**Title:** Frequency of Impaired Spinal Mobility in Patients with Chronic Back Pain Compared to Patients with Early Axial Spondyloarthritis

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**ABSTRACT**

***Objective.*** To examine the frequency of impaired spinal mobility in patients with chronic back pain of short duration and to compare the frequency of impaired spinal mobility in patients with axial spondyloarthritis (axSpA), possible SpA and no SpA.

***Methods*.** The SpondyloArthritis Caught Early (SPACE) cohort includes patients with chronic back pain (≥3 months, ≤2 years, onset <45 years). Spinal mobility was assessed with lateral spinal flexion, chest expansion, cervical rotation, occiput-to-wall distance, and lumbar flexion. Hip mobility was assessed with intermalleolar distance. Mobility measures were defined as impaired if below the 5$^{th}$ percentile reference curve from general population, adjusted for age and height when appropriate. Proportions of patients categorized with impaired mobility were examined with chi square.

***Results***. In total, 393 patients with chronic back pain were included: 142 axSpA, 140 possible SpA and 111 no SpA. Impairment in ≥1 mobility measure was present in 66% of all patients. The most frequently impaired mobility measure was lateral spinal flexion (40%), followed by chest expansion (22%), cervical rotation (18%), intermalleolar distance (17%), lumbar flexion (15%) and occiput-to-wall distance (11%). No statistically significant differences in

proportion of patients with impaired spinal mobility were found between patients with axSpA and the other subgroups in any of the tests.

***Conclusion.*** Two out of 3 patients with chronic back pain of short duration had impaired spinal mobility compared to general population. Impaired spinal mobility occurs as often in patients with early axSpA as in other forms of chronic back pain.

*Key Indexing Terms*: back pain, axial spondyloarthritis, spinal mobility, outcome assessment

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**Running footline:** Spinal mobility in early axSpA

## INTRODUCTION

Back pain is one of the most common musculoskeletal disorders, affecting up to 80% of the population at some point in life (1) and represents large individual and societal costs (1, 2). Most patients with back pain experience a natural recovery within some weeks. However, symptoms and functional limitations remain over time in about 10% (1) and some of these patients have an inflammatory rheumatic disease, such as axial spondyloarthritis (axSpA) (3-6). AxSpA is characterized by inflammatory back pain and progressive restriction in spinal mobility (7) with available treatments allowing us to improve health related quality of life through control of symptoms and inflammation as the primary treatment goal (8).

Early initiation of treatment is considered to be favourable in the disease course of patients with axSpA, and the response to tumour necrosis factor inhibitor (TNFi) therapy may be better when initiated early in the disease course (9, 10). Further, regular exercise is included in the management recommendation throughout the disease course (8) and is shown to reduce disease activity and improve spinal mobility (11) even in patients receiving stable TNFi therapy (12). Because effective treatment is available, it is important to recognize patients with inflammatory rheumatic disease among the large group of patients with chronic back pain.

Reduced spinal mobility is regarded as an important clinical feature of axSpA, emphasised by the inclusion in the core set of clinical assessment that has been defined by the Assessment of SpondyloArthritis international Society (ASAS) (13). Both structural damage and inflammation may contribute in spinal mobility impairment (14, 15). In early disease, impairments in spinal mobility is shown to be more influenced by inflammation, whereas in

later disease structural damage is also important (14). Lateral spinal flexion and the frequently used index of spinal mobility, the Bath Ankylosing Spondylitis Metrology Index (BASMI), have the best ability to discriminate between patients with and without structural damage in ankylosing spondylitis (AS) (15). However, according to the current ASAS classification criteria, axSpA patients can be classified before structural, radiographic changes have occurred, and the role of impaired spinal mobility as a disease-specific clinical feature in the early phase of the disease is not clear (16). Age-adjusted normal values have recently been defined for the spinal mobility measures, which enables comparing spinal mobility of patients with the general population (17). The objectives of our study were therefore to examine the frequency of impaired spinal mobility in patients with chronic back pain of short duration; and further, to compare the frequency of impaired spinal mobility between patients with axSpA and those with other forms of chronic back pain with similar symptom duration.

**MATERIAL AND METHODS**

*Patients.* Data from the SpondyloArthritis Caught Early (SPACE) cohort are used for this analysis. The SPACE cohort is a European ongoing observational inception cohort established in 2009 (18) and includes patients with chronic back pain for at least 3 months, not exceeding 2 years of duration, with an onset before the age of 45 years. All patients included in SPACE between January 2009 and December 2014 from the five rheumatology outpatients' clinics are included in the current analysis; Leiden University Medical Center, Amsterdam Medical Center and Groene Hart Ziekenhuis, the Netherlands; University of Padova, Italy; and Diakonhjemmet Hospital, Norway. In the Netherlands the SPACE-protocol was approved by medical ethical committee in Leiden University Medical Center (P08.105),

in Norway by the regional committee for medical and health research ethics in South East Norway (2010/426) and in Italy by the Azienda Osperdaliera di Padova (2438P). The study was performed in compliance with the Helsinki agreement. All patients provided their written informed consent before participation.

*Assessments.* Data used in the current study refer to the baseline visit, in which all patients underwent a diagnostic assessment for potential axSpA and were classified according to the ASAS axSpA criteria (16). Laboratory assessment consisted of HLA-B27 typing, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). The presence or history of SpA features including inflammatory back pain, arthritis, enthesitis, uveitis, dactylitis, psoriasis, inflammatory bowel disease, response to nonsteroidal antiinflammatory drugs (NSAIDs) and family history of SpA were recorded (18). Imaging was obtained with plain radiographs of pelvis with anteroposterior view and magnetic resonance imaging (MRI) of the sacroiliac joints with a semi-coronal plane. All imaging was scored independently by 2 experienced readers in a central reading. The pelvic radiographs were scored according to the modified New York criteria (19) and MRIs were scored according to the ASAS definition of active sacroiliitis (20).

