CLASSIFICATION OF SAGITTAL THORACO-LUMBO-PELVIC ALIGNMENT OF THE ADOLESCENT SPINE IN STANDING USING TWO-DIMENSIONAL PHOTOGRAPHIC IMAGES AND THE ASSOCIATION WITH BACK PAIN

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Purpose
To identify subgroups of adolescents based upon standing sagittal thoraco-lumbo-pelvic alignment and investigate the association with back pain.

Relevance
Identification of subgroups of adolescents with different sagittal plane spinal posture will enable a more thorough understanding of the relationship between standing posture and spinal pain.

Methods
Sagittal thoracolumbar posture was assessed in 235 adolescents, of mean age 14.0 years, enrolled in a larger cohort study. Retro-reflective markers were placed on the C7 and T12 spinous processes, anterior superior iliac spine (ASIS), greater trochanter and lateral malleolus by one examiner. Lateral photographs were taken after each adolescent was asked to stand normally looking straight ahead. Marker points were digitised using the PEAK motion analysis system and three angular measures describing thoraco-lumbo-pelvic alignment were calculated. Subjects gender, height and weight were recorded and adolescents completed a questionnaire which included the question 'Have you ever had back pain' (yes or no).

Analysis
K-means cluster analysis was performed on the standardised scores of the three angular measures, using four pre-specified cluster centres based upon an initial hierarchical cluster analysis (Ward's method).

Results
The profile and frequencies of the four identified groups agreed with a previously described classification of adult lumbo-pelvic sagittal alignment from spinal radiographs. In the current study, these subgroups were termed 'neutral', 'hyperlordotic', 'flat' and 'sway'. The validity of the cluster solution was further confirmed by split-half sampling. Subgroup profiles on gender proportions, anthropometric data and back pain history were examined as further confirmation of criterion validity. There was a higher proportion of adolescents that had never experienced back pain in the 'neutral' subgroup compared with all other subgroups (35.4% versus 51.3%, $p = 0.021$).

Conclusions
Meaningful subgroups of sagittal thoraco-lumbo-pelvic alignment in adolescents were able to be identified using a photographic postural assessment method. These subgroups were similar to previously identified adult. Subgroups differed in terms of anthropometric measures and back pain history with neutral spine postures being associated with less back pain.

Implications
Spinal pain research is complicated by the likelihood of the existence of subgroups of both spinal pain and risk factors for spinal pain. An understanding of the subtypes of sagittal postural alignment will enable a more targeted examination of the association between spinal alignment and spinal pain. Neutral upright spinal postures are known to be associated with activation of the local spinal stabilising muscles whilst optimising load transfer through the spine. This may decrease passive spinal structure loading in turn reducing the risk of back pain.

Key words:
sagittal posture, spine, classification, subgroups, adolescents