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MEASUREMENT OF ABDOMINAL AND BACK MUSCLE STRENGTH WITH AND WITHOUT LOW BACK PAIN

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ABSTRACT. This study was performed to find whether measurement of maximum instantaneous tension of spinal and abdominal muscles in normal painfree subjects and in patients with low back pain would reveal differences that might help to elucidate the importance of muscular strength in this syndrome. The tests were performed in 160 men and women, 63 of whom were suffering from low back pain. In the male groups the values for those patients who had been incapacitated less than one month were not significantly lower than for the controls. This was the case, however, in those who had been inactive for more than one month, where the values of strength were lower for both trunk extension and flexion. In the female groups the values for the strength variables tested were significantly lower for the patients than the controls except for abdominal muscle strength in the older women. Pain during the performance of the tests was found to be a probable strength reducing factor. There was no difference in strength between those women who complained of back pain and those who for a long period had been painfree and wearing a corset. These findings thus show—in variance with the general expected view—that the strength of spinal and abdominal muscles are of doubtful importance for the prevention of low back syndrome.

In spite of the increasing incidence of low back pain syndromes in most modern societies the aetiology is still obscure. Anatomic, histologic, chemical and biomechanical studies have so far failed to reveal the true cause; most probably a combination of several factors exists in these patients.

Muscular factors have long been considered of relevance in this connection, but few studies on the strength of the abdominal and spinal muscles in relation to low back pain have been conducted, although their importance in protecting the lower back from disease and injury has frequently been postulated. Weak muscles as a contributory cause of chronic low back pain syndrome have been discussed, by among others, Schede (10), Matthiash (9), Sparup (11), Kottke (7), Hansen (6), and Alston *et al.* (1).

The study reported here was performed to find whether measurement of maximum instantaneous tension (3) of spinal and abdominal muscles in normal pain-free subjects and in patients with low back pain would reveal any difference that might help to elucidate the importance of muscular strength for this syndrome. Corsets are often prescribed for such patients, but it has been said (7) that they may lead to a severe weakening of the abdominal and back muscles that might prove harmful and predispose to further attacks. The effect on the trunk-muscle strength of wearing a corset for a long period will also be reported.

MATERIAL

The total material consisted of 160 subjects, 63 of whom were patients suffering from the low back pain syndrome (33 men, 30 women). No case of sciatica was included, but only patients with localized symptoms from the lumbar region. The symptoms had been more or less permanent for some time, and most of the patients had been incapable of working for a period. No patient with acute pain was examined. At the time of the tests all the patients were recovering from their latest attack of low back pain.

The control group comprised 43 men and 37 women who had no history of low back pain.

The third group consisted of 17 women who had been using a corset constantly for at least 6 months ($^1/_2$–20 years, mean 5 years). When wearing the corset none of these patients suffered from low back pain. The mean age, weight and height for the men and women divided according to age (20–35 and 36–55 years) are shown in Tables I–V. A statistical analysis by Student's *t*-test revealed no significant differences between the controls and the patient groups as regards age, weight and height.

All the subjects tested were divided into 3 groups according to their usual type of work; 1) collar work, 2) moderately hard physical work and 3) hard physical work.

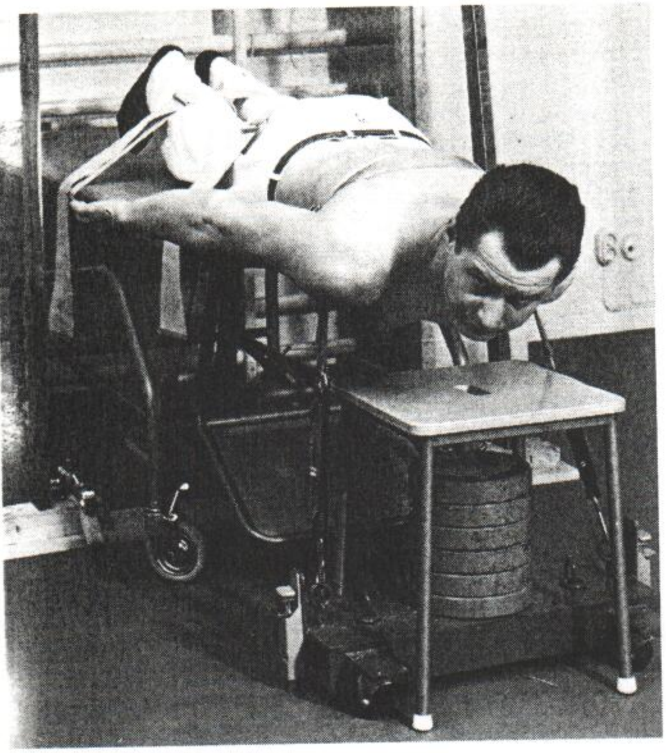

Fig. 1. Methods used for testing trunk extension strength in the prone position.

