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## Effects of lifestyle intervention on neck, shoulder, elbow and wrist symptoms

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**Objectives** The objective of this study was to determine whether lifestyle intervention to control hypertension can affect neck, shoulder, elbow, and wrist symptoms.

**Methods** In a randomized controlled trial, 731 employees from 45 worksites were assigned for 12 months to lifestyle intervention in a rehabilitation center or to usual care provided by occupational or primary health care services. The participants had a systolic blood pressure of 140–179 mm Hg or a diastolic blood pressure of 90–109 mm Hg, or antihypertensive drug treatment. In addition to the cardiovascular risk factors, the occurrences of neck, shoulder, elbow, and wrist symptoms and disability during the previous 12 months were recorded before the intervention and 1 year later.

**Results** The reported disability due to neck pain during the previous 12 months fell significantly more (–7%) in the intervention group than in the group in usual care (–2%). The perceived shoulder pain during the previous 7 days also decreased significantly more in the intervention group than in the control group among the women (net change 16%) and among the participants who were more highly physically active (net change 10%). Weight, body mass index, and waist and hip circumferences decreased, and physical activity increased, substantially more in the intervention group. The changes in elbow or wrist pain and related disability did not differ significantly between the intervention and control groups.

**Conclusions** Lifestyle intervention to control hypertension has a favorable impact on perceived disability due to neck pain.

**Key terms** blood pressure, hypertension, multidisciplinary, musculoskeletal symptom, randomized controlled trial, rehabilitation center.

Neck and shoulder pain is common and accounts for a considerable expenditure of health care resources. The two types of pain also reduce work productivity (1). Neck pain is believed to have a multifactorial etiologic origin, with several risk factors contributing to its development. Many studies have been conducted to identify risk factors for neck pain, but most of them have focused either on only one or, at best, a few risk factors or one particular category of risk factor. Neck pain is associated with sedentary work, smoking, female gender, overweight, mental stress, and physical risk factors of work (2–6). There is no consensus on whether any relationship exists between exercise and neck pain (3, 7–9). Using the evidence from etiologic studies as a basis,

one could hypothesize that multidisciplinary lifestyle intervention would decrease the occurrence of neck and shoulder pain and resulting disability.

Upper-limb disorders are often considered to be work-related. Prolonged pain tends to evoke a combination of physical, psychological, and social disabilities. Several treatment regimes including physical, psychological, behavioral, social, and occupational modalities have been developed to help patients with these disabilities. However, there is a lack of evidence on their effectiveness with respect to upper-limb disorders.

Two trials evaluating the effectiveness of biopsychosocial rehabilitation among working age patients with neck and shoulder pain have shown poor results (10, 11).

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However, no randomized controlled trial assessing the effects of lifestyle intervention on the prevention of neck or shoulder pain has yet been published. In a systematic review on biopsychosocial rehabilitation for upper-limb disorders, two trials were found (12–14), and their results showed only a limited level of scientific evidence in support of the effectiveness of biopsychosocial rehabilitation with respect to upper-limb disorders.

During the years 1996–2000, a randomized controlled trial was carried out among hypertensive patients who were trained in a rehabilitation center. The purpose was to assess the effect of lifestyle modification on the control of their hypertension (15). A questionnaire on neck, shoulder, elbow, and wrist symptoms was included in the evaluation measures to examine the effects of this intervention also on the occurrence of musculoskeletal symptoms. In the present paper we report the effects of this lifestyle modification on neck, shoulder, elbow, and wrist symptoms and related disability.

## Material and methods

### Screening and randomization of the participants

Altogether 731 volunteers with mild-to-moderate hypertension were recruited from 45 worksites by occupational health care services in 1996 and 1998. The worksites

