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Healthy lifestyle behaviour improves the prognosis of low back pain in women: A population based cohort study.

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Abstract

Objectives

To study the influence of healthy lifestyle behaviour on the prognosis of occasional low back pain among men and women in a general population.

Design

Cohort study with a four year follow-up.

Settings

General population in Stockholm County, Sweden.

Participants

The study sample comprised 3938 men and 5056 women, aged 18-84, from the Stockholm Public Health cohort reporting occasional low back pain in the baseline questionnaire 2006.

Measures

Lifestyle factors and potential confounders were assessed at baseline. The lifestyle factors smoking habits, alcohol consumption, leisure physical activity and consumption of fruit and vegetables, were dichotomized using recommendations for a health-enhancing lifestyle and combined to form the exposure variable “healthy lifestyle behaviour”. The exposure was categorised into five levels according to the number of healthy lifestyle factors met. The follow-up questionnaire in 2010 gave information about the outcome, long duration troublesome low back pain. Crude and adjusted binomial regression models were applied to estimate the association between the exposure and the outcome analysing men and women separately.

Results

The risk of developing long duration troublesome low back pain among women with occasional low back pain decreased with increasing healthy lifestyle behaviour (test for trend: p=0.006). 21% (28/131) among women with no healthy lifestyle factor (reference group) experienced the outcome

compared to nine percent (36/420) among women with all four factors. Compared to the reference group, the risk was reduced by 35% (RR: 0.65, 95% CI: 0.44 to 0.96) for women with one healthy lifestyle factor and 52% (RR: 0.48, 95% CI: 0.31 to 0.77) for women with all four healthy lifestyle factors. There were no clear associations found among men.

Conclusion

Healthy lifestyle behaviour decreases the risk of developing long duration troublesome low back pain among women with occasional low back pain and may be recommended to improve the prognosis.

Article summary

Strengths and limitations of this study

- Strengths of this study are the large sample, the longitudinal design, the long term follow-up, robust analyses and the large number of potential confounding factors assessed.
- Possible limitations of this study were the potential risk of misclassification of the exposure variable and the relatively large loss to follow-up, although these limitations most probably lead to an underestimation of the associations studied. Further the results may have been affected by questionnaire items not fully validated.

Introduction

Lifestyle factors such as non-smoking, physical activity, healthy diet and moderate alcohol use seem to influence the risk and the prognosis in several diseases (e.g. cancer, type 2 diabetes mellitus, and cardiovascular disease) as well as mortality, especially when the factors are combined.[1-5]

Low back pain (LBP) is one of the most common health problems worldwide and comprises a large burden on individuals as well as on society.[6, 7] When estimating the global prevalence of activity-limiting LBP using 165 studies from 54 countries, Hoy and colleagues found the mean point- and 1 month prevalence to be 11.9 ± 2.0% and 23.2 ± 2.9% respectively.[6] Current knowledge of prognostic factors, e.g. lifestyle factors, for LBP is limited and the above mentioned facts support the need for more research on this topic.

In a "review of reviews" from 2009, Hayden and colleagues reported older age, negative cognitive characteristics, poor general health, increased psychological or psychosocial stress, poor relations with colleagues, physically heavy work, functional disability, sciatica, and the presence of worker´s compensation to be associated with poor outcomes of acute and sub-acute LBP.[8] Another 2009 review found recovery expectations to be associated with activity limitations or participation restrictions (e.g. return to work) in persons with non-chronic non-specific LBP.[9] In the review by Hayden and colleagues smoking was the only lifestyle factor included and found, by two studies, to have no association with poor outcomes of acute and sub-acute LBP.[8] Similarly, a recent review studying prognostic factors for recovery from chronic LBP found no association between smoking and the outcome pain and disability.[10] Moreover, reviewing observational studies on LBP patients Hendrick and colleagues found moderate evidence for sports, leisure and occupational physical activity not to be associated with LBP outcomes.[11]

Women seem to have higher prevalence, be more severely affected and have worse prognosis of LBP than men and some studies suggest that men and women should be assessed separately when studying risk and prognostic factors for LBP.[6, 12-14]

To our knowledge, it is not known if healthy lifestyle behavior, defined by a combination of lifestyle factors, is associated with the prognosis of LBP. Healthy lifestyle behaviour seems to have a larger

potential to affect health problems and mortality than separate lifestyle factors alone.[1-5] We hypothesized that healthy lifestyle behaviour would decrease the risk of a poor outcome among men and women with occasional low back pain. If healthy lifestyle behaviour affects the prognosis of LBP implementing this knowledge could potentially prevent transition into disabling LBP and thereby reduce the burden on the individual as well as on the society.

