Relationships Between Lumbar Flexibility, Sit-and-Reach Test, and a Previous History of Low Back Discomfort in Industrial Workers

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Catalogue Data

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Mots clés: flexibilité du tronc, test de condition physique, amplitude de mouvement, lombalgie, cinétique lombaire

Abstract/Résumé
The sit-and-reach (S&R) test is often included in standard fitness tests (e.g., Canadian Physical Activity, Fitness and Lifestyle Appraisal [CPAFLA]), justified on the assumption that it is an indicator of low back health. Two issues were examined here: Is low back flexibility linked to having a history of low back disorders? And is the S&R test an indicator of low back flexibility? The relationship between S&R test scores, lumbar range of motion, and having a history of low back discomfort was examined in 72 asymptomatic (at test time) industrial workers (70 M, 2 F; mean age 35 ys; height 1.79 m; mass 84.7 kg). The S&R test, among many collected, was performed according to the CPAFLA guidelines. History of low back discomfort (LBD) was categorized based on whether or not time was lost from work. The S&R test was unable to distinguish between those with a history of LBD and those without. Specific lumbar sagittal range of motion could make this distinction. A moderate correlation ($r = 0.42$) surfaced between S&R and lumbar flexibility. This study suggests that the value of S&R as an indicator of previous back discomfort is questionable and there may be better indicators for inclusion in the CPAFLA.

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Introduction

Sit-and-reach (S&R) scores are thought to represent low back flexibility (Jackson et al., 1998; Minkler and Patterson, 1994) and have been used as a surrogate indicator of low back health (Albert et al., 2001; Gledhill, 2001). This test, or a similar fingertip-to-floor distance test, has been used as a method of estimating trunk flexibility or mobility (Biering-Sorensen, 1984; Hoeger and Hopkins, 1992; Minkler and Patterson, 1994). For these reasons it is included in fitness testing protocols, specifically as a measure of low back and hamstring flexibility (e.g., Albert et al., 2001; Hui and Yuen, 2000; Jackson et al., 1998). However, Jackson et al. (1998) have suggested that the sit-and-reach test is not related to low back pain status, and they question its inclusion in testing protocols as a measure of low back flexibility. Based on the Hui and Yuen (2000) report, the sit-and-reach test appears valid and reliable in comparison to other modified versions of the test but, based on Jackson et al.’s (1998) results, they also question its use for estimating either hamstring or low back flexibility.

Given that S&R tests involve a whole body motion, scores may be influenced by many anthropometric and joint flexibility factors in the shoulders, upper spine, and upper extremities. Given the controversy of both the scientific rationale and the applicability of the S&R test to low back health, we were motivated to investigate the relationship between lumbar flexibility, S&R scores, and having a history of low back discomfort (LBD) in a group of currently employed workers.

Jackson et al. (1998) with a very large sample size (N = 2,747) found no relationship, linear or otherwise, between S&R scores and incidence of low back pain (LBP). They mailed a musculoskeletal health survey to over 14,000 participants approximately 6 years after an initial health and fitness assessment. Although sit-and-reach measures were taken according to the standard protocol, lumbar range of motion (ROM) and its possible relationship to LBP was not quantified. Predictive capabilities of the S&R scores were assessed by Battie et al. (1990) who, with a very large sample size (N = 3,020), found no significant association between S&R scores, lateral bend measures, and the risk of future back pain. In addition to
S&R scores, lumbar ROM has been assessed. Sullivan et al. (2000) reported a moderate correlation between lumbar sagittal ROM and not having clinically relevant impairment of the low back ($r = -0.39$). Others have reported correlations between 0.09 (e.g., Gronblad et al., 1997) and 0.48 (e.g., Deyo and Diehl, 1983), generally suggesting a moderate relationship. It may be that LBD is not related to S&R scores but rather to lumbar ROM; this remains a point of contention.

