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THE RELATIONSHIPS BETWEEN SPINAL SAGITTAL CONFIGURATION, JOINT MOBILITY, GENERAL LOW BACK MOBILITY AND SEGMENTAL MOBILITY IN FEMALE HOMECARE PERSONNEL

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ABSTRACT. The aim of this study was to investigate joint mobility, segmental and general spinal mobility and their interrelationship in 607 women working as homecare personnel. Joint mobility (mainly peripheral) was estimated using the "Beighton" score. Spinal posture and mobility were measured by Debrunner's kyphometer. Passive segmental mobility and pain provocation were estimated manually. Reliability tests between two physiotherapists of segmental mobility and pain provocation ($n = 150$ subjects) were performed. Positive correlations were found between joint mobility, sagittal thoraco-lumbar mobility and segmental mobility. Hyperlordosis ($>39°$) was associated with greater lumbar mobility. The reliability of manual segmental mobility and segmental pain provocation was good, especially in the lowest back segments (kappa ≈ 0.7). Joint mobility, general mobility and segmental spinal mobility intercorrelated. Segmental mobility manually estimated showed intertester reliability. The good positive correlation between sagittal lumbar mobility and manually tested segmental mobility indicates criterion validity for the latter.

Key words: women; homecare; pain; musculoskeletal; kyphometry; segmental mobility; hypermobility; spine; joint mobility.

INTRODUCTION

Low back pain is most often treated with non-surgical methods. Body posture and spinal mobility are often regarded as important in choosing a therapeutic approach. Their importance in choice of therapy is mainly based on clinical experience. In clinical practice, kyphometry can be used to estimate *posture* and *sagittal mobility* of the thoraco-lumbar spine. Öhlén et al. (18) reviewed the method and found it efficient, with good reproducibility. *Joint mobility* can be assessed using certain tests (2, 4). Peripheral joint mobility plays a large part and spinal mobility a very small one (1 point out of 9 possible) in the test of Beighton et al. (2). Manual examination of *segmental mobility* is often made by physiotherapists (10), chiropractors (21) and osteopaths (23) as a part of the treatment decision. Riddle (22) found only a few articles concerning the reliability of signs in such manual examinations, and these showed either poor reliability or poor clinical design. The only article found to indicate method validity was an investigation as to whether or not manual examination could be used to identify the role of zygapophyseal joints in the symptoms of patients with neck and headache pain (inference criterion: nerve block) (13). Frequently used physical signs in patients with low back pain have low intertester reliability (3, 16), although a recent study reported acceptable intertester reliability for intersegmental mobility (25).

The *main aims* of the present study of a population of female homecare personnel in the community of Nyköping, Sweden were to:

1. Investigate the prevalences of, and interrelationships between, joint laxity, spinal sagittal mobility, segmental spinal mobility and thoraco-lumbar posture, and to
2. Evaluate the reliability of segmental manual examination in the low back.

METHODS

Subjects

To take part in the study the subjects had to fulfil the following criteria: they had to be employed by the local authority of Nyköping (Sweden) and working part-time (at least 50%) as homecare personnel (permanent appointment or employed long-term without permanent position). All female employees fulfilling these criteria ($n = 643$) were invited to participate in the study, and of these, 607 (94%) participated in this part of the investigation, 1.3% were on parental leave and 1.5% were on sick leave. The sample of subjects thus consisted of occupationally active homecare personnel.

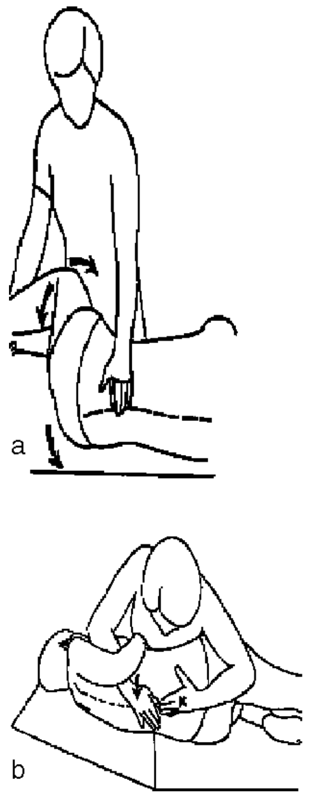

Fig. 1. Testing of segmental mobility. (a) Flexion/extension. (b) Rotation.