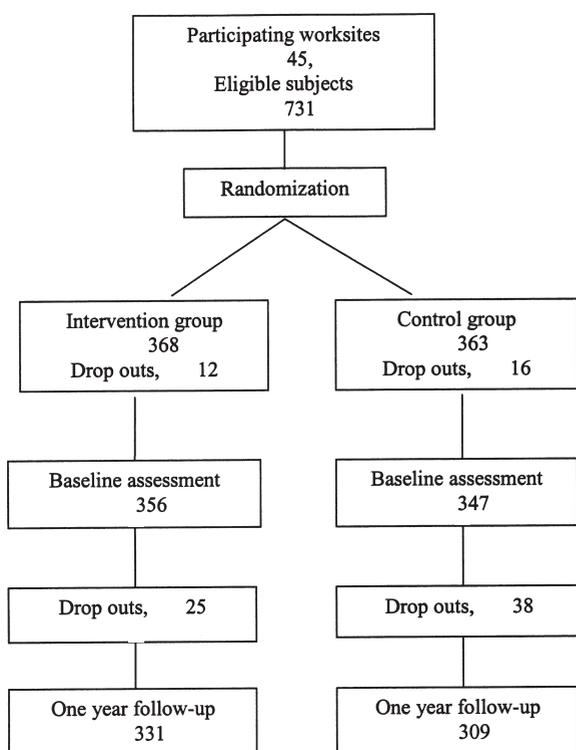


Figure 1. Study design.

differed from each other with respect to the occupation of the employees, although most of the workers came from the pulp and paper industry. Most of the participants lived in the southern part of Finland. At baseline, all the participants were employed.

The recruitment and screening process, as well as the measures for the effect evaluation, have been described earlier in detail (15). Workers were eligible for enrollment in the study if their mean systolic blood pressure (SBP) was 140–179 mm Hg or their mean diastolic blood pressure (DBP) was 90–109 mm Hg or if they were taking antihypertensive medication. The exclusion criterion was any diagnosed disease or condition (such as excessive use of alcohol or pregnancy) that may negatively influence the well-being or compliance of the participants during the intervention and follow-up. Altogether 356 men and 375 women were randomized into the intervention and control groups. The randomization was stratified according to treatment status (drug treatment yes or no) and worksite using a block size of eight. After the randomization, but before the baseline assessment, a total of 28 eligible persons dropped out. The baseline characteristics of the dropouts did not differ from those of the remaining participants as a whole, or between the two groups. Twelve of the dropouts were from the intervention group and 16 from the control group. Thus the total number of the participants at baseline was 703 (figure 1). The demographic and clinical characteristics of the participants at baseline are described in table 1. The occurrence of neck and shoulder symptoms (pain and discomfort) and disability due to neck or shoulder pain during work or leisure time are described in table 2.

### Baseline assessment

Specially trained nurses, who were rotated between the commercial enterprises in question to eliminate possible observer bias, performed the baseline assessments. The nurses measured height, weight, and circumference of waist and hip and handed out standardized self-administered questionnaires to the participants.

**Questionnaires.** Sociodemographic factors, physical activity, and previous and current diseases during the last 12 months were assessed with self-administered questionnaires used earlier in The North Karelia Project and in The National FINRISK Study (16). The neck, shoulder, elbow, and wrist pain and disability (inability to perform some tasks during work or leisure time due to pain) were asked using the standardized self-administered Nordic musculoskeletal symptom questionnaire (17). The questionnaire included a picture of the neck, shoulder, elbow, and wrist areas, as depicted in figure 2.

**Table 1.** Baseline demographic and clinical characteristics of the participants. (F = female, E = employed, S = smoking, PLW = physically light work, Q = quite or very satisfied with work, PA = physical activity  $\geq 3$  times per week, D = depressed sometimes or often during previous month)

	Age (years)		F (%)	E (%)	Education (years completed)		Weight (kg)		Body mass index (kg/m <sup>2</sup> )		Waist circumference (cm)		Hip circumference (cm)		S (%)	PLW (%)	Q (%)	Ability to work <sup>a</sup>		PA (%)	Physical activity times per week		D (%)
	Mean	SD			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD				Mean	SD	Mean	SD	Mean	SD
Intervention group (N=356)	49.9	5.9	54	100	12.0	3.6	84.0	18.4	29.4	13.1	96.8	14.1	106.4	10.1	19	65	72	7.8	1.3	36	2.3	1.8	53
Control group (N=347)	49.8	6.3	50	100	12.0	3.3	84.4	16.2	29.0	4.8	97.5	13.6	106.3	9.7	19	61	71	7.7	1.5	37	2.3	1.8	52

<sup>a</sup>Subjects' own estimation of their work ability (scale being 0–10, 10 points being the best work ability).

**Table 2.** Occurrences of neck and shoulder symptoms <sup>a</sup> and related disability <sup>b</sup> and the changes in their occurrence during the follow-up.