With this fairly crude classification no statistical differences were detected between the controls and the other groups.

TEST METHODS

The methods used are essentially the same as those described by Mayer & Greenberg (8), Asmussen & Heeböll-Nielsen (2), Sparup (11), Hansen (6), and Alston *et al.* (1).

Trunk extension strength (Fig. 1)

The subject was placed on a plinth in the prone position with the edge of the plinth on a level with the upper border of the iliac crest. A stabilizing belt was strapped over the lower legs. In this position the patient was instructed to rest the upper part of the body on a chair 0.2 m below the plinth. A belt was placed across the back just under the arms and drawn tight, and each end was connected to a spring balance fixed to a beam on the floor. The subject was asked to raise his back with his arms at his sides.

The strength was determined by adding the readings of the two spring balances. The test was repeated three times and the mean taken.

Trunk extension strength 2 (Fig. 2)

The subject was placed facing a vertical board with a stabilizing belt over the buttocks. A belt with two straps over the shoulders was placed across the back just under the arms. The belt was tightened and each end connected to a spring balance fixed to a bar behind the board. The patient was told to bend backwards against the force of the belt. Three determinations were made and the mean was recorded.

Abdominal strength (Fig. 3)

The subject was placed on the plinth in the supine position with hip- and knee-joints flexed and the feet supported. A belt with two straps that passed over the shoulders was placed across the chest under the arms. Each end of the belt was connected to a Zadig dynamometer fixed to a beam on the floor and stabilized by two vertical posts bearing on the ceiling.

The belt was tightened and the subject instructed to curl up against the force of the belt. This arrangement permitted a range of movement of about 30°; according to Flint (4) most of the abdominal muscle strength is exerted between 15 and 30° of forward flexion of the trunk. The sum of the two dynamometer readings was taken as a measure of the abdominal muscle strength. Three determinations were made and the mean was recorded.

RESULTS

The results obtained in the 160 subjects are presented in Tables I–V. The material was divided

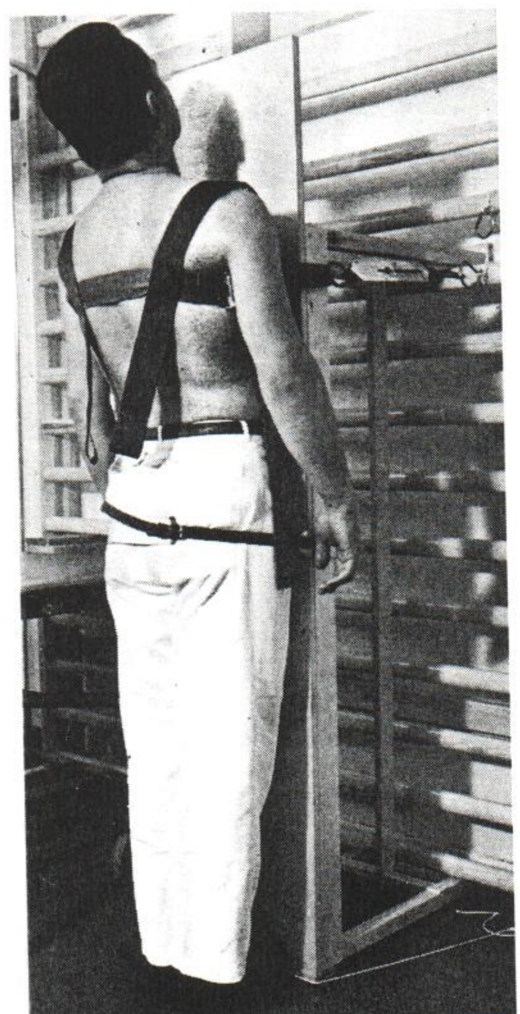

Fig. 2. Method used for testing trunk extension strength in the standing position.