Some of the variability in the reported correlations of lumbar motion may have been due to the wide range of methods utilized for measurement, such as the Schober test (Biering-Sorensen, 1983), fingertip-to-floor distance (Deyo and Diehl, 1983), flexi-curve scores (Burton, 1986), sit-and-reach scores (Jackson and Langford, 1989; McQuade et al., 1988; Minkler and Patterson, 1994), inclinometer scores (Mandell et al., 1993; Mellin, 1988; Sullivan et al., 2000), kinematic analysis (Esola et al., 1996), and electromagnetic techniques (Hindle and Pearcy, 1989). Some of these techniques have been validated against lumbar motion documented with radiographic techniques, namely the electromagnetic approach (Adams and Dolan, 1991; Hindle and Pearcy, 1989a; Van Herp et al., 2000), the flexi-curve (Burton, 1986), the inclinometer (Saur et al., 1996), and the Schober test (McRae and Wright, 1969).

Other techniques seem not to have been validated. In fact the fingertip-to-floor distance and S&R are quite similar in their nonspecificity since they require spine, hip, and shoulder motion. They have been suggested as poor indicators of low back motion (Kippers and Parker, 1987). Although hip and shoulder motion may be important to measure in their own right, their potential contribution to S&R scores complicate interpretation (Battie et al., 1990). In addition, leg and arm length proportion has also been shown to affect S&R scores and this may affect correlations to lumbar flexibility (Hoeger and Hopkins, 1992). Esola et al. (1996) found a link between hip and lumbar sagittal motion in healthy subjects, but those with a history of LBP demonstrated a different lumbar-to-hip-flexion ratio at various stages of the flexion motion. All of these issues cloud the interpretation of sit-and-reach scores in the context of assessing back health or fitness.

The hypotheses of this study were as follows: (a) that S&R scores would not be related to lumbar sagittal range of motion; (b) that S&R scores would not be related to having a history of LBD; (c) that specific lumbar sagittal ROM scores would be related to a history of LBD; (d) that S&R scores would not be related to lumbar motion in the lateral bend and axial twist planes; (e) that LBD would be unrelated to lumbar motion in the lateral bend and axial twist planes; and (f) that hip or shoulder flexibility would not be related to S&R scores and LBD. The previous review demonstrated that there is some question as to which components of flexibility are important in achieving a given S&R score. For example, if S&R scores are not related to lumbar motion, what is the source of the ability to reach? Even if these variables are related, is there an alternate measure of flexibility that would better correlate to S&R scores?

**Methods**

The subject pool for this study consisted of 72 blue-collar workers, including some from an electroplating plant where car bumpers and wheels were manually handled as well as workers from a hydro plant (see Table 1 for subject characteristics). Of
the 72 workers, 28 had not had a back injury or lost any work time, 26 had had an injury and lost time from work, and the remaining 18 had a history of LBD but it was never severe enough to result in time lost from work. In cases where data was pooled, if no time was lost from work then these subjects were considered together with those who had never been injured. Their respective employers paid them regular hourly wages for the time spent traveling to the Occupational Biomechanics Laboratory and participating in the study.

This project was approved by the Office of Research Ethics at the university. All subjects gave informed consent prior to testing. Subjects were screened for current low back symptoms or other contraindications documented by the PAR-Q for participation in a variety of physical tests that were performed in conjunction with the current study (Canadian Society of Exercise Physiology, 1996). All subjects were asymptomatic at the time of testing.

Several categories of self-reported LBD history were evaluated (Table 2). These categories were based on subjects’ answers to a questionnaire detailing their previous history of low back discomfort. The questionnaire posed seven questions, three of which required “yes” or “no” answers:

1. Have you ever experienced low back discomfort that did not cause you to stop normal daily activities? [NWL–LBD = No Work Loss from Low Back Discomfort]
2. How long ago was the last episode of discomfort? [TSNWL–LBD = Time Since No Work Loss–LBD, measured in weeks]
3. How long did the discomfort last? [DNWL–LBD = Duration of No Work Loss–LBD, measured in days]
4. Have you ever experienced disabling low back troubles that caused you to miss work? [WL–LBD = Work Loss due to LBD]
5. How long ago was the last episode that caused you to miss work? [TSWL–LBD = Time Since Work Loss due to LBD, measured in weeks]
6. How long were you off work? [DWL–LBD = Duration of Work Loss due to LBD, measured in days]
7. Have you ever sought medical attention for low back discomfort or injury? [SMA–LBD = Sought Medical Attention due to LBD] (The results of Question 7 were not reported in this work.)