	At baseline (%)		At 1-year follow-up			
	Intervention group (N=355)	Control group (N=347)	Change (%) <sup>c</sup>		Net change (%) <sup>d</sup>	P-value
			Intervention group (N=355)	Control group (N=347)		
<b>Symptoms during 12 months</b>						
Neck	64	69	-6	-4	-2	0.72
Shoulder	72	68	-6	0	-6	0.35
Elbow	23	22	-4	-6	2	0.34
Wrist	31	31	-3	-4	1	0.63
<b>Cause of disability during 12 months</b>						
Neck pain	13	15	-7	-2	-5	0.023
Shoulder pain	15	16	-5	-4	-1	0.65
Elbow pain	5	4	-1	1	-2	0.86
Wrist pain	8	6	-1	2	-3	0.82
<b>Symptoms during previous 7 days</b>						
Neck	35	43	-4	-6	2	0.73
Shoulder	44	42	-5	3	-8	0.17
Elbow	11	10	-1	0	-1	0.85
Wrist	14	16	3	0	3	0.32

<sup>a</sup> Neck, shoulder, elbow, and wrist symptoms indicate pain or discomfort or both.

<sup>b</sup> Disability indicates inability to perform some daily tasks during work or leisure time.

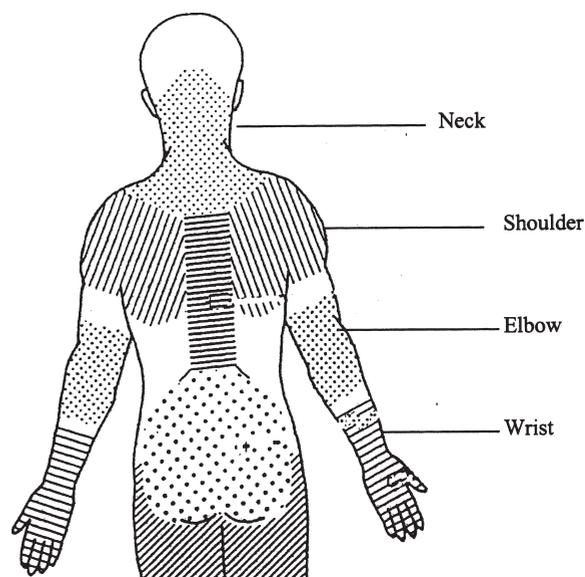
<sup>c</sup> Change (%) characterizes the changes in the variables from baseline to follow-up.

<sup>d</sup> Calculated for differences in the changes between the intervention and control groups.

### Intervention

Within 12 weeks after the randomization, the basic intervention period of 5 days took place in one of three rehabilitation centers (Espoo, Imatra or Savonlinna). After the basic intervention period, the men and women participated in two supplemental support interventions at 4 and 8 months on the average, each lasting 2 days.

A physician, a dietician, a physiotherapist, and a psychologist were responsible for the intervention, which focused on the treatment of hypertension. The



**Figure 2.** Schematic diagram of the neck, shoulder, elbow, and wrist areas in the symptom questionnaire.

intervention included lectures, group work, practical training, and tests, and the participants were also provided with written material. In terms of utilizing social support through group dynamics, the participants were allocated into the same group on each visit. The participants' own physician at the worksite (in both the intervention and the control group) maintained the responsibility for treating hypertension throughout the study. Supplemental support intervention at the rehabilitation center offered additional incentives for lifestyle changes aiming to reduce hypertension. The control group was treated routinely, and it did not receive any instructions from the researchers. The information given about the project to the occupational health care staff (physicians and nurses) was identical for both the intervention and the control group.

**Basic intervention period.** The intervention started with general information (3 hours) followed by group

sessions guided by the physician, physiotherapist, psychologist, dietician, and cook. The discussion with the physician (1.5 hours) included information on the causes and consequences of hypertension and a talk about cardiovascular diseases.

The physiotherapist's two lectures ( $2 \times 1.5$  hours) provided information on the effects of physical activity on the cardiovascular system and recommendations for enhancing cardiovascular fitness. He or she also trained the participants in the swimming pool ( $2 \times 0.5$  hours) and conducted a variety of aerobic exercises ( $2 \times 1$  hour). Pulse indicators were used to find the appropriate individual level of intensity of exercises. A walking test (18) was performed. Training in relaxation techniques supervised by a physiotherapist followed the physical exercise session ( $2 \times 0.5$  hours). The psychologist focused on identifying the symptoms of stress and on teaching ways to cope with stress ( $3 \times 1.5$  hours).

The participants underwent 24-hour ambulatory blood pressure measurement to reveal individual changes in blood pressure during different situations. The physician and the psychologist interpreted the results (2 hours).