The aim of this study was to explore the influence of healthy lifestyle behaviour on the prognosis of occasional low back pain among men and women in a general population, hypothesizing that healthy lifestyle behaviour can improve the prognosis.

Methods

Study design and source population

In this study we used data from the Stockholm Public Health Cohort (SPHC).[15] The SPHC was set up by the Stockholm County Council and administered by Statistics Sweden and the Department of Public Health Sciences at Karolinska Institutet, Stockholm. The SPHC is a population based cohort established within the framework of Stockholm County Council public health surveys. In 2006, Stockholm County had an adult population of approximately 1.4 million individuals. From this population a total of 56 634 individuals (18-84 years old) were randomly selected, after stratification for gender and residential area, and received the baseline questionnaire, which 34 707 (61%) answered. The responders received a follow-up questionnaire in 2010, answered by 25 167 participants (73%). Compared to consensus data from Stockholm County the SPHC participants were more likely to be of female gender, be born in Sweden, have higher education and income and be more than 45 years old.[15]

Study sample

The study sample (n=8994) consisted of participants reporting occasional LBP at baseline in 2006 who answered the follow-up questionnaire in 2010 and provided complete information on outcome and exposure variables (Figure 1). Occasional LBP at baseline was defined as reporting having had LBP,

on average, up to a couple of days per month during the past 6 months. The information was based on a modified version of a question from the Standardized Nordic Questionnaire.[16]

Data collection and variables

The baseline and the follow-up questionnaires comprised self-reported information on lifestyle, demographic- and socioeconomic characteristics, physical and psychological health and work related factors. The self-reported data were supplemented with information from regional and national registers.[15] Four reminders were sent after the baseline questionnaire and three reminders after the follow-up questionnaire.

Exposure: healthy lifestyle behaviour (HLB)

Using baseline information we constructed four binary healthy lifestyle factors where cut-offs (healthy/not healthy) were set in accordance with recommendations for a health-enhancing lifestyle made by Swedish authorities and WHO.[17-20] The exposure variable "healthy lifestyle behaviour" (HLB) was a combination of these binary factors and was categorised into five levels according to the number of healthy lifestyle factors included, i.e. from none to four (HLB0 to HLB4). A healthy lifestyle behaviour with regard to each of the considered healthy factors was defined by: non-smoking, no risk consumption of alcohol (≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, and consuming alcohol corresponding to about half a bottle of spirits (35 cl) on the same occasion less than once a month), recommended level of leisure physical activity (at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities), and recommended consumption of fruit and vegetables (≥ a total of 4 servings of fruit and vegetables/day, equal to about 400 g/day) (see the Appendix for a description of the questions and how the variables were constructed).

Outcome variable: long duration troublesome low back pain (LTLBP)

Information on the outcome LTLBP was collected from the follow-up questionnaire in 2010 and defined as having had LBP that decreased workability or interfered with other daily activities to some or to high degree, on average a couple of days per week or more often during the past 6 months. The

question used to measure LTLBP was modified from the Standardized Nordic Questionnaire and incorporated a dimension of disability suggested to be of importance when defining LBP.[16, 21]

Potential confounding factors

Potential confounders were chosen based on theoretic and empirical relevance, information from literature regarding the prognosis of spinal pain and availability in the questionnaire.[8, 22, 23] The following factors were considered: long-term illness (suffering from long-term illness, health problems following an accident, disability or other persistent health problems), neck pain and pain from hip, thigh or knee during the past 6 months (5 answer alternatives from “no pain” to “daily pain”), suffering from headache or migraine (“no”, “somewhat”, “severe”), rheumatoid arthritis diagnosed by a physician, living alone, living with children (children of all ages included) and hours of sleep a typical night during the workweek (dichotomized into “good sleep”: 6-8 h and “poor sleep”: <6 h or >8 h). The questionnaire also included the 12-item General Health Questionnaire were a sum score of ≥3 (using the recommended 0-0-1-1 scoring on the four answer alternatives) was used to asses psychological distress.[24, 25] The frequency of stress was measured by the question “How often do you feel stress?” with 5 answer alternatives from “never” to “most of the week”. Personal support (having persons who can give support in handling personal problems or critical life events) was measured using a question from the Social Support-13 instrument (SS-13).[26] Furthermore, financial stress was assessed by the question “Did it during the previous 12 months happen that you ran out of money and had to borrow from relatives and friends to be able to pay for food or rent?” (“no”, “yes, on one occasion”, “yes, on several occasions”). A Swedish national register supplied information on civil status (married, unmarried, divorced, widow/widower), country of birth (Sweden, Nordic countries and Europe, outside Europe), socio-economic status (SES), annual individual disposable income (grouped in quintiles) and education.[27, 28] The level of education was categorized into, low (only compulsory education and vocational training), intermediate (secondary school) and high (university studies).