| Table 1  Mean Characteristics of the 72 Participating Subjects (70 M, 2 F) |
|-----------------------------------|------------------|------------------|---|
| Minimum  | Maximum | Mean | SD |
| Age (yrs) | 20 | 51 | 35.2 | 8.6 |
| Height (m) | 1.58 | 2.0 | 1.79 | 0.07 |
| Mass (kg) | 58.5 | 118 | 84.7 | 12.9 |
| BMI | 19.7 | 32.4 | 26.3 | 2.9 |

Note: BMI = body mass index.
Isolated lumbar flexibility was quantified (accuracy, 0.75°; resolution, 0.1°) with a 3Space Isotrak electromagnetic device (Polhemus Navigation Sciences Div., Colchester, VT, USA). The source was placed with the cable vertically oriented over the sacrum at S1 and held with an elastic strap. The sensor was placed over T12, cable vertically oriented, and held with an elastic strap and tape on the skin. The difference between T12 and S1 indicated isolated lumbar motion in any whole-body task. This cable orientation minimizes the potential for cable tension to induce motion artifact.

The tasks for measuring lumbar motion began with a neutral standing position, then bending forward as far as possible and relaxing momentarily at the end of the flexion movement. Subjects were asked to let their torso and head hang in a rag doll fashion and return to a standing position, then extend the spine as far as possible. The end range position was only held momentarily so as to prevent creep from having an effect on the range (Peach et al., 1998). Motion was quantified in the lateral plane beginning in a neutral standing position, then bending as far to the right as possible within the sagittal plane, returning to neutral, and then bending left as far as possible. Finally, again from neutral standing, subjects slowly twisted to the right as far as possible, moving everything but their feet, then returning to neutral and repeating the twisting motion to the left side. Each movement was demonstrated by the experimenter beforehand. Each movement was repeated twice within a 20-sec trial.

The average of the two trials was used. The sit-and-reach test was conducted in separate trials on the same day in accordance with standard Canadian Physical Activity, Fitness and Lifestyle Appraisal protocol (CPAFLA, 1986). Hip and shoulder motion was measured manually by means of a Leighton Flexometer (Spokane, WA, USA). Hip flexion was measured from a supine position and hip extension from a prone position as described in the Professional Fitness and Lifestyle Consultant Resource Manual (Canadian Society for Exercise Physiology, 1996). Shoulder flexion and extension was assessed using a Leighton Flexometer. Shoulder

### Table 2  Means and Standard Deviations of Times for Each LBD Condition Recorded

<table>
<thead>
<tr>
<th>Condition</th>
<th>N</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Low Back Discomfort</td>
<td>28</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>No Work Loss</td>
<td>18</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>TSNWL–LBD (wks)</td>
<td>18</td>
<td>0</td>
<td>840</td>
<td>65.35</td>
<td>187.16</td>
</tr>
<tr>
<td>DNWL–LBD (days)</td>
<td>18</td>
<td>0</td>
<td>365</td>
<td>18.16</td>
<td>63.81</td>
</tr>
<tr>
<td>Work Loss</td>
<td>26</td>
<td>na</td>
<td>na</td>
<td>0.36</td>
<td>0.484</td>
</tr>
<tr>
<td>TSWL–LBD (wks)</td>
<td>25</td>
<td>3</td>
<td>960</td>
<td>270.52</td>
<td>277.51</td>
</tr>
<tr>
<td>DWL–LBD (days)</td>
<td>26</td>
<td>1</td>
<td>49</td>
<td>6.98</td>
<td>10.33</td>
</tr>
</tbody>
</table>

Note: LBD = low back discomfort; TSNWL = time (weeks) since no work loss; DNWL = duration (days) of no work loss; TSWL = time (weeks) since work loss; DWL = duration (days) of work loss.
flexibility was measured as follows: with the subject standing at the projected corner of a wall, the arm to be measured is extended to just beyond the projected corner, with the other arm at the side and the back to wall, with shoulder blades, buttocks, and heels touching the wall. The flexometer is fastened to the lateral side of the upper arm and the dial is locked with the arm in the vertical position; the elbow is locked in extension and the palm faces the thigh. The arm is then moved forward and upward as far as possible for flexion and moved backward and upward as far as possible for extension.