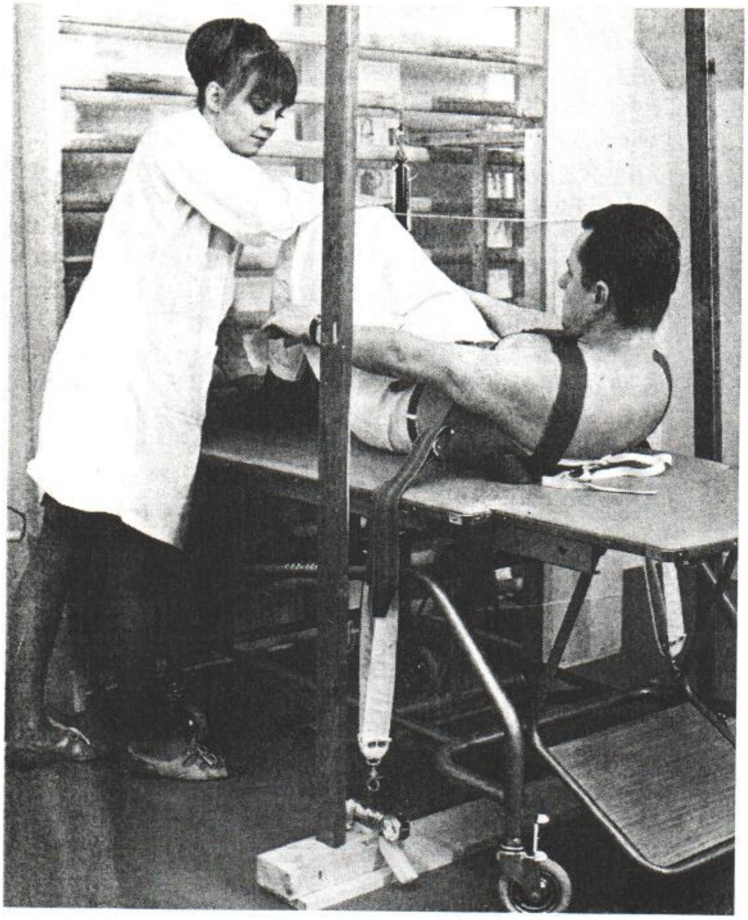

Fig. 3. Method used for testing abdominal muscle strength.

into four groups; men of 20–35 and 36–55 years; women of 20–35 and 36–55 years. Within these groups (or sub-groups, as in Tables III and V) there was no statistical difference between the patients and the controls with respect to age, height or weight. By multiple regression it was also found that the variables "trunk extension strength 1", "trunk extension strength 2" and "abdominal strength" were independent of age, height and weight, except for the group "women

Table I. *Men, 20–35 years*

		Controls	Patients	Difference[a]
Age, years	Mean	25.8	25.6	
	S.D.	4.9	5.1	Not signif.
	n	24	8	
Body height, cm	Mean	178.4	174.8	
	S.D.	5.6	6.5	No signif.
	n	24	8	
Body weight, kg	Mean	70.2	71.4	
	S.D.	6.0	6.5	Not signif.
	n	24	8	
Trunk extension strength 1	Mean	66.1	62.5	
	S.D.	13.9	16.2	Not signif.
	n	24	8	
Trunk extension strength 2	Mean	56.7	55.5	
	S.D.	12.0	12.2	Not signif.
	n	24	8	
Abdominal strength	Mean	50.9	39.4	
	S.D.	19.3	17.4	Significant
	n	19	7	

[a] Student's *t*-test.

Table II. *Men, 36–55 years*

		Controls	Patients	Difference[a]
Age, years	Mean	47.1	46.4	
	S.D.	5.9	6.7	Not signif.
	n	19	25	
Body height, cm	Mean	176.5	175.9	
	S.D.	5.7	7.0	Not signif.
	n	19	25	
Body weight, kg	Mean	76.1	75.6	
	S.D.	8.9	9.8	Not signif.
	n	19	25	
Trunk extension strength 1	Mean	61.4	46.5	
	S.D.	13.5	15.5	Significant
	n	19	25	
Trunk extension strength 2	Mean	54.0	46.9	
	S.D.	10.9	15.1	Significant
	n	19	25	
Abdominal strength	Mean	32.8	22.7	
	S.D.	12.2	14.7	Significant
	n	15	20	

[a] Student's *t*-test.