Statistical methods

We used generalized linear models with a binomial distribution to estimate the association between the exposure and the outcome analysing men and women separately. To determine the role of a potential confounding factor we included them, one at a time, into the crude model. Only factors that changed the estimated risk ratio (RR) by 10% or more were entered into the final model.[29-33] All final models were adjusted for age categorized into 10 year intervals. Age was categorized as it showed non-linearity with the outcome. We calculated relative risks (RR), using the log function, as well as risk differences (RD), using the identity function, with 95% confidence intervals (95% CI). A likelihood ratio test was used to assess effect measure modification between the exposure and possible confounders as well as between confounders included in the final models.[34] We used Wald test to evaluate potential trends in the associations between the exposure and the outcome, and a Chi-square test to assess if the overall adjusted risk differed between men and women.[34] The effect of attrition was assessed, using Chi-square tests, by comparing the distribution of the four healthy lifestyle factors included in the exposure, healthy lifestyle behaviour, in subjects who were lost to follow-up to the distribution in the study sample.

All p-values were two-sided, and analyses were completed using SAS® version 9.3 and STATA/IC® version 12.1.

Results

Baseline characteristics

The study sample (n=8994) consisted of 56% women. Participants were predominately middle aged, well educated, and born in Sweden. At baseline in 2006, about 15% of the participants were 65 years or older (men 17% and women 14%). Furthermore the majority were cohabitating, and about 35% had children living at home (Table 1). About three percent men and 10% women had an “optimal healthy lifestyle” (HLB4) whereas about five percent men and three percent women had an “unhealthy lifestyle” (HLB0). Healthy lifestyle behaviour improved with increased level of education. Participants being married or having children living at home had a high proportion of healthy lifestyle behaviour while participants living alone, being psychologically distressed and financially stressed

showed low proportions of healthy lifestyle behaviour (Table 1).

The other baseline variables assessed did not differ much between the categories of HLB, neither among men nor among women.

Table 1. Baseline characteristics by categories of the exposure healthy lifestyle behaviour (HLB0 - HLB4)* (n = 8994).

Baseline characteristics (%)	Men All (n=3938)	Men HLB0 (n=181)	Men HLB1 (n=958)	Men HLB2 (n=1747)	Men HLB3 (n=936)	Men HLB4 (n=116)	Women All (n=5056)	Women HLB0 (n=174)	Women HLB1 (n=897)	Women HLB2 (n=2080)	Women HLB3 (n=1416)	Women HLB4 (n=489)	Internal drop-out M/W (n)
Proportion of study sample	44						56						
Mean age, years (SD)	50(15)	49(14)	48(15)	49(15)	51(15)	50(14)	46(16)	43(17)	47(15)	46(16)	47(15)	46(14)	0/0
Education													234/287
Low	16	30	19	14	14	8	14	22	17	13	12	9	
Intermediate	43	43	46	44	40	35	41	57	46	42	38	34	
High	41	27	35	42	46	57	45	21	37	45	50	57	
Civil status													0/1
Married	54	42	49	56	56	65	47	27	41	46	53	53	
Unmarried	33	38	36	32	31	29	36	49	37	37	33	32	
Divorced/Widow/Widower	13	20	15	12	13	6	17	24	22	17	14	15	
SES[a]													292/398
Unskilled/semiskilled worker	14	22	17	13	12	9	16	23	19	16	14	10	
Skilled worker	15	25	16	14	15	8	10	22	12	9	9	11	
Assistant non-manual employees	8	8	10	9	7	5	20	22	21	22	18	15	
Intermediate non-manual	25	14	25	24	27	24	29	23	23	29	31	35	

employees													
Employed/self-employed professionals	25	17	18	28	28	34	19	7	17	18	21	24	
Self-employed (other than professionals)	13	14	14	12	11	20	6	3	8	6	7	5	
Poor sleep[b]													34/27
<6 or >8 hours/night	9	17	9	10	7	9	10	14	11	11	9	7	
Living alone	17	31	19	16	14	9	19	24	21	19	17	17	10/16
Living with children	34	24	31	35	34	42	38	27	32	39	41	41	10/16
Psychological distress[c]	13	18	15	13	11	5	21	33	23	22	19	17	38/37
Financial stress[d]	7	15	10	5	4	3	9	23	13	9	7	6	17/24

* HLB0 = no healthy lifestyle factor, HLB1 = 1 of 4 healthy lifestyle factors, HLB2 = 2 of 4 factors, HLB3 = 3 of 4 factors, HLB4 = all 4 healthy lifestyle factors.

