SPINE Volume 27, Number 24, pp 2747–2752
©2002, Lippincott Williams & Wilkins, Inc.

Can Passive Prone Extensions of the Back Prevent Back Problems?

A Randomized, Controlled Intervention Trial of 314 Military Conscripts

Kristian Larsen, PT, MPH,* Flemming Weidick, MD,† and
Charlotte Leboeuf-Yde, DC, MPH, PhD*

Summary of Background Data. Back schools may be effective in treating back problems, but there is conflicting evidence of the effect on prevention.

Objectives. To investigate if passive prone extensions of the back can prevent back problems.

Study Design. Prospective, randomized controlled intervention trial.

Methods. In total, 314 male conscripts were randomized into two groups. After randomization, 65 conscripts dropped out for administrative reasons, leaving 249 conscripts to participate fully in the study. Data were collected through questionnaires at the start of military duty and after 10 months. All conscripts in the intervention group had one 40-minute theoretical lesson on back problems and ergonomics and had to perform passive prone extensions of the back daily during the rest of their military duty. The control group had no intervention. Outcome variables were as follows: 1) number of persons with self-reported back problems during the last 3 weeks; 2) number of persons with self-reported back problems during the last year; and 3) number of persons who reported having consulted the regiment medical physician with back problems during their military service.

Results. In an intention-to-treat analysis, significantly fewer persons in the intervention group *versus* those in the control group reported back problems during the last year (33% *versus* 51%), and the number needed to prevent was 6. Significantly fewer persons in the intervention group *versus* those in the control group consulted the regiment infirmary (9% *versus* 25%), and the number needed to prevent was 6.

Conclusion. It may be possible to reduce the prevalence rate of back problems and the use of health care services during military service, at a low cost, using passive prone extensions of the back motivated by a back school approach, including the theory of the disc as a pain generator and ergonomic instructions. [Key words: back problems, back school, McKenzie exercises, randomized, controlled trial] **Spine 2002;27:2747–2752**

Research on back problems has, until recently, focused on people at working age. However, back problems start earlier in life than previously thought,[1,2,10,13,18] and young people who have back problems have an increased risk of also having back problems later in life.[5,9] Therefore, it is logical to focus more on prevention of back problems already existing in the young.

Back problems are common, particularly during military duty.[19] According to a Cochrane review, back schools may be effective for patients with recurrent and chronic low back pain in occupational settings, but little is known about their cost effectiveness or whether the educational content makes a difference.[17] Only a few randomized, controlled trials have been done on prevention, with conflicting results.[4,11] Passive prone extensions of the lumbar spine are widely used in the treatment of back problems,[6–8,12] but whether they can prevent back problems or not has never been tested. The vertebral discs are stated to be frequent pain generators in patients with chronic back pain,[3] and controlling flexion of the back is known to reduce pain and the costs associated with chronic pain.[15] Therefore, passive prone extension of the back was selected as the single exercise because of its theoretical ability to influence the disc nuclear position and to counteract the significant time spent in and the mechanical influence of flexion throughout the day.[12]

The aim of this study was to test the efficacy of passive prone extensions of the back motivated by a back school intervention program that consisted of a presentation of the "disc causes pain" concept and information on how to counteract the negative effects of prolonged lumbar flexion positions. This information was conveyed through the use of the well-known information booklet produced by McKenzie.[12]

Materials and Methods

Study Subjects. In total, 321 male conscripts who were drafted at the Jutland Dragoon Regiment in Holstebro, Western Jutland, Denmark, during the first half of 1998 were potentially available for this study. The conscripts originated from all parts of Denmark. They were drafted to three different units (Units 1 and 2 with 244 conscripts in February 1998 and Unit 3 with 77 conscripts in April 1998). Conscripts at all three units finished their military service at the same time in November 1998. Inclusion criteria for the study were as follows: presence at the regiment infirmary at the prescribed medical check during the first week of military service and willingness to participate. The only exclusion criterion was recent trauma to the