For the purpose of this study patients were classified as having axSpA if they fulfilled the ASAS criteria for imaging and/or clinical axSpA (16). Patients who did not fulfill the ASAS criteria, were classified as possible SpA if they (1) presented with either sacroiliitis on imaging with no other SpA feature, (2) HLA-B27-positive with 1 other SPA feature, (3) ≥1 of the following SpA features; periperal arthritis, uveitis, dactylitis, heel enthesitis, psoriasis, inflammatory bowel disease, eleveted ESR/CRP, or (4) had these 3 SpA features;

inflammatory back pain, positive family history, and good response to NSAID. Patients were classified as no SpA if they had low possibility of having axSpA (e.g. either being HLA-B27-positive with no other SpA feature or having ≤2 of the following SpA features; inflammatory back pain, positive family history, or good response to NSAID). A detailed description of the categorisation of patients in the possible SpA and no SpA groups has been published previously (21).

Information was collected about the patients' age, gender, age at onset of back pain and duration of back pain, location of back pain, and current use of medication were collected. Body height and weight was measured and body mass index (BMI) was calculated ($kg/m^2$); ≥25.0 was categorised as overweight. In addition, intensity of back pain during the last week was assessed by the patients on an 11-point numeric rating scale, anchored by 0 "no pain" and 10 "unbearable pain".

Five measurements of spinal mobility and 1 measure of hip mobility were collected and performed following the recommendations from ASAS (13). Spinal mobility was assessed with lateral spinal flexion, chest expansion, cervical rotation, lumbar flexion measured according to the 10 cm Schober's test and occiput-to-wall. Hip mobility was assessed with intermalleolar distance. All spinal mobility measurements were recorded in cm with 1 decimal, except for cervical rotation, which was recorded in degrees. Intermalleolar distance was recorded in cm and rounded to integer unit. The better of 2 tries for each measurement was recorded. More details on the measurement are in Supplementary Table 1 (available with the online version of this article).

The composite index BASMI includes lateral spinal flexion, cervical rotation, lumbar flexion, intermalleolar distance and tragus-to-wall distance (22). To calculate BASMI, the values of tragus-to-wall were derived from the occiput-to-wall results by adding 8 cm (18). By doing so, the value of zero in the occiput-to-wall corresponds to 8 in tragus-to-wall used in the calculation of BASMI linear, both equivalents to no increased kyphosis (23, 24). Further, measures of tragus-to-wall and occiput-to-wall are known to be comparative across the entire scale (24). The formula for BASMI linear was used to compute the total score, ranging from 0-10 where the highest score represents most impairment (23).

Reference data from the general population for lateral spinal flexion, chest expansion, cervical rotation, intermalleolar distance, lumbar flexion and BASMI were obtained from the MOBILITY study (17). The mobility measures, except BASMI, were defined as impaired if they fell below the reference values for the fifth percentile curve from the general population, adjusted for age for all measures, and for chest expansion and intermalleolar distance also for height (17). The BASMI has inverse scoring; therefore reference values above the $95^{th}$ percentile curve were defined as impaired. For occiput-to-wall, percentile curves could not be derived, and a cutoff of >0 was considered impaired. To analyze the sensitivity, we also performed the analyses with the $2.5^{th}$ percentile curve as cutoff for impairment.

*Statistical analyses.* Patient characteristics are presented as mean with standard deviation (SD) for continuous variables and as frequency (percentage) for categorical variables. Mobility measures and the BASMI are presented with mean (SD) for continuous variables with normal distribution or median with interquartile range for continuous variables with skewed distribution. Proportions of patients categorized with impaired spinal mobility are

presented as frequency (percentage). Overall group differences (definite, possible and no SpA) were examined with chi-square test for categorical variables, 1-way ANOVA for continuous normally distributed variables, and by Kruskal-Wallis test for continuous variables with skewed distributions. If statistically significant differences were detected in the overall group analyses, appropriate post-hoc analyses (chi-square test with Yates continuity correction, Fisher's LSD test or Mann-Whitney U test) were applied. Statistical analyses were performed using SPSS version 21.0 (SPSS Inc.) and the figures were made in GraphPad Prism version 7.0 (GraphPad Software).

**RESULTS**

In total, 395 patients with chronic back pain were eligible, but 2 patients had insufficient information, so 393 were included in our present study. Of the included 393 patients, 142 (36%) fulfilled the ASAS axSpA criteria, 140 (36%) were classified as possible SpA and 111 (28%) as no SpA. In the axSpA group, 58 (41%) fulfilled the imaging arm (28 with radiographic sacroiliitis and 30 with active inflammation on MRI) and 84 (59%) the clinical arm only of the ASAS axSpA criteria. In the possible SpA group, 108 (77%) who had normal imaging were HLA-B27 negative and had ≥1 of the following SpA features; periperal arthritis, uveitis, dactylitis, heel enthesitis, psoriasis, inflammatory bowel disease or eleveted ESR/CRP. There were 20 (14%) HLA-B27 postitve patients with normal imaging and one SpA feature. Eight (6%) who had normal imaging were HLA-B27-negative, with the following 3 SpA features: inflammatory back pain, positive familiy history, and good response to NSAID. Four (3%) patients had positive imaging and no SpA features.

The patients' characteristics are shown in Table 1. Patients classified with axSpA were more frequently male ($p<0.001$) and HLA-B27-positive ($p<0.001$). They reported less back pain

(intensity) ($p<0.001$) but more commonly buttock pain ($p=0.03$), and less frequently lumbar pain ($p=0.01$). There were no differences in age at onset or duration of back pain between the subgroups.