Procedures

The subjects selected received both written and verbal information about the study. The different mobility and posture tests were parts of an examination in which the whole physical examination (including any training or stretching advice) of each subject took approximately 60 minutes, of which the mobility tests took 30 minutes. The study consisted of the following steps:

1. Each subject filled in a questionnaire concerning age, weight, height, years of employment (total, within healthcare and current), percentage of full-time employment (40 hours/week = 100%), number of children and other sociodemographic variables.
2. The clinical examinations were done by three experienced physiotherapists according to a predetermined schedule consisting of segmental mobility and segmental pain provocation, spinal sagittal configuration and sagittal thoracic and lumbar mobility and joint mobility (as described below).

Segmental mobility and segmental pain provocation. The manual segmental mobility and pain provocation tests, regarded as the most subjective part of the examination, were always done first. With the subject lying on her side with hips and knees flexed and the examiner standing, the mobility of each of the eight segments from the lumbosacral segment up to T10-T11 was tested by *five passive movements*: extension and flexion, right and left rotation and translatoric joint play (in the following text labelled "gliding"), (Figs. 1a, b) (for detailed descriptions, see 10, 14). The lumbosacral segment was defined as segment L5-S1. Segmental mobility was estimated, from the neutral position, by stepwise interspinal palpation. Any tenderness/pain (labelled "provocation pain") during each part of the testing was recorded. From the five passive movements the examiner rated the *segmental mobility* using a five-point scale: $+2$ = extreme hypermobility, $+1$ = moderate hypermobility, 0 = normal mobility, -1 = moderate hypomobility and -2 = extreme hypomobility. No predetermined criteria for the segmental mobility with respect to the five passive movements were used. Segmental pain provocation was rated as $+1$ = pain and 0 = no pain.

The reliability study

A pilot study of 20 subjects took place in which the test schedule and examination results from each of two physiotherapists (with the Swedish examination in manual medicine) were discussed. Then a random sample ($n = 156$) of all subjects ($n = 607$) was examined by the examiners, who were not aware of each others' examination results. Six of the 156 subjects could not complete the reliability study (2 due to obesity and 4 due to pain). The time interval between the examinations was less than 15 minutes, and the order between the examiners was varied at random.

Spinal sagittal configuration and sagittal thoracic and lumbar mobility. Debrunner's kyphometer was used to measure spinal sagittal configuration and spinal (thoracic and lumbar) sagittal mobility (19) in the standing position. The kyphometer has a protractor with a 1° scale (80° to 0° to $-70°$) at the end of two double, parallel arms, connected to two blocks (19). The blocks are large enough to span two spinous processes. In total, 606 subjects participated in this part of the study. Data were incomplete for one subject. The neutral zero starting position was defined as the configuration in the erect standing relaxed position, arms hanging down by sides and barefoot, heels 10 cm apart.

Spinal sagittal configuration

Kyphosis was measured from a point between the spinous processes of T2 and T3 and from a second point between T11 and T12. Lordosis was measured between T11-T12 and S1-S2. The degrees of kyphosis and lordosis were read directly from the kyphometer scale. A schedule was used for the classification of body posture (20).

Sagittal thoracic and lumbar mobility

The sagittal range of motion was determined in the lumbar and thoracic spine separately. Maximal flexion and extension bending from a neutral position was recorded and the total sagittal range of movement was calculated.

Joint mobility. Joint mobility (mainly peripheral) was assessed using the modified Beighton score (0–9 points) (2): (i) passive dorsiflexion of MCP 5 beyond 90°, (ii) passive apposition of the thumb to the flexor aspect of the forearms, (iii) hyperextension of the elbow beyond 10°, (iv) hyperextension of the knees beyond 10° and (v) forward flexion of the trunk, with knees straight, so that the palms of the hands rested easily on the floor. *Mild* generalized joint hypermobility was defined as a score of 3–4, and *pronounced* generalized hypermobility as ≥ 5 (i.e. trichotomized score).