A partial correlation matrix (controlling for age) was generated and a significant ($p < 0.05$) Pearson $r$ was reported. In particular there was an interest in comparing the measures of flexibility to the categories of low back injury, thus all variables were correlated to each other. Furthermore, relationships between the anthropometric measures of chest, waist, and hip girth; body mass index; or sum of 5 skinfolds (measured as part of a standardized fitness test) and S&R scores or the lumbar flexibility measures were assessed through correlation. A one-way ANOVA was also performed with the injury category (no LBD, WL–LBD, NWL–LBD) as the independent variable and the flexibility measure (S&R, lumbar flexion) as the dependent variable. This permitted an evaluation of the differences among the flexibility measures between WL–LBD and healthy subjects with no history of work loss.

**Results**

**FLEXION**

Lumbar sagittal range of motion could distinguish between those who have had WL–LBD and those who have not had LBD ($F = 3.0260, p = 0.045$), while the sit-and-reach test could not make this distinction ($F = 0.247, p = 0.782$). When controlling statistically for variables so that scores were independent of age and time of day that the flexion trial was conducted, S&R significantly correlated to lumbar sagittal range of motion ($r = .42, p < 0.001, \delta = 0.978$). Also lumbar flexion correlated to LBD in three categories of no LBD, WL–LBD, and NWL–LBD ($r = 0.24, p = 0.046$), while S&R had no correlation with LBD ($r = –0.017, p = 0.89$). Mean values showed that lumbar flexion ROM decreased in those with a history of LBD, although this was only significant for WL–LBD (Table 3).

**EXTENSION**

When controlling for age, sit-and-reach correlated weakly to extension ROM ($r = 0.24, p = 0.045, \delta = 0.64$). Neither test was able to distinguish between those workers with NWL–LBD and those with no LBD, nor were the tests able to distinguish between WL–LBD and no LBD. Extension ROM, however, did inversely correlate to the time since the last WL–LBD ($r = –0.557, p = 0.003, \delta = 0.999$). Extension ROM decreased as the time since the last LBD episode increased, and mean values showed that lumbar extension tended to decrease with LBD history although this was not significant.

**LATERAL BEND AND AXIAL TWIST**

The S&R scores were unrelated to lumbar motion in the lateral bend plane.
The S&R scores were unrelated to lumbar motion in the axial twist plane. However, right axial twist was able to distinguish between all groups of LBD ($F = 3.814$, $p = 0.027$) whereas left axial twist was not. Mean values showed that axial twist increased with LBD history.

**HIP FLEXION AND SHOULDER EXTENSION**

There was some relationship between hip and/or shoulder flexibility, S&R scores, and LBD. Hip flexion did correlate significantly with S&R scores; left hip flexion $r = 0.47$ ($p < 0.001$, $\delta = 0.994$), right hip flexion $r = 0.38$ ($p < 0.001$, $\delta = 0.948$). These correlations were of the same magnitude as the lumbar flexion to S&R correlations. Shoulder extension was not correlated to S&R scores; the correlations in this case were nearly zero. Interestingly, the shoulder flexion scores were able to distinguish between NWL–LBD and WL–LBD in the ANOVA ($p = 0.028$), but only for the right side.

**COMPOSITE MEASURE (COMBINED LOW BACK, HIP, AND SHOULDER MOTION)**

A composite measure was created from the Pythagorean (square root of the sum of squares) sum of lumbar flexion, hip flexion, and shoulder extension flexibility scores. This sum treats each score as an independent variable relative to every

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**Table 3 Means and Standard Deviations of Measured Ranges**