Mobility measures are presented in Table 2. Comparisons between the subgroups showed that the axSpA group compared to possible SpA and no SpA groups had statistically significant better intermalleolar distance ($p=0.01$) and better cervical rotation than the possible SpA group ($p=0.01$). There were no differences between the subgroups in the other mobility measures. In the BASMI, the axSpA–group had a lower score (better mobility) compared to possible SpA- and no SpA group ($p=0.01$).

The proportions of patients categorized with impaired spinal mobility are shown in table 3. In all patients with chronic back pain, impairment in at least one mobility measure was present in 66% among those with complete assessment. The most frequently impaired mobility measure was lateral spinal flexion (40% of the patients) followed by chest expansion (22%), cervical rotation (18%), intermalleolar distance (17%) and lumbar flexion (15%) and occiput-to-wall (11%). Twenty-nine percent of the patients was categorised with impaired spinal mobility according to the composite score BASMI.

There were no statistically significant differences in the proportion of patients categorised with impaired mobility according the single instruments among the chronic back pain subgroups in any of the mobility measures (Table 3). However, for the BASMI, in accordance with the scores, a statistically significant lower proportion of patients with axSpA (21%) had impaired mobility compared to possible SpA (33%) and no SpA (33%; $p=0.03$). There were no

statistically significant differences in the proportion of patients with impairment according to sex in any of the measures (data not shown). The distributions of lateral spinal flexion and BASMI in the subgroups are shown in Figure 1, with percentile curves illustrating the age specific spinal mobility cutoff as defined from the general population. Details of other mobility measures are outlined in supplementary Figure 1-5 (available with the online version of this article).

In the subgroup of patients with axSpA, impaired mobility in at least one measure was present in 58% among those with complete assessment of mobility measures (Table 3). Among those with at least 1 impaired measure, lateral spinal flexion was most frequently impaired in 47 out of 76 (62%). Among the remaining 29 (38%) patients, chest expansion was most frequently impaired in 14 (48%), followed by cervical rotation in 9 (31%), occiput-to-wall distance 8 (28%), intermalleolar distance 7 (24%), and lumbar flexion 7 (24%).
The proportions categorized with impaired mobility were compared between patients fulfilling the ASAS criteria for axSpA according to radiographic sacroiliitis, active sacroiliitis on MRI and clinical arm, and no statistically significant difference were seen in neither of the mobility measures. Sensitivity analyses with the 2.5$^{th}$ percentile curve as cutoff showed similar results (data not shown).

**DISCUSSION**

In this study of patients with chronic back pain of short duration, we have shown that spinal mobility was impaired in 1 or more mobility measures in 66% of patients and that the most frequently impaired mobility measure was lateral spinal flexion. However, mobility measures

recommended for axSpA are as frequently impaired in patients with early axSpA as in those with other causes of chronic back pain.

To our knowledge, this is the first study comparing spinal mobility in patients with chronic back pain with age-adjusted percentile curves from the general population. Large variations in spinal mobility are demonstrated in the general population (17, 25, 26). Even so, in our current study 2 out of 3 of patients with chronic back pain had impaired mobility in 1 or more measures, defined as below the fifth percentile of the general population. In a previous study, a similar comparison was made for patients with established AS (27), with an even stricter cutoff between normal and impaired mobility ($2.5^{th}$ percentile). This study showed that 79% of the patients with AS had impaired spinal mobility compared to the general population (27), reflecting that restricted spinal mobility is more prevalent in patients with established AS.

In the current study, the most frequently impaired mobility measure in the axSpA group was lateral spinal flexion (35%), followed by chest expansion (20%), while the other mobility measures had lower proportions of impairment (12-15%). Lateral spinal flexion has also been reported to be the most frequently impaired mobility measure in established AS (27), but unlike in our early cohort the second most frequently impaired measures were found to be lumbar flexion and tragus-to-wall/occiput-to-wall distance (27). This finding may indicate that there is a different pattern of mobility impairment in early disease compared to late disease. It has been suggested that screening for impairment in mobility in AS can be done by assessing lateral spinal flexion and lumbar flexion (27). However, our results do not support screening with only these measures, since 28% (21 out of 76) of patients with early

axSpA with normal lateral spinal flexion and normal lumbar flexion had impairment in another mobility measure.

Because of the natural disease course of progressive restriction in spinal mobility in patients with axSpA (28), it could be expected that impaired spinal mobility would occur more often among patients with early axSpA than in patients with other causes of chronic back pain. However, no differences in proportions of impairment of spinal mobility were found between patients with axSpA and patients with chronic back pain of other causes in any of the measures. Therefore, our results indicate that mobility measures recommended for monitoring axSpA are of limited diagnostic value. Correlations between levels of back pain and reduced spinal mobility have previously been demonstrated in patients with chronic back pain (29-31), and because patients with axSpA reported less back pain than the other subgroups in our study, this may at least partly explain the lack of between-group differences. Further, we found differences in the location of back pain, where a larger proportion of patients with axSpA have buttock pain and a lower proportion have lumbar pain. It is plausible that also the location of back pain could influence the spinal mobility measures. Further research is needed to explore which factors are associated with reduced spinal mobility in early axSpA.

Even though the proportion of patients with impaired spinal mobility was similar in the subgroups, patients with axSpA showed to had better cervical rotation and intermalleolar distance than patients with other causes of chronic back pain. The intermalleolar distance is a measure of hip abduction and is therefore not included in the spinal mobility measures recommended by ASAS (13). However, intermalleolar distance is included in the BASMI (22)

and is therefore often reported as an outcome measure in studies with axSpA. Spinal mobility is known to be influenced by age (17, 25, 26), height (17, 26), sex (25, 26) and BMI (26) in the general population as well as in patients with axSpA (32-35). In our population, patients with axSpA were younger, taller, more often men and had lower BMI than patients with other causes of chronic back pain, which may have influenced the results. However, the categorisation of patients with impairment was adjusted for age (and height) and we did not find any differences between the sexes. On the other hand, we were unable to do subgroup analyses by BMI, because the extreme groups according to BMI were too small, which is a limitation of our study.