Table I. *Mean ± 1 SD, minimum and maximum values for anthropometric and lifestyle variables in homecare personnel (*n = *607)*

Variables	Mean	SD	Minimum	Maximum	*n*
Age (years)	40.5	11.9	21	64	607
Weight (kg)	67.2	12.0	41	115	543
Height (cm)	165.5	5.5	148	183	577
Duration of employment (years)	18.0	10.4	1	48	607
Employment in healthcare (years)	12.1	7.7	1	40	607
Duration of actual employment (years)	7.5	6.5	1	36	607
Percentage full-time employment (%)	78.8	15.4	25	100	585
No. of children	1.8	1.2	0	7	605

Statistics

All statistics were performed using the statistical packages STATISTICA for Windows (version 5.1) and SIMCA-S (version 6.01). Mean values ± one standard deviation (±1 SD) are generally reported. Linear regression analyses were made to determine the influence of age upon the different variables. Regression analyses of the rating of segmental mobility were made using the PLS technique (using SIMCA-S). To evaluate differences between groups, one-way analysis of variance (ANOVA), *t*-test and Kruskal-Wallis ANOVA by ranks were used. All statistical tests mentioned above were performed at the 5% significance level ($p \leq 0.05$; two-tailed).

In the reliability study for the binary terms (no pain/pain), the degree of agreement between the two examiners was calculated using the kappa coefficient (4), and for the mobility test (5°), using the weighted kappa coefficient (6). The kappa coefficient has a range between −1 and 1, where 1 corresponds to complete agreement, −1 to complete disagreement and 0 to no agreement. Kappa values were interpreted as follows: < 0.40 = poor, ≥0.40 to < 0.75 = fair to good, and ≥0.75 = excellent (7, 15). The kappa coefficient depends on the prevalence of deviations between findings and is severely attenuated towards low values when their prevalence is either especially low or high. The kappa coefficient was not calculated when the mean of the two examiners' prevalence of deviating findings was below 10% (27).

RESULTS

Anthropometric and sociodemographic data

Mean age was 40.5 ± 11.9 years and mean employment in healthcare was 12.1 ± 7.7 years. Anthropometric and sociodemographic variables are summarized in Table I.

Spinal sagittal configuration and thoracic and lumbar sagittal mobility

Results of the kyphometer measurements are given in Table II. A significant correlation existed between lumbar lordosis and thoracic kyphosis ($r = 0.30$, $p = 0.0001$). According to the scheme of body posture classification (19), 83.2% of the subjects were within normal limits (Fig. 2). The prevalence of bi-hyper-curvature posture was 4.6% and bi-hypo-curvature 3.6% (Table III). Generally no major (i.e. low explained R^2) clinical differences in spinal sagittal configuration by age were found, although significant relationships existed

Table II. *Sagittal configuration and sagittal mobility in the thoracic and lumbar spine in homecare personnel (*n = *606). Mean ± 1 SD, minimum and maximum values are given for measurements with Debrunner's kyphometer*

Variable	Mean	SD	Minimum	Maximum
Thoracic kyphosis	34.0	7.6	10	64
Thoracic backward bending (ROM)	14.1	7.1	2	53
Thoracic max backward bending angle	20.2	10.7	−10	55
Thoracic forward bending (ROM)	21.6	6.6	4	42
Thoracic max forward bending angle	55.5	7.1	18	76
Total thoracic sagittal movement (ROM)	35.7	10.1	8	73
Lumbar lordosis	32.9	6.5	55	10
Lumbar backward bending (ROM)	16.3	7.8	3	42
Lumbar max backward bending angle	49.1	10.1	15	70
Lumbar forward bending (ROM)	54.8	9.7	10	88
Lumbar max forward bending angle	21.9	9.3	−21	55
Total lumbar sagittal movement (ROM)	71.1	13.2	20	110
Total thoraco-lumbar sagittal movement (ROM)	106.9	18.7	50	169