A 3-day food diary, filled out prior to the intervention, formed the basis for the nutritional group counseling. The three sessions ( $3 \times 1.5$  hours) given by the dietician included information on the role of different nutritional components in the control of hypertension, such as salt, fat, and fiber intake, and body weight control. During the fourth session (1.5 hours), the participants prepared a "healthy pizza", which had a low fat and low salt content. The personal diary assisted the participants in identifying the individual need for possible dietary changes. During another practical session (1.5 hours) given by the cook, the participants made unsalted rolls and low-fat spreads. The cook talked about healthy cooking methods and healthy alternatives in food preparation.

At the end of the basic period, the physician, the physiotherapist, or the psychologist organized a summary group meeting (1 hour).

**First support period.** The support period aimed to encourage the participants in their efforts to achieve a healthier lifestyle and to utilize the positive dynamics of the group itself. During the weekend (2 days), the dietician and group discussed the group's experiences in changing their dietary habits and reiterated the information provided during the basic intervention period (4 hours). The physician, physiotherapist, and psychologist, together with the participants, talked about the changes that had taken place in physical activity, relaxation practice, perceived stress, body weight, smoking, alcohol use, and lifestyle in general since the basic period (2 hours). The participants were also asked to draft

an individual chart from the basic intervention period to the first support period to highlight any possible beneficial changes. The aim of this session was to encourage the participants to continue in their endeavors and to support those who had failed in their commitments. Progress in "small steps" was recommended.

The walking test was again performed to determine possible improvements in physical and aerobic condition. Training in the swimming pool (0.5 hours) and an aerobic physical activity session (1 hour), followed by relaxation training ( $2 \times 0.5$  hours), took place.

**Second support period.** The second 2-day support period took place again over a weekend with a program similar to that provided during the first support period, and the dynamics of the group were emphasized. The group was split into small groups of 2–4 persons. These small groups assessed hypothetical hypertension patients with provided information about their socioeconomic backgrounds and lifestyles (eating habits, physical activity, alcohol use, and smoking) and prepared guidelines for these "patients" with respect to their lifestyles (2 hours). The guidelines were discussed with the experts.

**Letters.** Between the intervention periods, the participants received a total of six support letters at 1-month intervals to remind them about the topics discussed during the course and about their personal commitments.

#### *Follow up assessment*

The follow-up assessment took place 1 year after the baseline, and it included the same measurements as those performed at baseline. Neck, shoulder, elbow, and wrist symptoms and disability constituted the primary outcomes. Weight, body mass index (BMI), the waist and hip circumferences, perceived depressive mood, and physical activity were the secondary outcomes.

#### *Statistical analyses*

The statistical analyses were primarily conducted with the statistical package SPSS (SPSS 10.0 for Windows, Chicago, IL, USA). The continuous variables were statistically compared on an intention-to-treat basis using an analysis of covariance (ANCOVA) with adjustment for baseline data (19). The changes in the variables characterize the changes from baseline to follow-up in a group, and the net change characterizes the difference between the groups at follow-up. The changes and net changes are given with 95% confidence intervals (95% CI). A P-value of  $<0.05$  was considered statistically significant.

The likelihood ratio test (20) was used in comparing the changes in the occurrences of musculoskeletal

symptoms (pain and discomfort) and related disability during work or leisure time, physical activity, and perceived depressive mood during the follow-up between the groups. The subgroup analyses were executed in terms of gender, weight (<82.5 kg versus ≥82.5 kg, the median), physical activity (<3 times/week versus ≥3 times/week), neck pain (≤30 days during the last 12 months versus >30 days during the last 12 months), age (≤51 years versus >51 years, the median), and physical character of the work (light versus moderate or heavy). The occurrence of disability due to neck pain was analyzed in two subgroups, those who managed to increase their physical activity and those who managed to decrease their body weight. Statistical analyses of the subgroups were also performed with the likelihood ratio test.

## Results

### Changes in lifestyle factors

The differences in the changes in weight and BMI between the intervention and control groups were significant at the 1-year follow-up (table 3). The waist and hip circumferences also decreased to a significantly greater extent in the intervention group. A significantly greater proportion of participants in the intervention group increased their physical activity, whereas concurrently more participants in the control group decreased or showed no change in their physical activity. During the follow-up, 9% more of the participants in the intervention group than in the control group increased the frequency of their physical exercise to at least three times per week (P=0.003).