From the *Medical Research Unit in Ringkjøbing County, Ringkøbing, and the †Jutland Dragoon Regiment, Holstebro, Denmark.
Acknowledgment date: February 16, 2001. First revision date: December 18, 2001. Second revision date: May 8, 2002. Acceptance date: May 13, 2002.
The manuscript submitted does not contain information about medical device(s)/drug(s).
Foundation funds were received in support of this work. No benefits of any kind have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.
Address correspondence to Kristian Larsen, PT, MPH, Medical Research Unit in Ringkjøbing County, Amtsrådhuset, Torvet 7, DK-6950 Ringkøbing, Denmark; E-mail: fekl@ringamt.dk

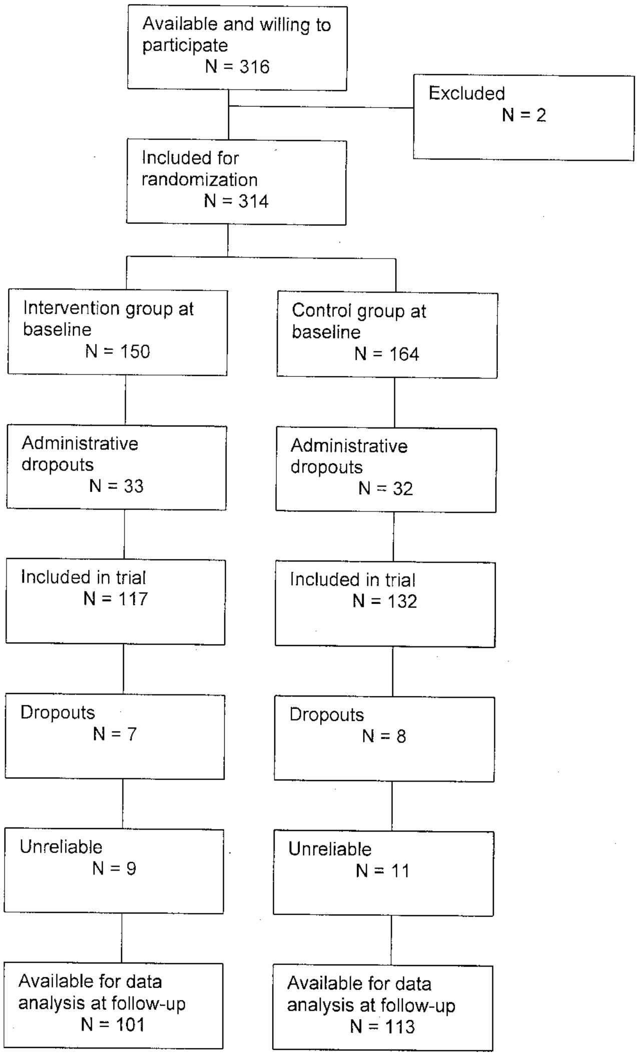

Figure 1. Number of participants at the time of randomization, baseline, and follow-up.

back. Of the 316 persons available, 2 were excluded, resulting in 314 conscripts who were willing to participate in the trial (Figure 1).

Informed written consent was obtained. The consent form emphasized that answers were strictly confidential and under no circumstances would have an influence on their military service. Hereafter, an infirmary assistant randomized all conscripts into two groups by taking the preliminary lists of the three units, in which the conscripts were listed according to person identification number. The first person on the three lists was randomized into intervention group, the second on the list to control, and so on. In Units 1 and 2, respectively, 8 and 7 conscripts more than those listed on the preliminary infirmary identification number list were drafted. The infirmary assistant placed all these extra persons in the control group.