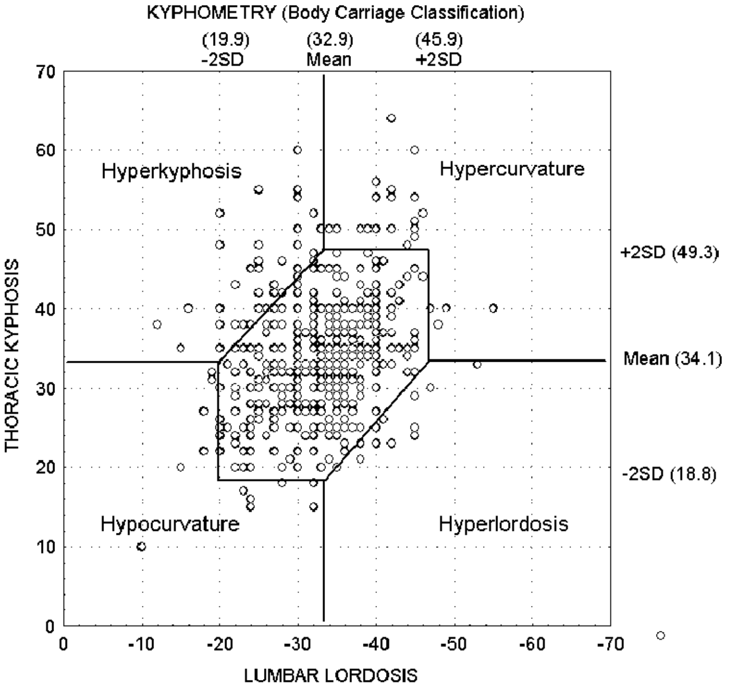

Fig. 2. Results of kyphometry and the limits in body posture classification ($n = 606$). Mean values $\pm$ 2 SD are marked with bold lines.

(Table IV). No significant age differences existed between the different posture groups.

The sagittal movements decreased significantly with increasing age (Table IV). The most pronounced age effects were found for total lumbar sagittal movement and total thoraco-lumbar sagittal movement, although the age effects were not extensive (i.e. the explained variances (R^2) were relatively low (0.22 and 0.17, respectively)) (Table IV).

Significant differences between the different groups of the body posture classification scheme (Fig. 2) and their total lumbar sagittal and total thoraco-lumbar sagittal mobility were found. The group with hyperkyphosis had less total lumbar sagittal mobility (59.5° vs 72.3° $p < 0.0001$) and less total sagittal mobility (88.4° vs 109.0° $p < 0.0001$). A significant correlation existed between lumbar lordosis and total thoracic lumbar sagittal mobility ($r = 0.30$, $p = 0.0000$). When only the *degree* of *lordosis* (using a limit of 40°) was analysed, 60 subjects had hyperlordosis (>39°). This group had significantly higher lumbar total sagittal mobility when compared with the normals (i.e. <40° lordosis) (76.0° vs 70.6° $p = 0.0032$). Significantly lower total lumbar sagittal mobility was found for the bi-hypo-curvature group (60.1° vs 72.3° $p = 0.0006$). Significantly lower total thoraco-lumbar sagittal mobility was also found in the bi-hypo-curvature (95.9° $p = 0.020$ vs normal: 109.0°) and the bi-hyper-curvature (93.6° $p = 0.0005$ vs normal: 109.0°) groups.

Joint hypermobility

The prevalence of *mild* hypermobility was 16% ($n = 98$) and *pronounced* hypermobility 8% ($n = 46$). A negative correlation existed between age and score ($r = -0.19$, $p \leq 0.05$). Those with normal joint mobility were approximately 4–5 years older than both hypermobility groups.

Segmental mobility tests

Segmental mobility. The prevalences of abnormal (used in this discussion only in the context of extreme

Table III. *Absolute and relative prevalences (%) of body posture classification groups in homecare personnel (n = 606)*

Body posture classification	*n*	%
Normal	505	83.2
Hypercurvatures	28	4.6
Hypocurvatures	22	3.6
Hyperkyphosis	36	5.9
Hyperlordosis	15	2.5
Missing	1	0.2

Table IV. *Results of the linear regression analyses between age and spinal sagittal configuration (kyphosis/lordosis) and age and sagittal motion in homecare personnel (*n = 606*). Correlation coefficients (R), R^2 and* p*-value are given for each analysis*