### Changes in neck and shoulder symptoms

There were no significant differences in the changes of the occurrence of neck or shoulder pain during the follow-up between the intervention and control groups (table 2). However, the occurrence of disability (perceived inability to perform tasks during work or leisure time) due to neck pain decreased in the intervention group by 7%, while the decrease in the control group was only 2%, the net change (5%) being statistically significant (P=0.023). There was also a trend towards a decrease in the duration of neck pain periods (data not shown) in favor of the intervention group. The number of participants who had experienced no days with neck pain during the previous 12 months increased 6% more in the intervention group than in the control group.

### Changes in elbow and wrist symptoms

There were no differences in the changes of elbow or wrist pain or related disability during the follow-up between the intervention and control groups (table 2).

### Subgroup analyses

Statistically significant net changes in favor of the intervention group were observed for the occurrence of disability attributable to neck pain during the previous 12 months among the women (net change 5%, P=0.023), among the participants exercising at least three times a week (net change 11%, P=0.040), among those with weight over 82.5 kg (net change 9%, P=0.047), those who had experienced neck pain for more than 30 days during the previous 12 months (net change 13%,

**Table 3.** Changes in weight, body mass index, circumference of waist and hip, subjective work ability, physical activity, and perceived depressive mood in the intervention and control groups during the follow-up.<sup>a</sup> (C = change, 95% CI = 95% confidence interval)

Group	Weight (kg)		Body mass index (kg/m <sup>2</sup> )		Waist circumference (cm)		Hip circumference (cm)		Ability to work <sup>b</sup>		Physical activity ≥3 times/week (%)	Physical activity times/week		Changes in physical activity times/week			Being depressed-sometimes or often during previous month (%)
	C	95% CI	C	95% CI	C	95% CI	C	95% CI	C	95% CI		C	95% CI	In-creased (%)	De-creased (%)	No change (%)	
Intervention (N=331)	-1.4	-1.9--0.9	-0.7	-0.9--0.4	-0.3	-0.7--0.2	-0.8	-1.2--0.4	-0.1	-0.3--0.0	10	0.2	-0.1--0.4	39	21	40	-4
Control (N=309)	-0.0	-0.6--0.5	-0.2	-0.5--0.1	0.9	0.4--1.4	0.1	-0.4--0.3	-0.1	-0.3--0.0	1	0.1	-0.1--0.2	28	23	49	0
Net change	-1.4	-2.1--0.6	-0.5	-0.9--0.0	-1.2	-1.9--0.4	-0.8	-1.3--0.2	0.0	-0.2--0.2	9	0.1	-0.1--0.4	11	-2	-9	-4
P-value <sup>c</sup>	0.001		0.021		0.001		0.007		0.79		0.003	0.17		0.014			0.55

<sup>a</sup> Data are presented as the change in the means (95% CI) or occurrences (%) or as occurrences (%) in both groups and as differences in the changes between the groups. The change characterizes the changes in the variables from baseline to follow-up in a group.

<sup>b</sup> Subjects' own estimation of their work ability (scale from 0 to 10, 0 points denoting a total inability to work, 10 points representing the best work ability).

<sup>c</sup> Calculated for differences in changes between the intervention and control groups.

$P=0.012$ ), those aged  $\leq 51$  years (net change 8%,  $P=0.004$ ), and those doing physically light work (net change 7%,  $P=0.024$ ). In favor of the intervention group, the participants who increased their physical activity during the follow-up showed a decreased occurrence of disability due to neck pain (net change 8%,  $P=0.038$ ). Also in favor of the intervention group, those whose body weight declined showed a trend towards a decreased occurrence of disability due to neck pain (net change among the participants with decreased body weight 6%,  $P=0.082$ , and net change among those with both a decrease in body weight and increased physical activity 8%,  $P=0.060$ ). Among those who had experienced neck pain for more than 30 days during the previous 12 months, there was a statistically significant change in favor of the intervention group in terms of easing disability due to shoulder pain during the previous 12 months (net change 16%,  $P=0.006$ ).

The occurrence of shoulder pain during the previous 7 days decreased significantly more in the intervention group among the women (net change 16%,  $P=0.020$ ) and among the participants exercising at least three times a week (net change 10%,  $P=0.006$ ).

## Discussion

As the aim of the study was to assess the effects of lifestyle intervention on hypertension, which was also the goal of the intervention among the participants, the design gave a unique opportunity to eliminate the placebo effect for perceived outcome of musculoskeletal symptoms and disability.