After randomization, there were 150 conscripts in the intervention group (70 in Unit 1, 41 in Unit 2, and 39 in Unit 3) and 164 in the control group (78 in Unit 1, 47 in Unit 2, and 39 in Unit 3). A total of 65 conscripts dropped out for administrative reasons: 33 conscripts in the intervention group and 32 in the control group. Of these 65 administrative dropouts, 22 in the intervention group and 17 in the control group were selected for sergeant school after 3 months. Before leaving their regiment, they went through an extensive medical examination at which all reported to have had no back problems within the first 3 months of military service. Another four and two, respectively (from the intervention group and control group), refused to fulfill the military service. Two and four, respectively, were excluded from military service because of psychosocial problems; three and six, respectively, were moved to other units because of psychosocial problems; and two and three, respectively, were excluded from military service due to absconding. After exclusion of the administrative dropouts, there were 249 conscripts who participated fully in the study: 117 in the intervention group and 132 in the control group (Figure 1).

Methods. To allow comparisons between the two groups at baseline, data were collected through questionnaires for: age, body weight, height, level of education, military volunteer status, self-rated health, sports activity, smoking habits, weekly alcohol consumption, back pain during the past 3 weeks, back pain during the past year, and previous consultation of a health care professional because of back pain.

Data were collected at the obligatory medical examination, during the first week of military service, and again at follow-up at a similar examination on completion of the military service, after 10 months for Units 1 and 2 and 8 months for Unit 3.

In the intervention group, all conscripts participated at a back school lesson lasting 40 minutes. The lesson consisted of the theory based on the booklet *Treat Your Own Back* by McKenzie,[12] which in a simple way describes good and bad posture, ergonomics, pain mechanisms, differentiation of chemical and mechanical pain, the intervertebral disc as a frequent pain generator, and load on the disc in relation to posture and activity. This was combined with the hurt-no-harm concept. In all theory lessons, a skeleton and drawings were used to illustrate postures, load on disc, and development of fissures in the intervertebral disc. The purpose of the theoretical lesson was to give the conscripts an understanding of the role of the disc and to motivate them to perform their exercises. At the end of the lesson, the conscripts had their lower backs taped with sports tape to make them aware of when they used their low back in a suitable way (*i.e.*, to maintain the lumbar lordosis). The conscripts were told to leave the tape in place as long as possible or a maximum of 4 days and to do their usual work in such way that they would feel the tape slightly pulling on their skin to make them aware of how much time they spent in flexed and extended positions. No attempt was made to measure the duration of the back tape stage. Finally, the conscripts were instructed in performing 15 passive prone extensions of the back (*i.e.*, to extend their lumbar region with the aid of their arms), morning and afternoon every day during the whole of their military duty. They were instructed to ignore slight soreness lasting for up to 15 minutes after exercises but to cease exercises temporarily if the soreness became more pronounced. They were told that their sergeants and officers would check them every day, keeping a record of their exercises during the first 3 months of basic military education, after which they had to perform exercises on their own. In addition, the Senior Medical Officer at all units enhanced compliance through a number of unexpected visits during the intervention period. There was no intervention in the control group, and no attempt was made to ensure that conscripts did not perform the same exercises.

Outcome variables at follow-up were as follows: 1) number of persons with self-reported back problems during the last 3

Table 1. Baseline Characteristics for 214 Military Conscripts: Western Jutland, Denmark, 1998

	Control Group (N = 113)	Intervention Group (N = 101)	Absolute Numbers (Total)
Age (yrs)	21 ± 1.5	21 ± 1.5	214
Height (cm)	179 ± 8	178 ± 6	214
Body weight (kg)	77 ± 11	73 ± 10	214
Educational level			
9–10th grade	46	37	83
Skilled manual	54	38	92
High school	9	11	20
BSc or higher	3	5	8
Volunteered	70	49	119
Self-rated health status			
Excellent	10	10	20
Very good	34	33	67
Good	49	44	93
Not very good	14	9	23
Bad	0	2	2
Smoker	48	45	93
Present sports active	60	47	107
Back problems in last 3 weeks	24	25	49
Back problems in last year	46	47	93
Any contact with health care with back problems in last year	25	18	43

Values are mean (SD).

weeks; 2) number of persons with self-reported back problems during the past year; and 3) number of persons who reported having consulted the military medical physician with back problems during their military service. In addition, conscripts in the intervention group were asked whether they considered it a problem to perform these exercises.