Variable vs age	R	R^2	*p*-value
Thoracic kyphosis	0.190	0.036	0.000
Thoracic max extension angle	0.220	0.048	0.000
Thoracic max flexion angle	0.124	0.015	0.002
Total thoracic sagittal movement	−0.151	0.023	0.000
Lumbar lordosis	−0.196	0.038	0.000
Lumbar max extension angle	−0.339	0.115	0.000
Lumbar max flexion angle	−0.275	0.076	0.000
Total lumbar sagittal movement	−0.462	0.213	0.000
Total thoraco-lumbar sagittal movement	−0.409	0.167	0.000

mobility, not as a synonym for pathology) mobility (i.e. −2, −1, 1 or 2) from Th10-11 down to L3-4 were low (approximately 10–13%) (Table V). In the two lowest segments, the prevalences of abnormal mobility were higher, 26–35%, almost equally distributed between hyper- and hypomobility. The prevalence of subjects with at least one hypomobile segment was 41.0% and with at least one hypermobile segment was 40.4%. The majority had one (hypomobile 18.8%; hypermobile 24.6%) or two abnormal segments (hypomobile 13.2%; hypermobile 13.0%). The prevalence of subjects with >2 hypomobile segments was 9.1% and >2 hypermobile segments was 2.8%.

When the 5-graded scale was trichotomized (i.e. into hypermobility (2 and 1), normal (0) and hypomobility (−1, −2)), the hypomobility group was found to be significantly older than the normal group (L4-L5: 45.8 years vs 40.2 years ($p = 0.0001$); L5-S1: 46.0 years vs 39.8 years ($p = 0.0000$)). No significant age differences between the hypermobility group and the normal group were found for these segments.

The five passive movements. All five passive movements at the Th11-L2 and L4-S1 levels and extension at segment L2-L3 showed deviations of >10% outside normal range. The prevalence of segmental pain during provocation was >10% in the two lowest segments only.

Prediction of segmental mobility rating. The segmental mobility rating was determined for the two lowest segments using the five passive movements as X-variables. At both L4-L5 and L5-S1 levels, sagittal movement was the strongest predictor, followed by left and right rotation for the rating of segmental mobility ($R^2 = 0.85$–0.88; $n = 606$). Since it is difficult to standardize the starting neutral position, modified regressions for L4-L5 and L5-S1 were made based on (i) the sum of flexion-extension, (ii) the sum of rotation to left and to right and (iii) translatoric joint play. These analysis also resulted in significant models ($R^2 = 0.89$–0.91; $n = 606$) and the same principal relationships between the passive movements. When the sums of the passive movements were calculated for L4-L5 and L5-S1, respectively, it was found that high significant correlations existed with the judgement of the examiner (L4-L5: $R^2 = 0.86$ and L5-S1: $R^2 = 0.90$).

Intertester reliability of segmental mobility and pain provocation. The degree of agreement (weighted kappa)

Table V. *The prevalence (%) of segmental mobility according to the 5-point scale for each segment of homecare personnel (*n = 606*)*

Segment	Extreme hypo (−2)	Moderate hypo (−1)	Normal (0)	Moderate hyper (+1)	Extreme hyper (+2)
Th10-11	0.0	9.6	88.6	1.7	0.0
Th11-12	0.0	8.2	86.8	4.6	0.2
Th12-L1	0.0	9.1	85.3	5.3	0.2
L1-L2	0.0	6.6	86.2	7.1	0.0
L2-L3	0.2	5.3	88.8	5.4	0.2
L3-L4	0.0	5.4	86.8	7.4	0.2
L4-L5	0.0	12.4	73.2	13.8	0.5
L5-S1	0.0	19.1	64.8	16.0	0.0
L4-L5-S1	0.0	5.8	54.6	5.9	0.0

Table VI. *The reliability study of the segmental mobility tests on levels Th10-S1. Weighted kappa values are presented for each of the five passive movements and for the rating of segmental mobility* (n = *150*)*. The results are not shown when the prevalence out of normal is <10%*

Variable/level	Th10-Th11	Th11-Th12	Th12-L1	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
Flexion		0.71	0.57	0.59			0.49	0.50
Extension		0.75	0.54	0.66	0.51		0.62	0.68
Rotation left		0.62	0.50	0.46			0.58	0.62
Rotation right		0.62	0.50	0.46			0.58	0.62
Gliding		0.63	0.48	0.54			0.65	0.42
Segmental mobility		0.73	0.59	0.68	0.61		0.75	0.70

between the two physiotherapists doing the segmental mobility tests varied between 0.59 and 0.75 (Table VI). The degree of agreement was relatively high in the two segments with the highest prevalences of non-normal clinical findings: L4-L5: 0.75 and L5-S1: 0.70 (Table VII). Intertester reliability for the five passive movements was generally lower than that for the rating of segmental mobility (Table VI). The degree of agreement (kappa) was also high for the segmental pain provocation tests of the two lowest segments: L4-L5: 0.71 and L5-S1: 0.67 (Table VIII).