<table>
<thead>
<tr>
<th>Ranges</th>
<th>No LBD</th>
<th>NWL–LBD</th>
<th>Avg NWL</th>
<th>NWL</th>
<th>WL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>29.9</td>
<td>36.3</td>
<td>33.1</td>
<td>39.1</td>
<td>26</td>
</tr>
<tr>
<td>Flexion ($^\circ$) + $\otimes$</td>
<td>64.0</td>
<td>60.7*</td>
<td>62.3*</td>
<td>55.2*</td>
<td>19.5</td>
</tr>
<tr>
<td>Extension ($^\circ$)</td>
<td>20.8</td>
<td>19.2</td>
<td>20.0</td>
<td>17.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Right bend ($^\circ$)</td>
<td>25.0</td>
<td>23.7</td>
<td>24.3</td>
<td>22.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Left bend ($^\circ$)</td>
<td>23.4</td>
<td>25.2</td>
<td>24.3</td>
<td>24.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Right twist ($^\circ$)</td>
<td>13.4*</td>
<td>15.7*</td>
<td>14.6</td>
<td>15.3*</td>
<td>3.8</td>
</tr>
<tr>
<td>Left twist ($^\circ$)</td>
<td>14.8</td>
<td>15.6</td>
<td>15.2</td>
<td>16.2</td>
<td>5.3</td>
</tr>
<tr>
<td>Right hip flex ($^\circ$) +</td>
<td>88.5</td>
<td>91.4</td>
<td>90.0</td>
<td>91.2</td>
<td>21.9</td>
</tr>
<tr>
<td>Left hip flex ($^\circ$) +</td>
<td>88.8</td>
<td>90.6</td>
<td>89.7</td>
<td>92.8</td>
<td>20.8</td>
</tr>
<tr>
<td>S&amp;R (cm)</td>
<td>29.8</td>
<td>30.5</td>
<td>30.1</td>
<td>28.9</td>
<td>12.0</td>
</tr>
<tr>
<td>SR rating</td>
<td>3.04</td>
<td>3.1</td>
<td>3.1</td>
<td>3.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Note:* AvgNWL = mean of both NWL categories (no LBD and NWL–LBD), which were pooled due to no difference between them. The groups that differed are indicated with * ($p$ values noted in text). For a given measure, categories of LBD identified by ($^\otimes$) were significantly different from each other as measured by ANOVA. Measures marked by (+) correlated positively to S&R scores. $\otimes$Flexion measure correlate positively to LBD.
other score and this independence is analogous to the biological independence of
the flexibility scores (i.e., assuming that shoulder ROM is independent of low
back and hip, etc.). This composite measure was then correlated to S&R scores.
The Pythagorean sum of lumbar flexion, hip flexion, and shoulder extension sig-
nificantly correlated to S&R scores ($r = 0.54, p < 0.001, \delta = 0.999$). The Pythagorean
sum of lumbar flexion and hip flexion returned the strongest correlation to S&R
scores ($r = 0.58, p < 0.000, \delta = 0.999$).

TIME OF COLLECTION

Since the tests (S&R or lumbar ROM) were not performed at standard times of the
day, it was important to verify that time of day had no impact on the results. De-
spite the fact that, after arising for the day, range of motion increases due to creep
from reduced hydration of the vertebral discs, the time of day at which each trial
was collected had no effect on the measured range of lumbar motion.

ANTHROPOMETRY

There was no correlation between the anthropometric measures of chest, waist,
and hip girth; body mass index; or sum of 5 skinfolds and S&R scores or the
lumbar flexibility measures.

LBD VARIABLES

Other than the variables reported as significant (NWL–LBD and WL–LBD) in the
preceding sections, only one of the other LBD variables correlated significantly
with flexibility measures. The time elapsed since WL–LBD correlated well with
extension flexibility ($r = -0.56$).