Data Handling and Analysis. The Data Entry Builder software package version 1.0 from SPSS was used for data entry. Data were analyzed with the statistical software package SPSS version 10.0 and Stata release 6.0. The Pearson χ^2 and Fisher exact tests were used to compare the two groups, accepting a significance level of $P < 0.05$. Data were analyzed in two different ways: first, an intention-to-treat analysis was done on all conscripts completing their military duty at their drafted unit, including dropouts because of musculoskeletal problems. Administrative dropouts could not be included in the intention-to-treat analysis. Second, a worst-case analysis was done, including all who entered the study on those variables for which a significant difference between groups was found in the intention-to-treat-analysis.[14] In this analysis, it was assumed that all dropouts had experienced back problems and that they had at least 1 day off duty. An exception from this was the 39 conscripts selected for sergeant school after 3 months who had reported no problems at a medical examination after the first 3 months. These sergeant-school conscripts were regarded as having had no back problems during the remaining duty time because they had reported no back problems during the first period with most strain.

Risk ratio was calculated as the postintervention prevalence in the intervention group divided by the prevalence in the control group. Absolute risk reduction was calculated as the prevalence in the control group minus the prevalence in the intervention group. Number needed to prevent was calculated as 1 divided by absolute risk reduction.[14] Costs were calculated as the number needed to prevent multiplied by the cost per conscript. The cost per conscript was calculated on the basis of a total cost of $125 divided by the 100 conscripts in the unit, giving $1.25 for the theoretical part of the intervention. The practical part of the intervention took place during the duty time and was set at no extra cost.

■ Results

Of the 249 conscripts included in the final intervention trial, data were collected from 234 conscripts at follow-up, giving a follow-up rate of 94% in the intention-to-treat analysis. Fifteen conscripts (7 in the intervention group and 8 in the control group) were lost at follow-up because of exclusion from further military service after the first 3 months due to musculoskeletal problems. Twenty persons (9 in the intervention group and 11 in the control group) were excluded from the data analysis because of illogical answers (*i.e.*, answering "yes" to back problems within last 3 weeks but "no" to back problems within last year) at baseline or follow-up (Figure 1).

The final study population consisted of men with a mean age of 21 years (SD 1.5 years); the youngest men were 19 and oldest were 29 years of age. Mean body weight was 75 kg (SD 11 kg), and mean height was 179 cm (SD 7 cm). At baseline, there were no significant differences between the two groups on age, height, level of education, military volunteer status, self-rated health, sports activity, smoking habits, 3-week prevalence period of back pain, 1-year prevalence period of back pain, or consulting medical care persons within the last year because of back problems. The body weight was significantly higher in the control group than the intervention group. For further details regarding baseline characteristics, refer to Table 1.

The baseline characteristics for the study population did not significantly differ from the total baseline population on any characteristics.

Table 2. Intention-to-Treat Analysis for 214 Military Conscripts in Three Military Units at Follow-up: Western Jutland, Denmark, 1998

	Intervention Group (N = 101)	Control Group (N = 113)	Effect
Back problems within last 3 weeks (N = 202)	22 (14–32)	32 (23–41)	
P value for difference between groups			0.109
RR			0.7 (0.4–1.1)
ARR			10 (−2–22)
NNP			10 (5, no benefit)
Cost (U.S. $)			12 (6–infinite)
Back problems within last year (N = 200)	33 (23–44)	51 (42–61)	
P value for difference between groups			0.009
RR			0.6 (0.5–0.9)
ARR			18 (5–32)
NNP			6 (3–20)
Cost (U.S. $)			7 (4–25)
Medical care consulting (N = 204)	9 (4–16)	25 (17–34)	
P value for difference between groups			0.002
RR			0.3 (0.2–0.7)
ARR			16 (6–26)
NNP			6 (4–17)
Cost (U.S. $)			8 (5–21)

Back problems within last 3 weeks, back problems within last year, and medical care consulting during military service in percent, with 95% confidence intervals in parentheses. Relative risk (RR), absolute risk reduction (ARR), number needed to prevent (NNP), and cost per prevented case (Cost), with 95% confidence intervals in parentheses.