Table III. *Men, 36–55 years*

		Controls	Patient's incapac. <1 month	Difference[a]	Patient's incapac. >1 month	Difference[a]
Age, years	Mean	47.1	45.2	Not signif.	47.5	Not signif.
	S.D.	5.9	8.1		4.7	
	n	19	13		12	
Body height, cm	Mean	176.5	177.5	Not signif.	174.2	Not signif.
	S.D.	5.7	6.6		7.3	
	n	19	13		12	
Body weight, kg	Mean	76.1	80.8	Not signif.	70.0	Not signif.
	S.D.	8.9	7.3		9.2	
	n	19	13		12	
Trunk extension strength 1	Mean	61.4	54.1	Not signif.	38.3	Significant
	S.D.	13.5	16.0		10.2	
	n	19	13		12	
Trunk extension strength 2	Mean	54.0	55.3	Not signif.	37.8	Significant
	S.D.	10.9	14.1		10.3	
	n	19	13		12	
Abdominal strength	Mean	32.8	30.6	Not signif.	14.8	Significant
	S.D.	12.2	13.7		11.5	
	n	15	10		10	

[a] Student's t-test.

of 20–35 years; where the trunk extension strength 2 was found to be dependent on age and body height. Student's t-test for this variable was performed after due correction for differences in age and body height (Table IV). For all the tests carried out a 5 per cent level of significance was applied.

For men of 20–35 years (Table I) the low back pain group showed a significantly lower abdominal muscle strength, but no difference in trunk extension strength. For men of 36–55 years (Table II) all the strength variables tested were significantly lower in the low back pain patients. When this group was divided into two sub-groups according to whether the patient had been incapacitated for less or more than one month at the time of the tests (Table III) the test values for the former sub-group were not lower than for the controls.

For women of 20–35 years (Table IV) the values for all the strength variables were significantly lower than for the controls.

For women of 36–55 years (Table V) the values in respect of the two trunk extension tests, but not the abdominal, were significantly lower both for the low back pain patients and those wearing corsets than for the controls.

Between the two patient groups no difference was found.

The subjects tested for abdominal muscle strength were fewer than for trunk extension because the former test was brought into the study at a later stage.

Table IV. *Women, 20–35 years*

		Controls	Patients	Difference[a]
Age, years	Mean	23.0	27.4	
	S.D.	4.5	4.3	Not signif.
	n	20	10	
Body height, cm	Mean	169.4	169.1	
	S.D.	4.5	6.4	Not signif.
	n	20	10	
Body weight, kg	Mean	61.6	57.2	
	S.D.	10.0	7.6	Not signif.
	n	20	10	
Trunk extension strength	Mean	46.9	28.3	
	S.D.	12.4	11.6	Significant
	n	20	10	
Trunk extension strength 2	Mean	45.3	27.1	
	S.D.	9.2	9.5	Significant
	n	20	10	
Abdominal strength 1	Mean	27.9	16.8	
	S.D.	15.4	13.6	Significant
	n	17	9	

[a] Student's t-test.

DISCUSSION

The muscular strength is difficult to determine because the test results may be influenced by

Table V. *Women, 36–55 years*

		Controls	Patients, no corset	Difference[a]	Patients, corset	Difference[a]
Age, years	Mean	47.9	45.1	Not signif.	49.9	Not signif.
	S.D.	5.7	6.8		5.6	
	n	17	20		17	
Body height, cm	Mean	162.6	163.7	Not signif.	166.2	Not signif.
	S.D.	5.6	6.0		6.5	
	n	17	20		17	
Body weight, kg	Mean	61.9	63.9	Not signif.	70.1	Not signif.
	S.D.	9.8	9.2		10.6	
	n	17	20		17	
Trunk extension strength 1	Mean	32.9	23.2	Significant	20.3	Significant
	S.D.	9.0	10.1		7.7	
	n	17	19		13	
Trunk extension strength 2	Mean	33.5	25.1	Significant	21.0	Significant
	S.D.	7.4	7.0		8.3	
	n	17	20		17	
Abdominal strength	Mean	7.1	8.2	Not signif.	5.2	Not signif.
	S.D.	4.5	9.3		4.1	
	n	13	17		17	