Discussion

Given the six hypotheses listed in the Introduction, the following six statements
can be made: (1) S&R scores are related to lumbar sagittal ROM. The correlation
was not high, but it was significant and within the range reported by others
(McQuade et al., 1988; Sullivan et al., 2000). (2) S&R scores are not related to a
history of LBD. This is in agreement with Jackson et al.’s (1998) suggestion that
the two were not related. (3) Lumbar sagittal ROM scores are related to having a
history of LBD. This is controversial, given the contradictory data reported by
others (Battie et al., 1990; Burton and Tillotson, 1989; Sullivan et al., 2000). Note
that a significant amount of time had elapsed for our subjects since the last lost-
work-time episode of LBD. (4) S&R scores are not related to lumbar motion in the
lateral bend and axial twist planes. Although motion in the spine has been shown
to be strongly coupled between planes of movement within a trial (Russell et al.,
1993), no data was found to indicate a relationship between the maximum ROM
between planes of motion. Our own data showed very poor correlation between
the maximum ROM in different planes ($r = 0.03$ to $0.4$). (5) LBD is not related to
lumbar motion in the lateral bend and axial twist planes. Right axial twist was
different between all groups of no LBD, WL–LBD, and NWL–LBD. (6) Finally,
there is a relationship between hip and/or shoulder flexibility and S&R scores and LBD. It was expected, given the nature of a measure such as the sit-and-reach, that if lumbar flexion was related to S&R scores, hip flexion might also be related; however, it was not related to LBD.

Mellin (1988) found some age-corrected relationships between hip flexion and low back pain as well as low back flexibility. Although the reported correlations were significant, they were not high, ranging from $r = 0.11$ to $r = 0.21$. The relationship of shoulder flexion on the right side to lost work time is somewhat confusing, especially given the total lack of correlation between this measure and LBD ($r = 0.042$). Our study assessed workers who were currently pain free, and thus all conclusions are related to ROM deficits lingering in those workers with a work-loss history. Whether or not these deficits were present prior to their LBD episodes is unknown. Nevertheless, perhaps this is why having a history of LBD (with the deficits documented here) is a strong predictor of reoccurrence. This may also be an important consideration for determining the components for assessing low back health or fitness.

There are several limitations to the results reported herein. Cady et al. (1979) stated that a higher level of fitness, as a composite of five variables of which flexibility was a component, had a protective effect against low back injury. The current study cannot establish the cause-and-effect nature of this relationship. The effects recorded here may have been present previous to their LBD episode. The four experimenters recording the measures were not constant, although they all were very experienced in administering these tests. Regardless, Barrett et al. (1999) found acceptable intra-examiner reliability using the 3Space Isotrak to measure spine motion.

The working-subject populations from which the data was collected, all male save two, are likely not representative of the general population but are representative of industrial workers performing manual work. Our lumbar flexibility data was recorded with a Polhemus 3Space Isotrak unit. Hindle and Pearcy (1989a) report that this unit systematically overestimates the magnitude of motion in the spine, although the patterns of motion are accurately reflected and normalized to the total ROM such that the resulting correlations would be unaffected. In any event, Adams and Dolan (1991) found no significant differences in one subject in which lumbar motion was measured by both 3Space Isotrak and x-ray. Van Herp et al. (2000) used vertical cable placement on the 3Space sensors, similar to that employed in this study. This in combination with plastic leveling wedges lead to good agreement with x-ray data. The self-report questionnaire used in this research has not been validated as a survey tool, although worker reports of work loss was in agreement with company records.

Our work shows a correlation between lumbar flexibility and LBD as well as between lumbar flexibility and S&R, but not between S&R and LBD. This may seem contradictory. In fact, in a general case, the correlation of Variables A and B as well as B and C does not necessitate that A and C also correlate. The reason for this is that the correlations are not perfect and the error accumulates perhaps to a sufficient extent that A and C may not correlate. Thus caution should be exercised when relating S&R to low back discomfort. A correlation ($r = 0.42$) between sit-and-reach and sagittal plane lumbar flexibility demonstrates a moderate relationship and is consistent with results reported by others.
Despite the use of widely varying methods of measurement, most researchers have obtained a similar correlation between these two variables. Shephard et al. (1990) report a correlation of 0.61 between S&R and a general trunk flexibility factor resulting from a factor analysis of several related variables. Jackson and Langford (1989) report a low \((r = 0.28)\) correlation between S&R and low back flexibility in males, as measured by a modified Schober test. They found no correlation between the two variables in females. Minkler and Patterson (1994) report a correlation of \(r = 0.40\) between S&R and low back flexibility, as measured by a modified Schober test. However, when leg and arm length were accounted for (Hoeger and Hopkins, 1992), the correlation dropped to \(r = 0.25\) \((p > 0.05)\). Although there seems to be some degree of correlation, there are clearly some confounding variables. In this study, when controlling for age, there was no correlation between S&R score and the anthropometric variables of chest, waist, and hip girth, body mass index; or sum of 5 skinfolds.