Intention-to-Treat Analysis (N = 214)

At follow-up, there were no significant differences between the two groups in relation to back problems within the last 3 weeks. There was a significantly lower 1-year prevalence period of back problems in the intervention group compared with the control group (33% *vs.* 51%, $P = 0.009$). The cost to prevent one conscript from getting back pain during military service would be $7 (Table 2). A significantly smaller number of persons had consulted the military medical practitioner during the military service in the intervention group than in the control group (9% *vs.* 25%, $P = 0.002$). The cost of prevention for one medical consultation was $8 (Table 2). For further information on risk ratio, absolute risk reduction, and number needed to prevent, refer to Table 2.

When adjusting for baseline status regarding back pain within 3 weeks preceding military service, there was no significant difference between groups regarding back pain at follow-up.

When adjusting for the 1-year period prevalence of back pain reported at baseline, there was a significant difference on reporting of back pain within the last year at follow-up in the group that had reported back pain 1 year preceding military service. Eighteen (45%) conscripts in the intervention group *versus* 36 (80%) conscripts in the control group ($P = 0.001$) reported back pain within the last year at follow-up. In the group that had reported no back pain at baseline, there were no significant differences between groups at follow-up. Eleven (23%) conscripts in the intervention group *versus* 17 (30%) conscripts in the control group ($P = 0.425$) reported back pain within the last year.

Regarding medical care consulting, there was a significant difference at follow-up in the group that had reported no medical care contact because of back problems preceding military service. Only 4 (6%) conscripts in the intervention group *versus* 18 (23%) conscripts in the control group ($P = 0.003$) had consulted the medical care unit because of back pain in the intervention period. There were no significant differences between groups at follow-up in the group who had reported seeking medical care because of back problems preceding military service: 4 (25%) in the intervention group *versus* 6 (25%) in the control group ($P = 1.000$).

Eighty-nine conscripts (89%) in the intervention group reported that it had been a problem doing the exercises during military service.

Worst-Case Analysis (N = 314)

The worst-case analysis included all conscripts and is reported only for previously significant differences between the study groups. The results of the worst-case analysis were not markedly different from the intention-to-treat analysis. There was a significantly lower 1-year prevalence period of back problems in the intervention group compared with the control group (45% *vs.* 57%, $P = 0.025$). The cost to prevent one conscript from getting back pain during military service would be $9 (Table 3). A significantly smaller number of persons had consulted the military medical practitioner during the military service in the intervention group than in the control group (27% *vs.* 38%, $P = 0.035$). The cost of prevention for medical consultation was $9 (Table 3). For further information on risk ratio, absolute risk reduction, and number needed to prevent, refer to Table 3.

■ Discussion

According to the results of this study, it is possible to prevent some young men from developing back problems during military service with passive prone exten-

Table 3. Worst-Case Analyses for 314 Military Conscripts in Three Military Units at Follow-up: Western Jutland, Denmark, 1998

	Intervention Group (N = 150)	Control Group (N = 164)	Effect
Back problems within last year	45 (37–53)	57 (49–65)	
P value for difference between groups			
RR			0.025
ARR			0.8 (0.6–0.9)
NNP			13 (2–24)
Cost (U.S. $)			9 (5–75)
Medical care consulting	27 (18–34)	38 (30–46)	
P value for difference between groups			0.035
RR			0.8 (0.6–0.9)
ARR			13 (1–24)
NNP			8 (4–95)
Cost (U.S. $)			9 (5–119)

Back problems within last year and medical care consulting during military service in percent, with 95% confidence intervals in parentheses. Relative risk (RR), absolute risk reduction (ARR), number needed to prevent (NNP), and cost per prevented case (Cost), with 95% confidence intervals in parentheses.

sions of the back and a back school intervention approach. The intervention was most effective in preventing recurrences of back pain and in preventing medical care use for those who had not used medical care for back pain the year preceding the military service.