[a] Student's *t*-test.

many factors (3). In this material, however, a statistical analysis within the groups showed that with one exception (standing trunk extension strength in women of 20–35 years) the values obtained were unaffected by age, body height and weight. These values should not be regarded as absolute measurements of force, but only as means of comparing the maximum instantaneous tension obtained in controls and patients with a set experimental procedure where the subjects used trunk extensors and flexors. In the tests for trunk extension the chief muscle groups to be engaged are the erectores spinae (5), and in the test for trunk flexion the anterior abdominal muscles (4).

The ability of a subject to perform a certain test is, of course, dependent on other factors than age, height and weight—for example, training and fear of pain. In this study the values reported for each test performed are the means from three trials and the difference between the trials were the same in the control and the patient groups. The deviations never exceeded 10 per cent of the mean and were the same for all the various test groups.

Pain, or fear of pain, was certainly common among these patients and much more so than among the controls. This factor is impossible to evaluate, however, and no attempt has been made to separate these patients from the rest. In view of this it might be considered surprising that not all the tests showed significant differences between the controls and the low back pain patients. In men, 20–35 years, only the strength of the abdominal muscles was significantly lower. If inactivity (inability to work) is taken into consideration, as was done in men of 36–55 years, there was no difference at all in muscle strength. With a period of incapacitation exceeding 1 month, on the other hand, all the strength tests were significantly lower than for the controls.

In women of 20–35 years with low back pain the values for all the strength tests were significantly lower than in the controls, except for abdominal muscle strength. The same is true for women of 36–55 years, including those wearing a corset. On the other hand, there was no difference between those women of 36–55 years who complained of back pain and those who for a long period had been pain-free while wearing a corset. It should be noted that in all the women of 36–55 years, including the controls, the abdominal muscle strength was lower than for the other major groups.

To judge from these results the strength of the trunk extensors and flexors tested is apparently of minor significance for the low back pain syndrome in men. The reduced strength noted by Sparup (11) and Alston *et al.* (1) in such patients is more likely to be the result of prolonged inactivity. In those groups in the present material where a statistically significant difference was demonstrated the lower strength was less than that reported by Sparup (11) and Alston *et al.* (1).

In the female groups the period of inactivity was impossible to ascertain, since most of the women had been performing some household work in spite of their pain; the lower strength noted for the patients than the controls is therefore difficult to account for. In these groups there was also a pain factor. The reduction in strength was the same in the women patients who had been wearing a corset for a long period as in those suffering from low back pain.

This study has thus revealed that at least for men a relative weakness of the muscles is of minor, if any, importance for the pathogenesis for low back pain. In the women the significantly lower values found in the low back pain patients for most of the tested parameters might imply that a reduced muscular strength is of significance, but since in the women there was no possibility of evaluating the two most important factors, pain and inactivity, this conclusion is by no means firmly established.

SUMMARY

Measurements of the maximum instantaneous tension of spinal and abdominal muscles have been performed in 160 men and women, 63 of whom (33 men, and 30 women) were suffering from low back pain syndrome. Another 17 female patients tested had been wearing a corset for a long period (mean 5 years). The remaining subjects, 43 men and 37 women who had no previous history of low back pain, comprised a control group.

A statistical analysis of the results obtained in the controls and patients of the various groups (men, 20–35, and 36–55 years; women, 20–35, and 36–55 years) showed that for men of 20–35 years only the abdominal muscle strength was significantly lower in the patients than in the controls. When incapacitation for work was taken into account in the older male group (36–55 years), the values for those patients who had been incapacitated less than one month were not significantly lower than for the controls. In the case of those who had been inactive for more than one month, however, the values were lower for both trunk extension and flexion strength.

In the female groups the values for the strength variables tested were significantly lower for the patients than the controls except for abdominal muscle strength in the older women; but here the values for the controls, too, were lower than for the other major groups.

There was no difference in strength between those women who complained of back pain and those who for a long period had been pain-free and wearing a corset.

It is deduced that strong spinal and abdominal muscles are of doubtful importance for the prevention of low back pain syndrome.

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