The study showed that lifestyle intervention positively affects perceived disability due to neck pain, and it possibly decreases the occurrence of shoulder pain among women and people with a high level of physical activity. Despite the lack of effect on neck pain itself, the intervention decreased disability due to neck pain. This outcome was plausible, as the aim of the intervention was to promote the participants' activity and self-management. However, the lifestyle intervention failed to decrease elbow or wrist symptoms.

No randomized controlled trial assessing the effects of comprehensive lifestyle intervention on the prevention of musculoskeletal symptoms has been reported earlier. Furthermore, our intervention focused on the effect of lifestyle intervention on hypertension, and a clear effect emerged (15). Its effects on musculoskeletal symptoms were also assessed, because there is evidence that lifestyle factors are among the causes of musculoskeletal symptoms. Neck, shoulder, elbow, and wrist symptoms and related disability were measured before the intervention and 1 year later. The participants

were not recruited to the study because they were suffering from musculoskeletal symptoms but, rather, because they had hypertension. The intervention was aimed at reducing blood pressure and other cardiovascular risk factors via lifestyle changes. Thus the participants were probably unbiased when they gave their answers to the questions on neck, shoulder, elbow, and wrist pain and related disability.

A strength of the study was that the study population consisted of ordinary workers, among whom it is difficult to run a randomized controlled trial. In volunteer-based intervention studies like this one, the sample is usually not representative of the general population. The participants may be more compliant to intervention than the catchment population as a whole. Many of the participants may have also changed their lifestyle already before the study, and such change could have reduced the power of the intervention. In addition, the participants in the control group were also under systematic observation in order to measure changes during the follow-up, and this systematic observation could have acted as a minor form of intervention and could have influenced the results. Elbow and wrist symptoms at baseline were rare, and no trend for effectiveness of lifestyle intervention was found for them.

The results of the decrease in body weight and neck symptoms among the intervention group and the better effectiveness of the intervention among the women with respect to neck symptoms are in concordance with the results of published risk-factor studies (4–6). In our study, it was not possible to assess the effects of a single component factor of the intervention on symptoms and disability. The effects described included the impact of all aspects of the lifestyle intervention. We hypothesize that the positive effects on neck and shoulder symptoms and related disability in this intervention were attributable to the decrease in body weight and the increase in physical activity, and studies published earlier support this hypothesis (5, 6, 21). The observed difference between the two groups in disability due to neck pain was 5%, which we consider a clinically important preventive effect.

As no previous studies have focused on preventive lifestyle intervention, we must compare our results with those of clinical trials. Only one randomized controlled trial has earlier described an assessment of the effectiveness of multidisciplinary rehabilitation on neck and shoulder pain (11). The study focused on determining the role of psychological treatment in a multidisciplinary intervention, with no positive effects being found. A second trial, not a randomized controlled trial, by Ekberg and his co-workers, evaluated the effects of an early, active, and multidisciplinary rehabilitation program on neck and shoulder symptoms, and it did not find any positive effect (10). The numbers of patients were

rather small in these studies, their methodological quality was low, and the interventions differed from that of our study. These facts and, above all, the fact that we carried out preventive intervention, not a clinical trial, may well explain the differences in the results between our study and these previous two studies. The scientific evidence is also very limited for the effectiveness of multidisciplinary rehabilitation with respect to upper-limb symptoms. There is only meager evidence showing that progressive exercise favorably affects tennis elbow (22).

According to the subgroup analyses, our lifestyle intervention was more effective for neck symptoms among women, physically active participants, participants without excessive overweight, younger participants, those doing physically light work, and participants who had suffered neck pain on more than 30 days during the last 12 months. The subgroup analyses showing an association between positive lifestyle changes during the intervention and a favorable outcome in the occurrence of this disability support the results of the total intervention population. However, the results of the subgroup analyses must be considered with caution. Their primary value is in generating hypotheses for additional trials assessing populations which might benefit from lifestyle intervention. Lifestyle intervention, to be effective for elbow and wrist symptoms, may also require some workplace intervention.

In conclusion, the occurrence of disability due to neck pain during leisure time or work decreased with our lifestyle intervention, which focused on dietary habits and physical activity to reduce hypertension. The results of this study may be important from a public health standpoint and for people who do not have any disability in the follow up. They emphasize the importance of using a comprehensive approach when positive results from lifestyle changes are the goal.

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