[a] Socio-economic status. For the economically active population SES was based on current occupation and education. For the non-active population SES was based on previous occupation, current education or the occupation of spouses.

[b] Hours of sleep a typical night during the workweek (dichotomized into "good sleep": 6-8 h and "poor sleep": <6 h or >8 h).

[c] From the 12-item General Health Questionnaire (GHQ-12) were a sum score ≥ 3 was used to asses psychological stress.

[d] Financial stress: Had to borrow money from relatives and friends to be able to pay for food or rent on several occasions during the previous 12 months.

The majority of both men and women were non-smokers and did not exceed risk consumption of alcohol. About 40% of both men and women reached recommended levels of leisure physical activity while 26% of the women consumed recommended levels of fruit and vegetables compared to seven percent for men (Figure 2).

Outcome

At follow-up in 2010, nine percent men and 11% women in the study sample reported LTLBP. Table 2 shows the crude and adjusted binomial regression estimations of the association between healthy lifestyle behaviour and the outcome.

Table 2. Association* between healthy lifestyle behaviour and long duration troublesome low back pain (LTLBP) in men and women with occasional LBP at baseline in 2006.

	MEN (n=3646)[a]				WOMEN (n=4658)[a]			
		Crude	Adjusted (Age, SES)[b]			Crude	Adjusted (Age, SES)[b]	
Healthy lifestyle behaviour[c]	**LTLBP/ no LTLBP[d] (n/n)**	**RR (95% CI)**	**RR (95% CI)**	**RD (95% CI)**	**LTLBP/ no LTLBP[d]**	**RR (95% CI)**	**RR (95% CI)**	**RD (95% CI)**
HLB0	14/155	1.0	1.0	0.0	28/131	1.0	1.0	0.0
HLB1	71/812	0.97 (0.56, 1.68)	1.02 (0.59, 1.76)	-0.01 (-0.06, 0.03)	94/735	0.64 (0.44, 0.95)	0.65 (0.44, 0.96)	-0.05 (-0.12, 0.01)
HLB2	133/1476	1.00 (0.59, 1.69)	1.05 (0.62, 1.78)	-0.01 (-0.05, 0.04)	181/1721	0.54 (0.38, 0.78)	0.54 (0.38, 0.78)	-0.07 (-0.13, -0.01)
HLB3	60/818	0.82	0.85	-0.02	125/1187	0.54	0.55	-0.07

		(0.47, 1.44)	(0.48, 1.48)	(-0.06, 0.02)		(0.37, 0.79)	(0.38, 0.81)	(-0.13, -0.01)
HLB4	6/101	0.68	0.75	-0.03	36/420	0.45	0.48	-0.08
		(0.27, 1.71)	(0.30, 1.89)	(-0.07, 0.01)		(0.28, 0.71)	(0.31, 0.77)	(-0.15, -0.02)

*note: *Log- binomial regression estimating the risk ratio (RR) and the risk difference (RD) with 95% confidence interval (95% CI).*

[a] Reduced number of observations due to missing information about socio-economic status (SES) (men n=292 and women n=398).

[b] Adjusted for age in 10 year categories and socio-economic status (SES) in six categories.

[c] HLB0 = no healthy lifestyle factor, HLB1 = 1 of 4 healthy lifestyle factors, HLB2 = 2 of 4 factors, HLB3 = 3 of 4 factors, HLB4 = all 4 healthy lifestyle factors. Healthy lifestyle factors included in HLB: non-smoking, no risk consumption of alcohol (≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, and consuming alcohol corresponding to ≈ half a bottle of spirits on the same occasion less than once a month), recommended level of leisure physical activity (at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities), and recommended consumption of fruit and vegetables (≥ 4 servings of fruit and vegetables/day).

[d] Numbers of participants with and without LTLBP at follow-up in 2010.

There was a decreased risk for LTLBP at follow-up for women with a healthy lifestyle behaviour compared to women with unhealthy lifestyle behaviour (test for trend: p=0.006). Twenty-one percent of women with no healthy lifestyle factor (HLB0) experienced LTLBP at follow-up compared to nine percent of women with all four factors (HLB4). A five percent lower proportion of women with one healthy lifestyle factor, and an eight percent lower proportion of women with all four factors had LTLBP, in comparison to the reference group (HLB0).Women with one healthy lifestyle factor and women with all four healthy lifestyle factors had a 35% and a 52% lower risk for LTLBP, respectively, compared to women with unhealthy lifestyle behaviour (HLB0). There were no clear associations between healthy lifestyle behaviour and LTLBP found among men.

SES was the only variable found to be a confounder, so the final log-binomial analyses were adjusted by SES and age in 10 year categories. There was no effect measure modifications found.