Strengths of our study are the use of wide inclusion criteria (chronic back pain ≥ 3months ≤ 2 years, onset <45 years), the inclusion of patients from several countries in Europe and having followed a thorough examination with assessment recommended by the ASAS. However, being a multicentre study, several assessors have collected data, which is a limitation. Because the cohort consists of patients with short symptom duration, it is possible that some patients not fulfilling the ASAS axSpA criteria at baseline might develop into axSpA later. In this and previous publications from this cohort, we therefore grouped patients not fulfilling the criteria, but with a higher likelihood of developing axSpA based on baseline features as having possible SpA. Included patients may not fully represent the chronic back pain population of young age in a community setting and findings are therefore most applicable to rheumatologist outpatients' clinics.

To be specific enough to identify all patients with definitely impaired spinal mobility and sensitive enough to capture those with potentially impaired spinal mobility, we chose to report the fifth percentile as a cutoff. To our knowledge, a unified definition of impaired

mobility has not been established, but this cutoff is in line with articles assessing normative values in general population (17, 25, 26). Moreover, data using the 2.5$^{th}$ percentile were very similar.

Spinal mobility is impaired in 2 out of 3patients with chronic back pain who are young and short symptom duration, but the frequency of impairment is similar in patients with early axSpA and those with chronic back pain of other causes.

Although spinal mobility may play an important role in clinical decision making and treatment evaluation in patients with axSpA, our results indicate that mobility measures are of no diagnostic value.

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**ONLINE SUPPLEMENT**

Supplementary material accompanies the online version of this article.

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**SUPPLEMENT**

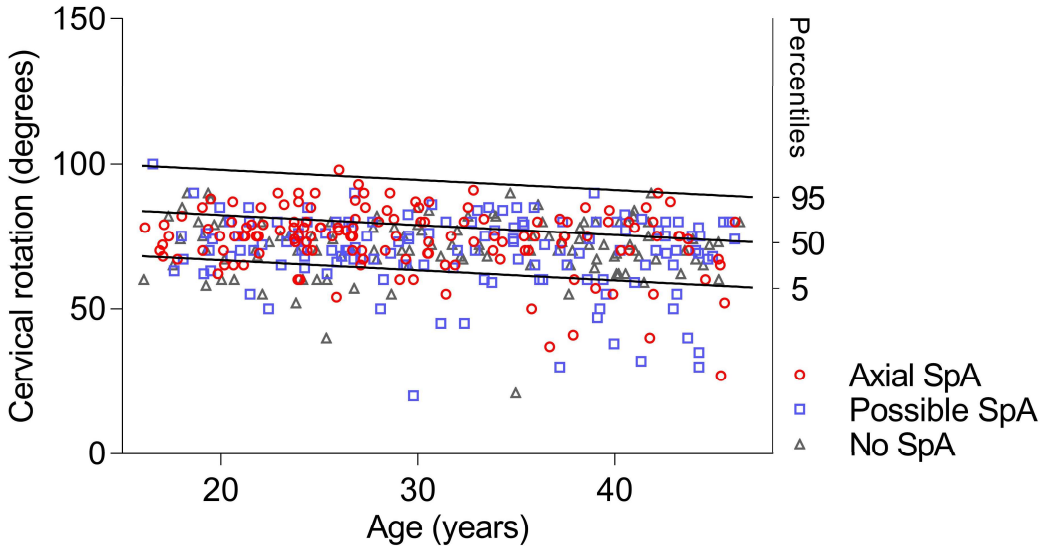
*Mobility measurements*

Five measures of spinal mobility and one measure of hip mobility were collected. Measurements were performed following the recommendations of the ASAS (1). More detailed explanations on the measurement techniques (including images) can be found in the slide library of the ASAS website (http://asas-group.org). For each of the measures, the better of two tries for each measurement were recorded. All measurements were recorded in cm, except for cervical rotation which was recorded in degrees. All measurements were rounded to decimals, except for intermalleolar distance and cervical rotation that were rounded to units.

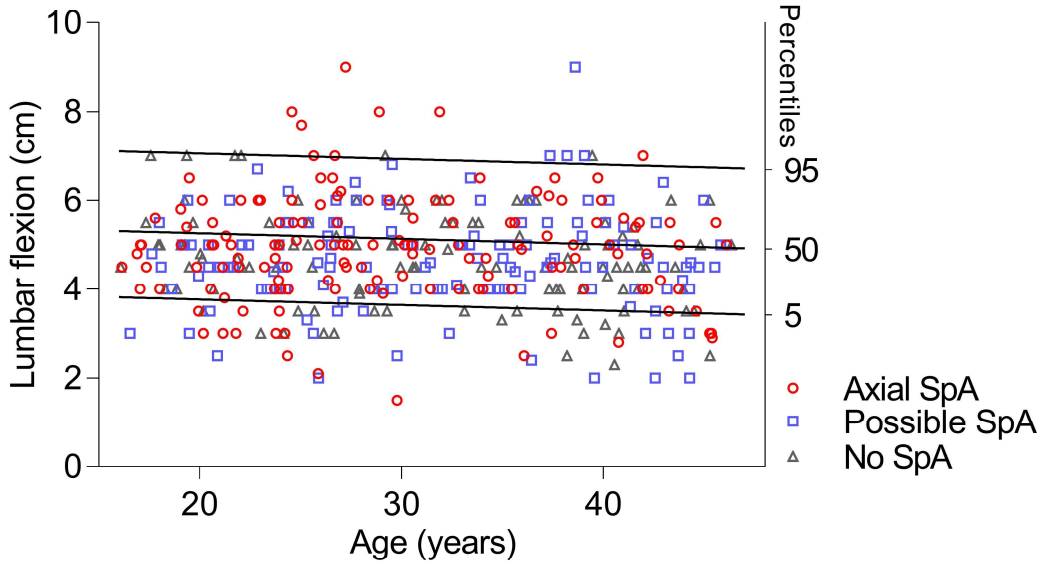
*Supplementary Table 1.* Methods used for measuring mobility