The subjects classified as NWL–LBD showed no flexibility impairments, regardless of history of LBD, in either S&R or lumbar flexion, although when severe enough to cause WL–LBD, flexibility was compromised. This reinforces a suggestion by Battie et al. (1990) that the severity of LBD, as measured by an absence from work, decreased subsequent flexibility measures. They found that LBD had a lingering effect on the modified Schober test results as well as on S&R. Research by Burton and Tillotson (1989) and by Burton et al. (1989) also supports the finding that males with recurrent LBD have reduced mobility. McQuade et al. (1988) report that flexibility (in their case, sit and reach) increased as physical dysfunction decreased. Although S&R correlation has been proven moderate at best in other studies, a likely cause for a relationship in this case is the use of a continuum of physical dysfunction rather than assignment to one of two groups. The finding in the current study, that the more severe LBD (WL–LBD) was related to lumbar flexion but not on S&R, strengthens the association between LBD history and flexibility impairment. More important, severity of LBD seems to play a significant role.

Since lumbar flexibility appears to be linked to a history of WL–LBD the question then becomes, Was the flexibility impairment present before the LBD, possibly leading to it? The current study was not designed to answer this question. Battie et al. (1990) found no prospective association between flexibility, as measured by a modified Schober test, and LBD reported in the workplace, though in this case LBD was not necessarily serious enough to cause WL–LBD. Biering-Sorensen (1984) did find a prospective association, however, but only in males. Burton and Tillotson (1989) identified both extremes of hypo- and hypermobility as risk factors for LBD. Troup et al. (1987) also showed a prospective association between reduced sagittal flexibility and LBD reports in the follow-up year. Bigos et al. (1991) also found a similar prospective association.

The balance of evidence seems in favor of reduced flexibility affecting future risk of LBD. A follow-up over the next few years of subjects tested in this study may contribute an answer to this cause-and-effect issue. However, in terms of including the S&R in a general test as an indicator of future back problems, there appears to be no rationale nor support.

Interestingly, the current study showed that although there were no correlations between planes of motion, there were asymmetrical differences in lateral
bend and axial twist. Movement to the right side was significantly different between WL–LBD and no LBD. Battie et al. (1990) and Barrett et al. (1999) also showed some lateral-bending differences between groups, although Barrett’s data was in a coupled motion. Perhaps this bears closer investigation. It is also interesting that in a companion study (McGill et al., in press), deficits were observed in muscle endurance in addition to deficits in those with a history of having less spine ROM in both flexion and extension but more range in both right and left axial twist. This is in agreement with recent data suggesting that as disc degeneration progresses from Grades I to V, range of motion (especially in axial twist) increases to a maximum in Grade IV before decreasing again in Grade V (Tanaka et al., 2001). The magnitude of the difference in range of axial rotation between Grades I and IV is similar to the magnitude found in the present data (3–4 deg). Coupled movements were unaffected.

In conclusion, there is some evidence to suggest that S&R is related to some general aspects of flexibility, but it is difficult to interpret (Shephard et al., 1990). The current and considerable body of knowledge on this topic permits a consensus that sit-and-reach tests contain too many confounding variables to act as a surrogate for defining lumbar sagittal range of motion. Is the S&R test of any value for indicating back health? Lumbar-specific tests, as opposed to sit-and-reach tests, strongly support the idea that LBD is related to impairment of lumbar sagittal range of motion. The search for tests to incorporate into a fitness test is always a struggle between validity and utility. While the data of this study suggests that measures of lumbar ROM may be more valid in terms of the relationship between LBD and back fitness, they are more difficult to obtain. On the other hand, there are other fitness variables that are linked to both having a history of LBD and predicting those who will develop LBD in the future. For example, a test of torso isometric muscle endurance (Albert et al., 2001; Luoto et al., 1995; Payne et al., 2000), both flexor and extensor (McGill et al., 1999), may be more justified for inclusion into a standard fitness test such as the Canadian Physical Activity, Fitness and Lifestyle Appraisal.

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