Figure 3 shows the adjusted risk to develop LTLBP for men and women with occasional LBP by categories of healthy lifestyle behaviour. Women had an overall higher adjusted risk for LTLBP than men (p=0.001).

The subjects lost to follow-up (n=4552) had significantly lower proportions of healthy lifestyle factors than the study sample ($p < 0.01$ for all four factors). The differences in proportions were eight percent for non-smoking, 16% for no risk consumption of alcohol, six percent for leisure physical activity and five percent for consumption of fruit and vegetables.

Discussion

In this cohort study we found that healthy lifestyle behaviour had a positive influence on the prognosis of occasional low back pain among women. Healthy lifestyle behaviour comprised four healthy lifestyle factors: non-smoking, no risk consumption of alcohol, recommended level of leisure physical activity and recommended consumption of fruit and vegetables. Compared to women with no healthy lifestyle factor, the risk for development of long duration troublesome low back pain (LTLBP) decreased by 35% among women with one healthy lifestyle factor and by 52% among women with all four healthy lifestyle factors. In absolute terms, the proportion of women with LTLBP at follow-up

was five percent lower if they had one healthy lifestyle factor and eight percent lower if they had four healthy lifestyle factors when compared to women with unhealthy lifestyle behaviour. These associations were not confirmed among men but the results indicated the same tendency.

Further, compared to women, men had an overall lower adjusted risk for LTLBP, and a low risk even in the unhealthy reference group (Figure 3). Men with unhealthy lifestyle behaviour had about the same risk for LTLBP as women with optimal healthy lifestyle behaviour. These findings were not aimed to be addressed in the present study and needs to be further investigated.

We found no studies concerning the effects of healthy lifestyle behaviour, defined as a combination of healthy lifestyle factors, on the prognosis of LBP or other types of spinal pain. Nevertheless, considering the risk of developing chronic back pain Pronk and colleagues showed results in line with our study.[2] Studying employees, the authors found that an "optimal lifestyle" decreased the 2-year risk of chronic LBP by 66% compared to employees with an unhealthy lifestyle. Having optimal lifestyle was equal to having all four of the healthy lifestyle factors similar to the ones included in our study: non-smoking, adequate physical activity, five servings of fruit and vegetables per day and limited or no alcohol consumption.

Strengths and limitations

To our knowledge this is the first study concerning the influence of healthy lifestyle behaviour (HLB) on the prognosis of LBP assessing men and women separately. Measuring the exposure prior to the outcome and the dose-response relationship found supports the validity of the associations between HLB and LTLBP found among women.[32] We believe the use of a complete study sample, the large sample size and the large number of potential confounders assessed strengthens the internal validity, though we cannot rule out residual or unmeasured confounding.[32] The questions used in this study have, since 1975, been used in several Swedish national and local public health surveys. They have on several occasions been tested (e.g. cognitive testing) and improved by Statistics Sweden's test centre and several questions have shown to have acceptable psychometric properties. Moreover, information on education, disposable income, SES, country of birth and marital status were collected from

Swedish national registers known to have high quality. The questions concerning leisure physical activity and consumption of fruit and vegetables have shown to have acceptable validity and reliability, and the method to measure alcohol consumption has been recommended by Romelsjö and colleagues.[35-38] Despite this the measurements used may not have been optimal in terms of validity and reliability.

Our study also has limitations. Self-reported exposure information may be hampered by low accuracy. For example, some participants may wish to present themselves in a favourable light and overestimate their healthy lifestyle (social desirability) or some may have difficulties understanding the questions and therefore report less well.[32, 39, 40] This could lead to misclassification of the exposure which may result in an under- or overestimation of the association. As this potential misclassification is likely to be non-differential it would probably dilute a true association, at least when comparing extremes.[32] Moreover, if men tend to misclassify their healthy lifestyle factors to a greater extent than women this may partly explain why we did not find any associations among men. For example, Dyrstad and colleagues found that men overestimated their self-reported physical activity when compared to accelerometer-measures to a greater extent than women.[41] As we studied a population between 18-84 years old a large proportion of the participants did not provide work related information why we did not assess potential confounding effects from work related variables, something that may have affected the results. About 34% of participants in the baseline survey were not part of the study sample due to attrition and exclusion (Figure 1). These subjects had significantly lower proportions of healthy lifestyle factors than the study sample. This may have biased our result, most probably leading to an underestimation of the associations.

Considering strengths and limitations in our study we regard our result as a valid contribution to the body of research showing that a healthy lifestyle affects health problems.[1-5] Our study results showing that healthy lifestyle behaviour influences the prognosis of LBP are new and important knowledge with the potential to have an impact on a very common public health problem and have implications both in a public-health and a clinical perspective. Even though the association for healthy lifestyle behaviour to affect LBP among men was not clear, the results showed the same tendency as

for women. Considering this together with the obvious effect of healthy lifestyle on other health problems the work to encourage both men and women to adapt to healthy lifestyle should certainly be continued.