Relationships between kyphometry and joint hypermobility test

The *pronounced* mobility group had significantly greater total thoracic and lumbar sagittal mobility than the normal group (Table IX).

Relationships between kyphometry and segmental mobility

In most segments a positive relationship between segmental mobility (trichotomized) and lumbar total sagittal mobility was found (Table X). The relationship was especially strong in the two lowest segments. The group with segmental hypermobility at level L5-S1 had a 14° greater total lumbar sagittal mobility than the group with segmental hypomobility. If both the two lowest segments were taken together (i.e. L4-L5-S1), a strong positive correlation was found (both L4-S1 hypomobile: 56.8° ($p < 0.0001$); both normal: 74.7°;

Table VII. *Intertester reliability study. Physiotherapists A and B (Pt A and Pt B) rated spinal segmental mobility in the 2 lowest segments in 150 randomly selected homecare personnel. Segmental mobility was graded on a 5-point scale*

L4–L5	Pt B							
Pt A	−2	−1	0	+1	+2	Totals		
−2	**0**	0	0	0	0	0	Weighted kappa	0.75
−1	0	**8**	2	0	0	10	s.e.	0.14
0	0	1	**117**	3	0	121	−95% confidence	0.47
+1	0	0	6	**13**	0	19	+95% confidence	1.02
+2	0	0	0	0	**0**	0		
All groups	0	9	125	16	0	150		
L5-S1	**Pt B**							
Pt A	−2	−1	0	+1	+2	Totals		
−2	**0**	0	0	0	0	0	Weighted kappa	0.70
−1	0	**8**	5	1	0	14	s.e.	0.13
0	0	6	**102**	4	0	112	−95% confidence	0.44
+1	0	0	3	**21**	0	24	+95% confidence	0.95
+2	0	0	0	0	**0**	0		
All groups	0	14	110	26	0	150		

Table VIII. *Intertester reliability study. Physiotherapists A and B (Pt A and Pt B) rated segmental pain provocation (0 = no tenderness; 1 = tenderness) in 150 randomly selected homecare personnel. Kappa values are given for each level*

L4-L5	Pt B				
Pt A	0	1	Totals		
				Kappa	0.71
0	125	6	131	s.e.	0.09
1	4	15	19	−95% confidence	0.54
All groups	129	21	150	+95% confidence	0.88

L5-S1	Pt B				
Pt A	0	1	Totals		
				Kappa	0.67
0	115	9	124	s.e.	0.08
1	6	20	26	−95% confidence	0.51
All groups	121	29	150	+95% confidence	0.83

both hypermobile: 79.2° ($p < 0.0001$)). Sagittal mobility was predicted (using PLS regression) using the five passive movements and the rating of segmental mobility (trichotomized) as X-variables. It was not possible to predict total thoracic mobility. A significant model could predict total lumbar sagittal mobility, but the degree of explained variance found for this model was low ($R^2 = 0.16$). The variables of levels L5-S1 and L4-L5 were significant, unlike those of the other levels (Th12-L1, L1-L2, L2-L3). A significant model could also be established for total thoraco-lumbar mobility ($R^2 = 0.17$), in which the variables of levels L5-S1, L4-L5 and Th11-Th12 were significant. When the ratings of segmental mobility for the different segments were used alone in the model, the significantly important levels were L5-S1, Th11-Th12 and L4-L5, ($R^2 = 0.16$).

Relationships between joint hypermobility test and segmental mobility

A high degree of correlation was found between segmental mobility (trichotomized) in the two lowest segments (i.e. L4-L5-S1) and the modified Beighton score (Table XI). The strongest relationship was found at the L5-S1 level in the hypomobility group according to the segmental mobility test. This group had a Beighton median value score of 0. Corresponding median values for the normal and hypermobility groups were 1 and 2, respectively.