Regarding the passive prone extension of the back intervention component, this result is in accordance with the study of Donelson *et al*,[8] who documented changes in the intensity and location of low back and referred pain in response to repeated end-range lumbar flexion and extension movements performed first while standing and then while recumbent. Results are also in agreement with those reported in the study by Spratt *et al*,[16] who showed improvement with the extension treatment in an intervention with flexion and extension treatments, incorporating braces for low back pain patients with retrodisplacement, spondylolisthesis, or normal sagittal translation.

The results are also in accordance with Snook *et al*,[15] who reported reduction of chronic nonspecific low back pain through the control of early morning flexion, and Williams *et al*,[20] who reported significantly reduced back and leg pain when sitting with a lordotic posture maintained with a lumbar roll.

Regarding the back school intervention component, this result is in accordance with the study by Lonn *et al*,[11] although they used a much more extensive and costly intervention. Their active back school consisted of 20 lessons over a 13-week period. Each lesson was divided into a theoretical and an exercise part, each consisting of 20 and 40 minutes. They concluded that active back school reduced the recurrence and severity of new low back pain episodes at follow-up examinations performed 5 and 12 months after enrollment. Our findings are, however, in conflict with those of Daltroy *et al*,[4] who used a less extensive intervention procedure involving about 4000 postal workers. Their intervention consisted of a two-session back school, with a theoretical part and 3 hours of training followed by three or four reinforcement sessions over the succeeding years but no component of regularly supervised exercise. They concluded that an educational program to prevent work-associated low back injury resulted in no long-term benefits. We could find no studies including passive prone extension of the back or taping of the back in the prevention of back problems.

There is a need in future research to uncover which part of our intervention is the effective one, for example, by randomly allocating subjects into one of four alternatives: 1) the educational program alone, 2) passive prone extensions of the back alone, 3) both in a coordinated fashion, and 4) neither program.

It is a limitation of the present study that there were as many as 20 conscripts who were excluded from the intention-to-treat analysis because of illogical answers, but the conclusions of the study are not changed regarding the 1-year period prevalence of back pain when these conscripts are included in the worst-case analysis. Another problem was that eight and seven conscripts, respectively, in two of the three units, mistakenly were lumped together and randomized to the control group. It is not known how this has affected the result, but it weakens the study.

Although compliance with this intervention was high in all three units during the first 3 months of military service (when sergeants and officers were responsible for the exercises actually taking place), it was probably considerably reduced during the rest of the duty time. For this reason, it is assumed not to be important for the result of the study that data from Unit 3 (with an 8-month duty time) were combined with the data from Units 1 and 2 (with a 10-month duty time) because the intensive intervention period with high compliance was probably the same in all three units.

It is possible that the conscripts in the intervention group who received more attention from sergeants and officers exhibited a Hawthorne effect, but because there are so many new activities during the first 3 months of military service, this is unlikely.

The generalization of the effect due to likely noncompliance could be questioned in less motivated persons because as many as 89% of the conscripts reported that it was a problem doing the exercises during almost a year.

Conclusion

The results of this study indicate that it may be possible to reduce the 1-year period prevalence rate of back problems and the use of health care services during military service, at a low cost, using passive prone extensions of the back motivated by a back school approach, including the theory of the disc as a pain generator and ergonomic instructions. However, it may not be possible to reproduce the same result in the general population because of an anticipated lower compliance.