Conclusion

Healthy lifestyle behaviour, defined as combinations of non-smoking, no risk consumption of alcohol, recommended level of leisure physical activity and recommended consumption of fruit and vegetables, decreases the risk of developing long duration troublesome low back pain among women with occasional low back pain. There were no clear associations found among men.

Contributors: TB, ES, LA, EV and IJ contributed to the design of the study. JH and LA were part of the expert group responsible for the design and implementation of the SPHC cohort. TB made the statistical analyses and wrote the first manuscript version. All authors contributed to the interpretation of the data and critically revised all versions of the manuscript and finally approved the last version.

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Data sharing: No additional data available.

Transparency: The lead author (TB) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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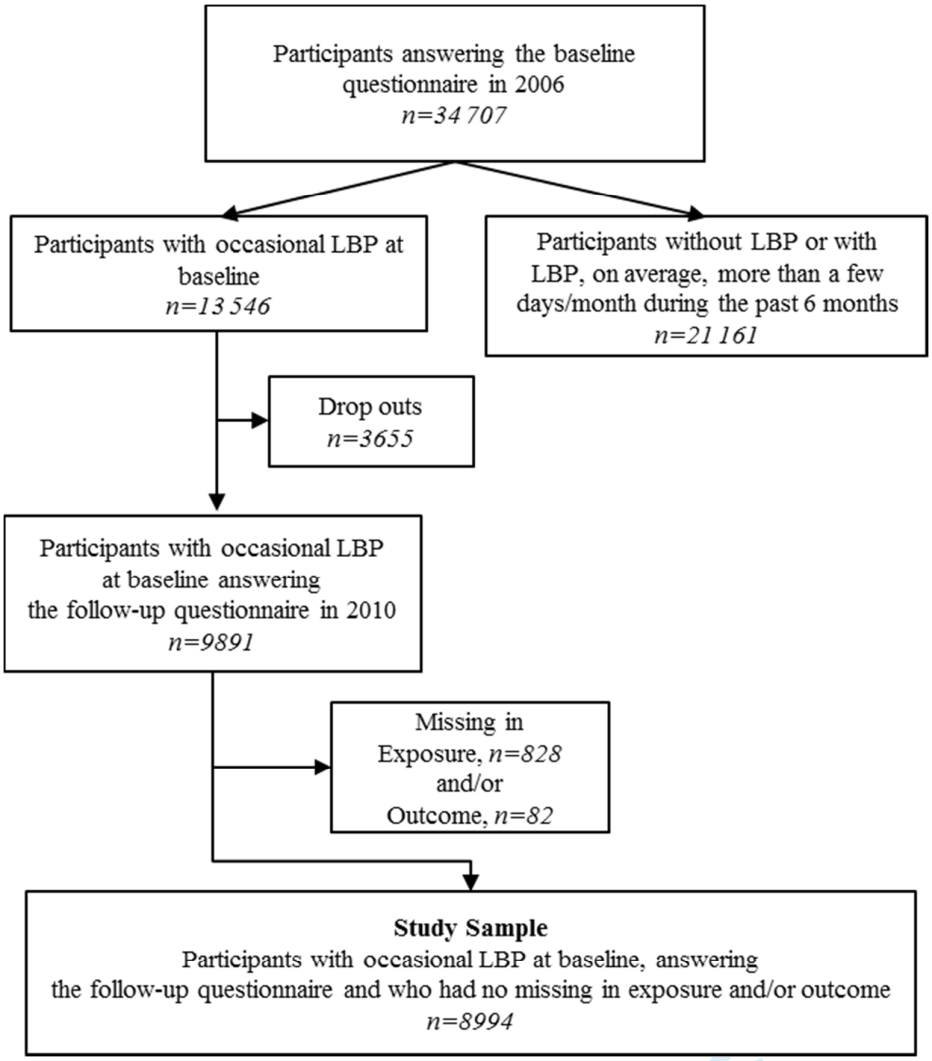
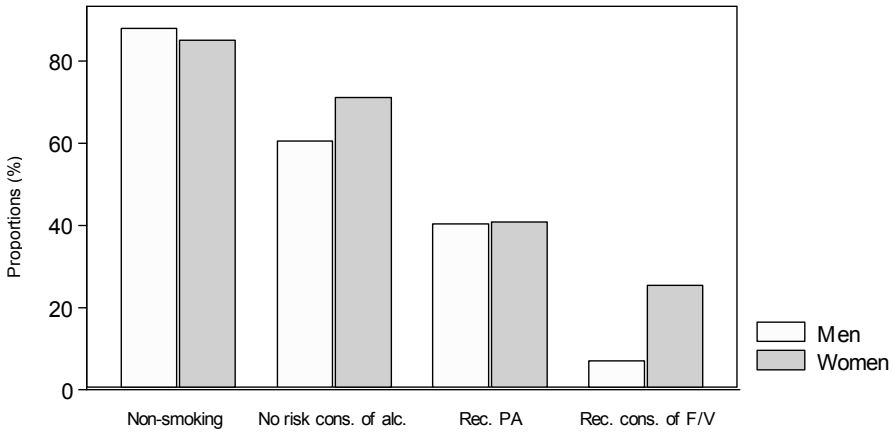
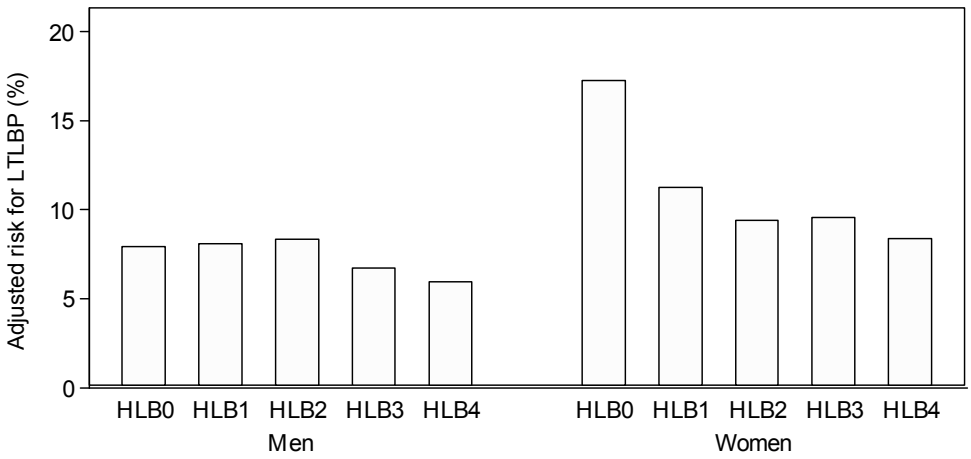
Figure 1. Flowchart of the inclusion process for the study sample. LBP: low back pain.