DISCUSSION

Posture and its relation to mobility

We found positive significant correlations between

Table IX. *Total thoracic sagittal mobility and total lumbar sagittal mobility vs joint mobility (trichotomized modified Beighton score; see text) in homecare personnel (*n *= 606).* p*-values for the statistical comparisons between the two hypermobility groups and the normal group are shown*

	Joint mobility				
Sagittal mobility	Normal (0–2)	Moderate (3–4)	*p**	Pronounced (5–9)	*p*§
Total thoracic sagittal movement	35.0	37.0	n.s.	40.2	0.004
Total lumbar sagittal movement	69.8	74.6	0.004	77.5	0.001

* Denotes normal vs moderate.
§ Denotes normal vs prominent.

Table X. *Segmental mobility (i.e. trichotomized (−1, 0, +1)) in different segments vs total thoracic and lumbar sagittal mobility in homecare personnel (*n = *606).* p-*values for the statistical comparisons between the segmental mobility groups are also given if significant; n.s. = not significant*

Total thoracic sagittal mobility Segment	−1	Statistics −1 vs 0	0	Statistics 0 vs +1	+1
Th10-11	32.6	0.0432	36.0	n.s.	38.2
Th11-12	32.8	n.s.	35.9	n.s.	38.5
Th12-L1	34.6	n.s.	35.7	n.s.	38.4
Total lumbar sagittal mobility **Segment**	**−1**	**Statistics** **−1 vs 0**	**0**	**Statistics** **0 vs +1**	**+1**
Th10-11	64.1	0.0002	71.8	n.s.	77.3
Th11-12	62.1	0.0000	71.5	0.0019	80.2
Th12-L1	67.0	n.s.	71.1	0.0138	78.1
L1-L2	67.2	n.s.	71.0	0.0192	76.9
L2-L3	67.3	n.s.	71.0	0.0105	78.0
L3-L4	71.6	n.s.	70.9	n.s.	74.1
L4-L5	63.7	0.0000	71.6	0.0220	75.6
L5-S1	63.1	0.0000	72.0	0.0006	77.3
L4-L5-S1	56.8	0.0000	74.7	0.0001	79.2

thoracic kyphosis and lumbar lordosis. The findings are in agreement with other studies (19, 20). The importance of postural deviations in the sagittal plane for the generation and maintenance of musculoskeletal complaints is not clear at present (17). Hyperkyphosis was associated with low spinal sagittal mobility, while hyperlordosis (>39°) correlated positively with sagittal spinal mobility. The latter findings are in contrast to the findings of Öhlen et al. (19), who reported a negative correlation in young female gymnasts. When defining *posture* as in Fig. 2 (20), we found less total sagittal mobility in the hyperkyphosis and bi-hypo-curvature groups. Thus, at group level it is reasonable to conclude that posture appears to indicate what mobility may be expected.

The relationships between different kinds of mobility

Posture and mobility are often estimated by visual inspection of the subject standing and bending in different directions. A more objective method measuring general spinal posture and mobility is Debrunner's kyphometry. Using this we found an average lumbar flexion angle of 29.9° which, split into age groups, was very similar to the range of motion presented by Sullivan et al. (26). However, in this study the averages of the lumbar extension angles were 6–10° lower. This may partly be due to methodological differences. Sullivan et al. used inclinometers and measured the extension angle with the "having the subject lie prone on a couch with palms pressing down on the couch at shoulder level and completely extending the elbows to lift the upper body off the couch" (26, p. 683). In our study the extension angle was measured in the standing position. Furthermore, the kyphometers we used could not exceed −70°. Twenty-one subjects reached −70°, and some of them were able to exceed the extension angle. Hence, in the present study we tended to underestimate the relationships.

In the present study joint mobility, general spinal and local segmental mobility (especially in the two lowest lumbar segments) were found to be intercorrelated. We have not been able to locate any other studies analysing the relations between joint mobility, general spinal mobility and manually tested segmental mobility. One possible interpretation of our findings is that the positive intercorrelations between the different mobility variables reflect constitutional factors. Mobility of the spine, neurological status and pain analysis are used in clinical practice to evaluate a patient with low back pain. Often the aim of both physical therapy and medical care is, besides pain relief, to increase spinal mobility (12) or to improve coordination. A probable example is trying to improve decreased knee mobility after a knee injury. Decreased mobility in the spine can be due to several anomalies, disc hernia with rhizopathy and pain, lumbago with muscular spasm, rheumatic disease or age-related degeneration, for example (28). In agreement with other studies we found that spinal as well as joint mobility decreased with increasing age (1, 2, 26).