| Measure | Methods |
|---|---|
| Occiput-to-wall distances | The subject stands with heels and back against a wall, with hips and knees straight and chin held at usual carrying level. The patient tries to touch his/her head against the wall. The distance between occiput and the wall is measured with a tape measure. |
| Lateral spinal flexion | The subject stands in the same position as for the occiput-to-wall distance. Without bending forward, the patient bends sideways as far as possible without bending the knees or lifting the heels. The distance between the participant's middle fingertip in the initial position and on maximum lateral flexion is measured with a tape measure and averaged for both sides. |

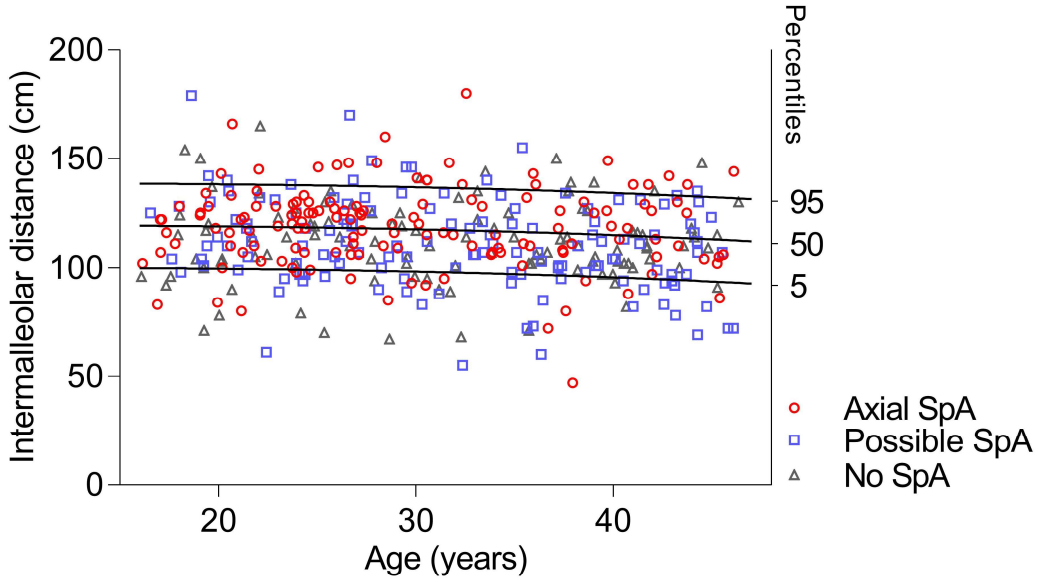
| | |
|---|---|
| Chest expansion | The subject is asked to rest his/her hands on or behind the head. The difference between maximal inspiration and expiration is measured anteriorly at the fourth intercostal level. |
| Lumbar flexion | The subject stands erect with his/her feet about shoulder width apart. The assessor marks a point on the patient's skin on the imaginary line between the two posterior superior iliac spines, close to the dimples of Venus. A second mark is placed 10cm above the first mark. The patient is asked to bend forward as far as possible, keeping the knees straight throughout the entire movement, and the distance between the skin marks is measured. |
| Intermalleolar distance | The subject is lying in a supine position, the knees straight and the feet pointing straight up. The patient is asked to separate the legs as far as possible and the distance between the medial malleoli is measured. |
| Cervical rotation | The subject sits straight on a chair, chin at usual carrying level, and hands on the knees. The assessor places the goniometer/myrinometer at the top of the subject's head, in line with the nose/north, assuring that the assessor can see from the top of the subject's head. The patient then rotates the head as much as possible only rotating the neck and the angle of the movement is measured and averaged for both sides. |



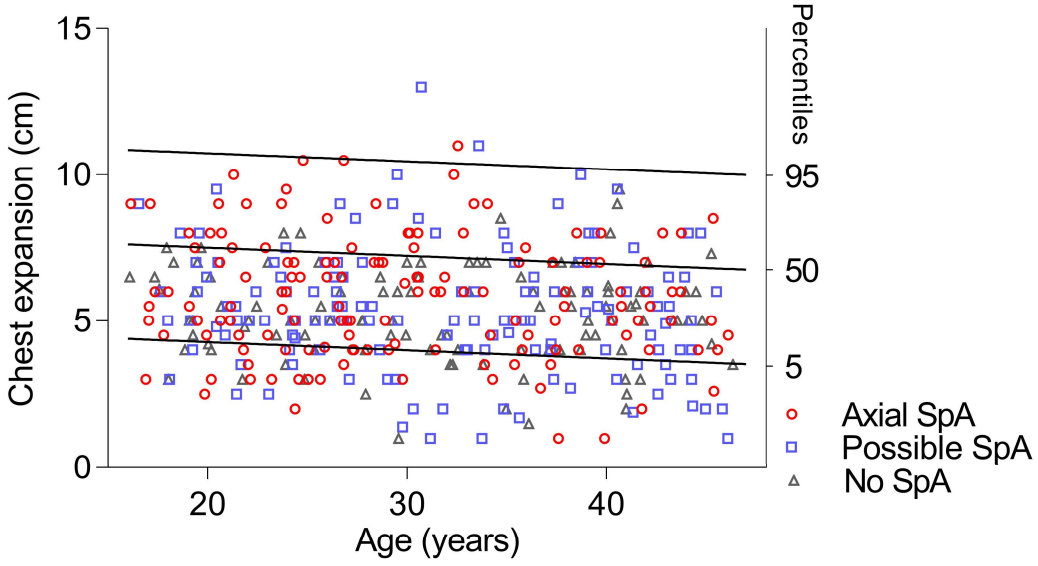

*Supplementary Figure 1.* Distribution of measurements for cervical rotation in function of age and with the percentile curves derived from measurements in general population. Patients below the 5$^{th}$ percentile are categorized as having impaired spinal mobility.