Figure 2. Distribution of healthy lifestyle factors. PA: Leisure physical activity. F/V: Fruit and vegetables.

Figure 3. Estimated risk for LTLBP, adjusted for SES and age. Men (n=3646), women (n=4658).







Appendix

Construction of the binary lifestyle factor variables incorporated in the exposure variable "healthy lifestyle behaviour" (HLB), based on questions from the baseline questionnaire in 2006 (Health Survey 2006, Stockholm County Council).

Non-smoking:

26. Do you smoke daily?

1 ☐ No

2 ☐ Yes

Recommended level of leisure physical activity:

24. How much have you exercised and exerted yourself physically in *the past 12 months*?

If your activity for example varies between summer and winter, try to state an average. Indicate one alternative.

1 ☐ Sedentary leisure time
You spend most of your time reading, watching TV, going to movie theatres or carrying out some other form of sedentary activity. You take walks, cycle or exercise in some other way for less than 2 hours per week.

2 ☐ Moderate leisure time exercise
You take walks, cycle or exercise in some other way for at least 2 hours per week, usually without sweating. This also includes walks, ordinary garden chores, fishing, table tennis and bowling.

3 ☐ Moderate, regular leisure time exercise
You exercise regularly 1–2 times per week for at least 30 minutes each time by jogging, swimming, playing tennis, badminton or through another activity that makes you sweat.

4 ☐ Regular leisure time exercise and training
You, for example, jog, swim, play tennis or badminton or carry out gymnastics or the like and which makes you sweat an average of at least 3 times a week. Each occasion lasts at least 30 minutes..

25. How many days in **an average week** do you devote to at least 30 minutes of physical activity that makes you grow warm?