Key Points

- Back pain is common already in early life. Prevention should therefore occur in childhood and adolescence.
- A potential prevention method was tested on military conscripts to provide high compliance.
- Intervention consisted of daily passive prone extensions of the back twice daily for almost a year, combined with an introductory motivated lecture.
- Intervention was tested in a randomized, controlled study.
- The study showed that it was possible to prevent back problems and the use of health care services during military service in a group of male conscripts.

References

1. Balagué F, Nordin M. Back pain in children and teenagers. Baillieres Clin Rheumatol 1992;6:575–93.
2. Balagué F, Skovron M-L, Nordin M, et al. Low back pain in schoolchildren: a study of familial and psychological factors. Spine 1995;20:1265–70.
3. Bogduk N. The anatomical basis for spinal pain syndromes. J Manipulative Physiol Ther 1995;18:603–5.
4. Daltroy LH, Iversen, MD, Larson MG, et al. A controlled trial of an educational program to prevent low back pain injuries. N Engl J Med 1997;337: 322–8.
5. Darre EM, Biering-Sørensen F, Deis A, et al. Rygbesvær under aftjening af værnepligt: betydning for senere rygproblemer [in Danish]. Ugeskr Laeger 1999;161:1926–30.
6. Donelson R. The McKenzie approach to evaluating and treating low back pain. Orthop Rev 1990;19:681–6.
7. Donelsen R, McKenzie R. Effects of spinal flexion and extension exercises on low back pain and spinal mobility in chronic mechanical low back patients. Spine 1992;17:1267–8.
8. Donelson R, Grant W, Kamps C, et al. Pain response to sagittal end-range spinal motion: a prospective, randomized, multicentered trial. Spine 1991;16: 206–12.
9. Harreby M, Kjer J, Hesselsøe G, et al. Epidemiological aspects and risk factors for low back pain in 38-year-old men and women: a 25-year prospective cohort study of 640 school children. Eur Spine J 1996;5:312–8.
10. Leboeuf-Yde C, Kyvik KO. At what age does low back pain become a common problem? A study of 29,424 individual aged 12–41 years. Spine 1998;23:228–34.
11. Lonn JH, Glomsrod B, Soukup MG, et al. Active back school: prophylactic management for low back pain. A randomised, controlled, 1-year follow-up study. Spine 1999;24:865–71.
12. McKenzie R. Treat Your Own Back. Waikanae, New Zealand: Spinal Publications, 1987.
13. Olsen TL, Anderson RL, Dearwater SR, et al. The epidemiology of low back pain in an adolescent population. Am J Public Health 1992;82:606–8.
14. Sackett DL, Strauss SE, Richardson WS, et al. Evidence-Based Medicine, 2nd ed. Edinburgh: Churchill Livingstone, 2000:245–52.
15. Snook SH, Webster BS, McGorry RW, et al. The reduction of chronic nonspecific low back pain through the control of early morning lumbar flexion: a randomized controlled trial. Spine 1998;23:2601–7.
16. Spratt KF, Weinstein JN, Lehmann TR, et al. Efficacy of flexion and extension treatments incorporating braces for low-back pain patients with retrodisplacement, spondylolisthesis, or normal sagittal translation. Spine 1993; 18:1839–49.
17. Van Tulder MW, Esmail R, Bombardier C, et al. In: Back Schools for Non-Specific Low Back Pain (Cochrane Review). Oxford: Cochrane Library, 2000:3.
18. Wedderkopp N, Leboeuf-Yde C, Andersen LB, et al. Back pain reporting in a Danish population-based sample of children and adolescents. Spine 2001; 26:1879–83.
19. WONCA. Forsvarets registreringssystem til infirmerihenvendelser [WONCA, The Danish Army registration system for infirmary consultations]. Holstebro, Denmark, 1998–1999.
20. Williams MM, Hawley JA, McKenzie RA, et al. A comparison of the effects of two sitting postures on back and referred pain. Spine 1991;16:1185–91.