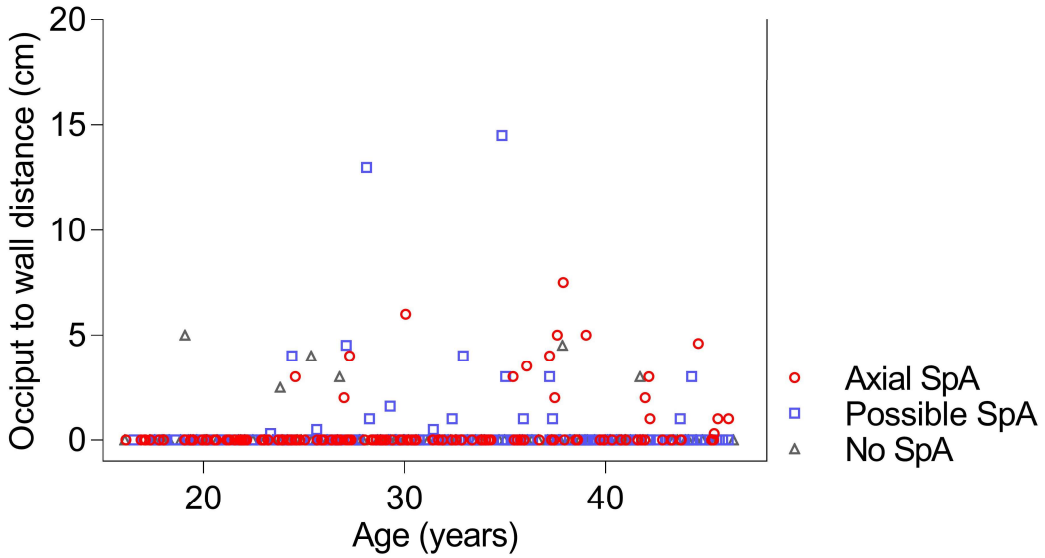

*Supplementary Figure 2.* Distribution of measurements for lumbar flexion in function of age and with the percentile curves derived from measurements in general population. Patients below the 5$^{th}$ percentile are categorized as having impaired spinal mobility.




*Supplementary Figure 3.* Distribution of measurements for intermalleolar distance in function of age and with the percentile curves adjusted for height 175 cm derived from measurements in general population. Patients below the 5$^{th}$ percentile are categorized as having impaired spinal mobility.




*Supplementary Figure 4.* Distribution of measurements for chest expansion in function of age and with the percentile curves adjusted for height 175 cm derived from measurements in general population. Patients below the 5$^{th}$ percentile are categorized as having impaired spinal mobility.




*Supplementary Figure 5.* Distribution of measurements for occiput to wall distance. Patients with score above zero are categorized as having impaired spinal mobility.

**Reference**

1. Sieper J, Rudwaleit M, Baraliakos X, Brandt J, Braun J, Burgos-Vargas R, et al. The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis 2009;68 Suppl 2:ii1-44

*Table 1.* Characteristics of the patients according to subgroups. Values are n(%) unless otherwise specified.

| | | All patients | Axial SpA | Possible SpA | No SpA | |
|---|---|---|---|---|---|---|
| Characteristics | n | 393 | 142 | 140 | 111 | p |
| Male | 393 | 138 (35%) | 69 (49%) | 39 (28%) | 30 (27%) | $< 0.001^{\alpha,\beta}$ |
| Age, years | 393 | 31.1 (8.3) | 29.7 (8.0) | 32.0 (8.3) | 31.7 (8.4) | $0.04^{\alpha}$ |
| Height, cm | 373 | 175 (9) | 177 (10) | 172 (9) | 175 (9) | $0.01^{\alpha}$ |
| Overweight (BMI≥25.0) | 372 | 147 (40%) | 43 (33%) | 63 (48%) | 41 (38%) | $0.04^{\alpha}$ |
| Age at onset of back pain, years | 391 | 29.4 (8.2) | 28.1 (7.9) | 30.4 (8.3) | 30.0 (8.4) | 0.05 |
| Duration of back pain, months | 392 | 13.1 (7.2) | 13.2 (7.4) | 12.4 (6.8) | 13.7 (7.4) | 0.39 |
| Back pain intensity, NRS 0-10 | 352 | 5.0 (2.3) | 4.2 (2.3) | 5.3 (2.3) | 5.6 (2.2) | $<0.001^{\alpha,\beta}$ |
| *Location of back pain* | | | | | | |
| Buttock | 389 | 212 (55%) | 88 (63%) | 70 (50%) | 54 (49%) | $0.03^{\alpha,\beta}$ |
| Lumbar | 393 | 333 (85%) | 108 (76%) | 124 (89%) | 101 (91%) | $0.01^{\alpha,\beta}$ |
| Thoracic | 393 | 137 (35%) | 48 (34%) | 42 (30%) | 47 (42%) | 0.12 |
| *SpA features* | | | | | | |
| IBP | 393 | 246 (63%) | 114 (80%) | 74 (53%) | 58 (52%) | $<0.001^{\alpha,\beta}$ |
| Positive family | 393 | 150 (38%) | 72 (51%) | 55 (39%) | 23 (21%) | $0.01^{\beta,\gamma}$ |

