obesity were important potential determinants of nonneutral posture among adults from the general population. Future research should investigate the

FDA device/drug status: Not applicable.

Author disclosures: ***FA:*** Grant: National Foundation for Science and Technology (F, Paid directly to institution). ***RL:*** Grant: Fundação para a Ciência e a Tecnologia (F, Paid directly to institution). ***NA:*** Fundação para a Ciência e a Tecnologia (F, Paid directly to institution). ***AA:*** Fundacão para a Ciência e a Tecnologia (F, Paid directly to institution). ***HB:*** Fundacão para a Ciência e a Tecnologia (F, Paid directly to institution).

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

* Corresponding author. Instituto de Saúde Pública da Universidade do Porto, Rua das Taipas, 135-139, 4050-600 Porto, Portugal. Tel.: +351 22206 1820; fax: +351 22206 1821.

E-mail address: fabio.araujo@ispup.up.pt (F. Araújo)

http://dx.doi.org/10.1016/j.spinee.2014.01.040

potential effectiveness of overweight prevention and management in avoiding sagittal misalignment conditions.

Keywords: Posture; Spine; Pelvis; Radiography; Obesity; Population survey

Introduction

Sagittal standing spinopelvic alignment is a known determinant of musculoskeletal symptoms and quality of life in samples of patients with diverse spinal conditions [1–4]. Among the complex set of parameters that comprise standing posture, sagittal balance and pelvic tilt were identified as those most strongly associated with pain and physical disability [2,3].

Suboptimal sagittal alignment and its attributable disability are among the most frequent reasons for adults to seek health care. In 2010, musculoskeletal spinal conditions were accountable for the loss of 116,704 disability-adjusted life years worldwide, and this indicator almost duplicated in a 10-year time frame [5]. Low back pain alone—whose patients frequently exhibit smaller lumbar lordosis and a more vertical sacrum in clinical practice [6–8]—globally accounts for the leading number of years in which individuals live with disability [5].

Conservative and surgical treatments attempting to change the prognosis of sagittal misalignment spinal conditions are available [9–12], but these approaches are commonly saved for relatively advanced stages of the disease course. Additionally, knowledge on primary prevention strategies to avoid suboptimal sagittal alignment is clearly lacking. For such evidence to be produced, research on the causes of sagittal misalignment is warranted.

The development of a suboptimal sagittal posture is a complex occurrence, reflecting exposure to diverse interrelated factors, both at the individual and contextual levels. In previous studies of adult samples selected based on the absence of clinically relevant orthopedic conditions, sagittal spinopelvic alignment was found to be associated with age [13–16], sex [13,17,18], and body mass index (BMI) [19]. However, even this small group of potential determinants has not been consensual and the possible link between contextual variables and upstream sagittal standing posture phenotypes has been rarely assessed.

Furthermore, previous evidence on standing alignment has originated from highly selected samples of patients or healthy subjects, probably excluding an important fraction of population variability and limiting the generalizability of findings regarding the general adult population.

Recently, it was suggested that the study of extreme sagittal alignment etiology should be based on overall postural patterns rather than on single alignment parameters [18,20,21]. Nevertheless, postural patterns have seldom been researched, namely regarding their population frequency and potential determinants.

Identifying individual and contextual determinants of nonneutral sagittal standing posture among adults from the general population may allow for the recognition of groups that will be more likely to develop sagittal posture-related diseases and for the development of primary prevention strategies focusing on modifiable determinants.

Using data from a population-based sample of adults, our aim was to estimate the association of sociodemographic, anthropometric, and behavioral characteristics with sagittal posture, considering both individual alignment parameters and standing postural patterns.

Participants and methods

Participants were evaluated as part of the EPIPorto cohort study that comprises a sample of Portuguese adults, living in the city of Porto. As previously described [22], recruitment was performed in 1999 to 2003 by random digit dialing using households as the sampling frame. In each household identified, a resident aged 18 years or more was randomly selected for evaluation without replacement if a refusal occurred. A participation proportion of 70.0% was initially achieved and 67.7% of subjects were reevaluated during 2005 to 2008. Of these, a subsample of 518 subjects consecutively evaluated was invited to undergo X-ray examination. Subjects were excluded if they had instrumentation of the spine (n=2), hip arthroplasty (n=10), and inflammatory spinal arthropathies (n=17). The final sample included 489 subjects that were evaluated by trained health professionals after a standardized protocol. The sample size allowed for the estimation of a 5% prevalence of Type 1 postural pattern, with 2% precision and 80% power, at a 95% confidence level.

The ethics committee of Hospital de São João approved the study protocol. All participants gave written informed consent to participate in the study.

Sagittal spinopelvic alignment

Radiographic data collection consisted of 36-inch standing sagittal radiographs obtained in free-standing posture, performed by one of eight radiology technicians according to routine operating procedures. All radiographic films were digitized using a Vidar scanner (Vidar Systems Corp., Herndon, VA, USA) with 75 dpi resolution and 12 gray levels and then analyzed using a spine dedicated software with a precision of 0.1° in angles and 0.1 mm in distances (Sectra Imtec AB, Linköping, Sweden). Radiographic spinopelvic measures were recorded by a single physical therapist who was trained to the effect and remained blind regarding sociodemographic, anthropometric, and behavioral participants' characteristics.