Table XI. *Median (bold type) and mean for joint mobility (modified Beighton score) in the three segmental mobility groups (trichotomized: −1, 0, +1) at the L4-S1 level in homecare personnel (*n = 606*). The results of the statistical evaluation (ANOVA by ranks) are shown in the two far right columns*

Segment	Segmental mobility				
	−1 **median**/mean	0 **median**/mean	+1 **median**/mean	H	*p*
L4-L5	**0**/1.32	**1**/1.42	**2**/2.14	13.25	0.0013
L5-S1	**0**/0.78	**1**/1.47	**2**/2.57	48.26	< 0.0000
L4-S1 (both)	**0**/0.66	**1**/1.48	**3**/2.93	25.05	< 0.0000

Decreased range of motion of the spine is a common sign in individuals with acute low back pain. However, an aetiological role of the general mobility of the spine with respect to low back pain has not been clearly established (1).

We found mild and pronounced *joint hypermobility* in 16% and 8% of the present subjects. General joint and spinal hypermobility has been described as a possible factor in lumbar insufficiency/pain, or even as an *aetiological* factor of generalized pain problems such as fibromyalgia (9). Increased segmental or general spinal mobility may be due, for example, to constitution, hereditary anomalies, spondylosis with olisthesis, focal segmental hypermobility/instability after injuries, multiple microtrauma (gymnastics) or early disc degeneration (11, 29, 30).

Segmental mobility

Segmental mobility tested by manual procedures in the lumbar spine, such as segmental palpation of passive movement in different directions, is claimed by practitioners of manual medicine to estimate actual mobility and to give additional information relevant to the choice of therapeutic approach. Few studies have considered the reliability of manual segmental mobility (22, 25) and pain provocation procedures, their validity compared to other measurement procedures and to X-rays (8) or their clinical relevance in the assessment of pain and functional disturbances. The *intertester reliability study* of segmental mobility and segmental pain provocation showed relatively good reliability for the two lowest segments L4-L5 and L5-S1. It could be argued that the examiners were specially trained, that the pilot study of 20 patients had been done with the express purpose of achieving consensus and that, indeed, the situation was, from a traditional clinical point of view, unrealistic. However, Strender et al. have also shown acceptable interexaminer reliability for intersegmental movement and pain tests (25) provided sufficient time is allowed for examination and conformity of performance, definitions and evaluations by working together. Low interexaminer reliability of clinical signs and tests could thus be due to insufficient time allowed for standardization of techniques (25). The five passive movements were less reliable than the rating of segmental mobility. Regression analysis showed that the rating of segmental mobility of the physiotherapists was based significantly upon three of the five movements (i.e. sagittal movement, left and right rotation). It is reasonable to conclude that the combination of information from the three passive tests resulted in higher reliability for the rating of segmental mobility.

Although the present study shows acceptable reliability for the segmental tests in the two lowest segments, the question arises as to *what* is registered (i.e. validity). The question of validity is complex and the terminology used is difficult (24). Criterion validity reflects the correlation between a new scale or method, ideally with a "gold standard", which has been used and accepted in the field (24). An ideal "gold standard" for the aspects of segmental mobility could be different kinds of functional radiography, but such studies are difficult and ethically controversial to design. In the present study we found correlations between joint mobility and multisegmental sagittal thoraco-lumbar spinal mobility, which indicates validity in relation to a more "objective" mobility test such as kyphometry. However, kyphometry is obviously not ideal as a "gold standard" since it is a multisegmental method and in this study the same physiotherapists performed both the segmental mobility tests and the general spinal mobility test. In clinical practice—according to our experience—segmental mobility tests are regarded as relatively subjective, while kyphometry is a more objective method. However, in the present study the segmental mobility test was always performed (and registered) prior to the kyphometry in order to eliminate or reduce the risk that the kyphometry directly influenced the rating of segmental mobility. Optimally, the segmental mobility test and the kyphometry would be done by different examiners. However, such a design was not possible for practical reasons.

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