| | | | | | | |
|---|---|---|---|---|---|---|
| history | | | | | | |
| HLA-B27$^{+}$ | 387 | 147 (38%) | 123 (89%) | 20 (15%) | 4 (4%) | <0.001$^{\alpha,\beta,\gamma}$ |
| Good response to NSAID | 386 | 136 (35%) | 62 (45%) | 46 (34%) | 28 (25%) | 0.01$^{\beta}$ |
| Elevated CRP/ ESR | 383 | 86 (23%) | 38 (28%) | 48 (35%) | 0 | <0.001$^{\beta,\gamma}$ |
| Heel enthesitis | 393 | 64 (16%) | 31 (22%) | 33 (24%) | 0 | <0.001$^{\beta,\gamma}$ |
| Peripheral arthritis | 388 | 54 (14%) | 27 (19%) | 27 (20%) | 0 | <0.001$^{\beta,\gamma}$ |
| Psoriasis | 392 | 38 (10%) | 18 (13%) | 20 (14%) | 0 | <0.001$^{\beta,\gamma}$ |
| IBD | 393 | 33 (8%) | 9 (6%) | 24 (17%) | 0 | <0.001$^{\alpha,\beta,\gamma}$ |
| Uveitis | 393 | 31 (8%) | 23 (16%) | 8 (6%) | 0 | <0.001$^{\alpha,\beta,\gamma}$ |
| Dactylitis | 393 | 21 (5%) | 11 (8%) | 10 (7%) | 0 | 0.01$^{\beta,\gamma}$ |
| Sacroiliitis present on imaging | 354 | 62 (17%) | 58 (45%) | 4 (3%) | 0 | <0.001 $^{\alpha,\beta}$ |
| X-ray | | 19 (5%) | 17 (13%) | 2 (2%) | 0 | |
| MRI | | 31 (9%) | 30 (23%) | 1 (1%) | 0 | |
| X-ray and MRI | | 12 (3%) | 11 (8%) | 1 (1%) | 0 | |
| *Current use of medication* | | | | | | |
| NSAID | 393 | 273 (70%) | 105 (74%) | 90 (64%) | 78 (70%) | 0.21 |
| DMARD | 378 | 24 (9%) | 11 (8%) | 13 (10%) | 0 | 0.01 $^{\beta,\gamma}$ |

Statistically significant subgroup difference between $^{\alpha}$ axial SpA and possible SpA, $^{\beta}$ axial SpA and no SpA, $^{\gamma}$ possible SpA and no SpA. AxSpA: axial Spondyloarthritis; BMI: body mass index, CRP: C-reactive protein, DMARD: disease modifying anti-inflammatory drug, ESR: erythrocyte sedimentation rate, IBD: inflammatory bowel disease, IBP: inflammatory back pain, MRI:

magnetic resonance imaging, NRS: numeric rating scale, NSAID: non steroid anti-inflammatory drug, SpA: Spondyloarthritis.

*Table 2.* Spinal mobility measures according to subgroups. Values are mean (SD) expect where indicated.

| | All Patients, n = 393 | AxSpA, n = 142 | Possible SpA, n = 140 | No SpA, n = 111 | p |
|---|---|---|---|---|---|
| Measure | | | | | |
| Lateral spinal flexion, cm, mean (SD), n = 393 | 17.3 (4.4) | 17.8 (4.3) | 17.2 (4.6) | 16.8 (4.2) | 0.25 |
| Chest expansion, cm, mean (SD), n = 393 | 5.5 (2.0) | 5.8 (2.1) | 5.3 (2.2) | 5.3 (1.6) | 0.07 |
| Cervical rotation, degrees, mean (SD), n = 389 | 72 (12) | 74 (11) | 70 (13) | 71 (10) | 0.01 [α] |
| Intermalleolar distance, cm, mean (SD), n = 390 | 114 (20) | 118 (19) | 110 (21) | 112 (18) | 0.01 [α, β] |
| Lumbar flexion, 10 cm Schober's, cm, mean (SD), n = 393 | 4.7 (1.2) | 4.9 (1.2) | 4.7 (1.1) | 4.7 (1.1) | 0.12 |
| Occiput-to-wall distance, cm, median (IQR), n = 393 | 0 (0.0-0.0) | 0 (0.0-0.0) | 0 (0.0-0.0) | 0 (0.0-0.0) | 0.12 |
| BASMI (0–10), mean (SD), n = 386 | 1.9 (0.9) | 1.7 (0.8) | 2.0 (0.9) | 2.0 (0.8) | 0.01 [α, β] |

Statistically significant subgroup difference between [α] axSpA and possible SpA, [β] axSpA, and no SpA. BASMI: Bath Ankylosing Spondylitis Metrology Index, axSpA: axial spondyloarthritis, IQR: interquartile range.

*Table 3*. Proportion of patients categorised with impaired spinal mobility according to subgroups. Values are n (%).

| | | All Patients | AxSpA | Possible SpA | No SpA | |
|---|---|---|---|---|---|---|
| Measure | n | 393 | 142 | 140 | 111 | p |
| Lateral spinal flexion | 393 | 158 (40%) | 50 (35%) | 57 (41%) | 51 (46%) | 0.22 |
| Chest expansion[γ] | 373 | 81 (22%) | 27 (20%) | 31 (24%) | 23 (21%) | 0.81 |
| Cervical rotation | 389 | 69 (18%) | 21 (15%) | 31 (23%) | 17 (15%) | 0.18 |
| Intermalleolar distance[γ] | 370 | 63 (17%) | 16 (12%) | 28 (21%) | 19 (18%) | 0.13 |
| Lumbar flexion, 10 cm Schober's | 393 | 57 (15%) | 17 (12%) | 20 (14%) | 20 (18%) | 0.40 |
| Occiput-to-wall | 393 | 42 (11%) | 18 (13%) | 18 (13%) | 6 (5%) | 0.10 |
| BASMI | 386 | 111 (29%) | 29 (21%) | 45 (33%) | 37 (33%) | 0.03 [α, β] |
| Number of impaired mobility measures [δ] | | | | | | |
| | n | 367 | 131 | 128 | 108 | |
| 1 | | 118 (32%) | 38 (29%) | 40 (31%) | 40 (37%) | |
| 2 | | 68 (19%) | 18 (14%) | 23 (18%) | 27 (25%) | |
| 3 | | 37 (10%) | 15 (11%) | 15 (12%) | 7 (6%) | |
| ≥4 | | 19 (5%) | 5 (4%) | 9 (7%) | 5 (5%) | |
| Number with at least one impaired mobility measure | | | | | | |
| | | 242 (66%) | 76 (58%) | 87 (68%) | 79 (73%) | |

Statistically significant subgroup difference between [α]axSpA and possible SpA, [β] axSpA and no SpA. [γ] Derivation of reference percentile included height, [δ] patients with complete set of

mobility measures. AxSpA: axial Spondyloarthritis; BASMI: Bath Ankylosing Spondylitis Metrology Index.

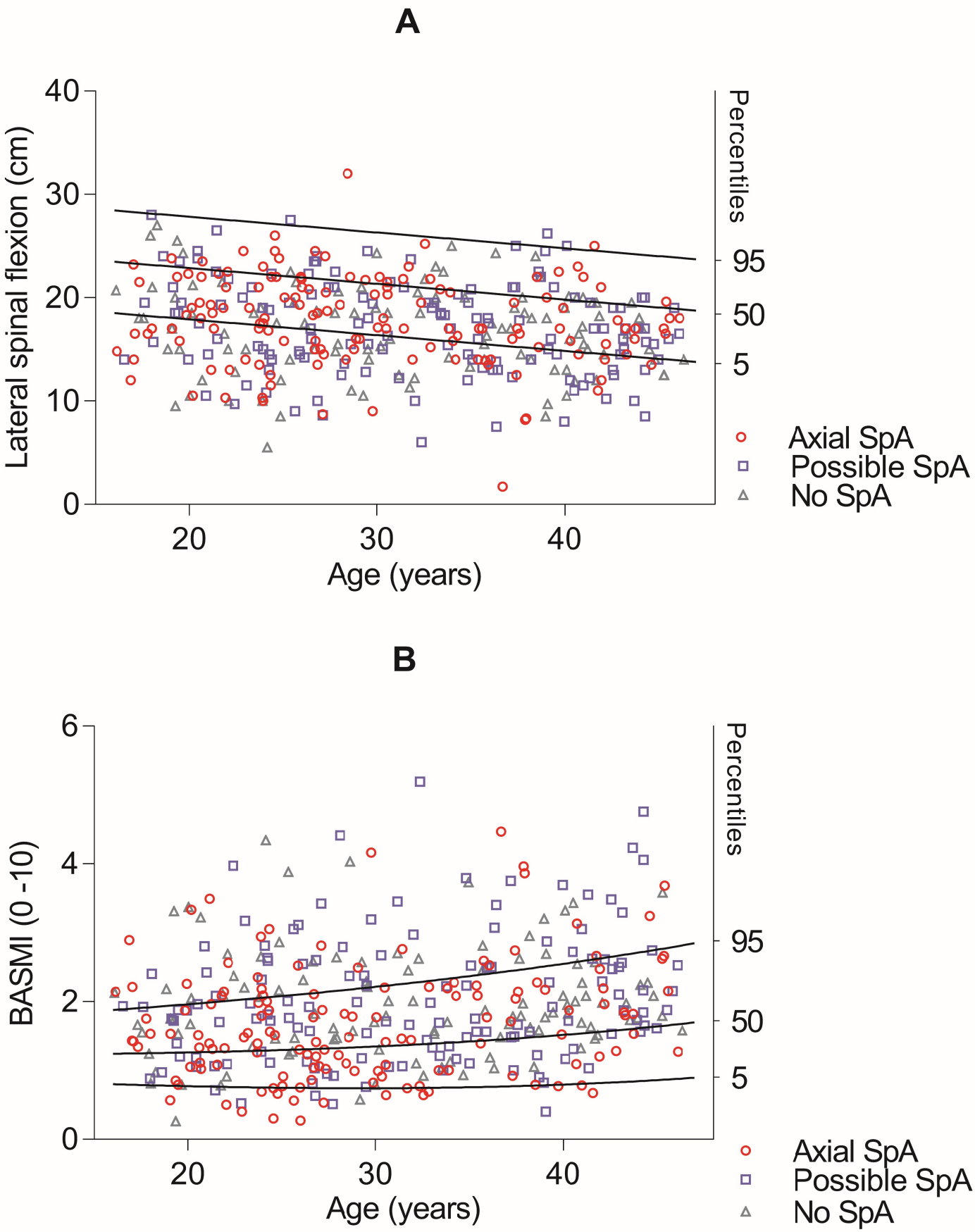



*Figure 1.* Distribution of measurements for lateral spinal flexion (A) and BASMI (B) in function of age and with the percentile curves derived from measurements in general population. Patients below the 5$^{th}$ (A) and above 95$^{th}$ (B) percentile are categorized as having impaired spinal mobility.