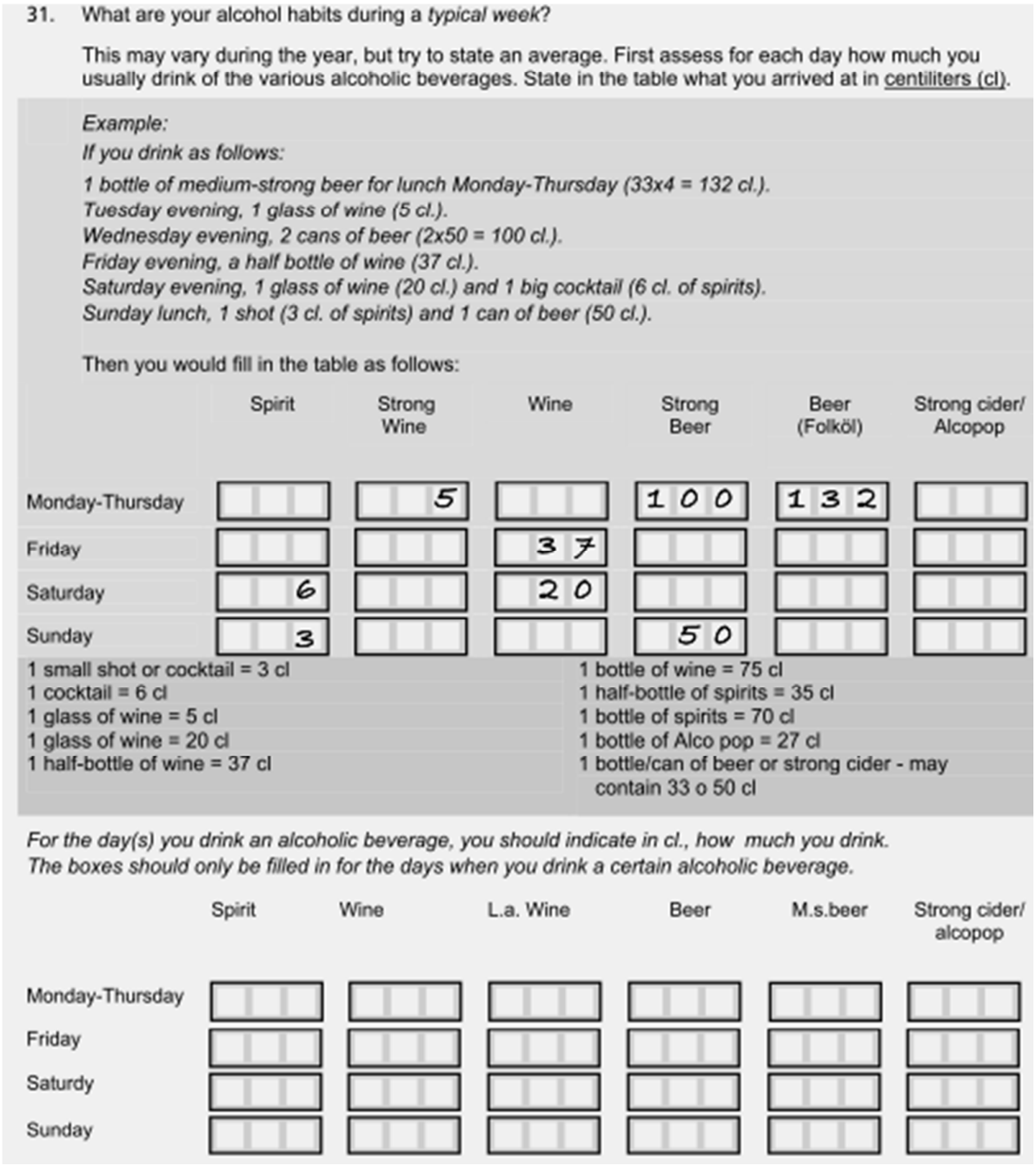
Count fitness training as well as brisk walks, gardening work, heavy household work, cycling, swimming and the like. This may vary during the year, but try to state an average.

☐ days a week

"Recommended level of leisure physical activity" was theoretically defined as performing leisure physical activity at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities. This was equal to alternative 4 in question no.24 *OR* ≥ 5 days a week

in question no.25 *OR* a combination of alternative 3 in question no.24 and 3 or 4 days a week in question no.25.

No risk consumption of alcohol:



31. What are your alcohol habits during a *typical week*?

This may vary during the year, but try to state an average. First assess for each day how much you usually drink of the various alcoholic beverages. State in the table what you arrived at in centiliters (cl).

Example:
If you drink as follows:
1 bottle of medium-strong beer for lunch Monday-Thursday (33x4 = 132 cl.).
Tuesday evening, 1 glass of wine (5 cl.).
Wednesday evening, 2 cans of beer (2x50 = 100 cl.).
Friday evening, a half bottle of wine (37 cl.).
Saturday evening, 1 glass of wine (20 cl.) and 1 big cocktail (6 cl. of spirits).
Sunday lunch, 1 shot (3 cl. of spirits) and 1 can of beer (50 cl.).

Then you would fill in the table as follows:

	Spirit	Strong Wine	Wine	Strong Beer	Beer (Folköl)	Strong cider/ Alcopop
Monday-Thursday		5		100	132	
Friday			37			
Saturday	6		20			
Sunday	3			50		

1 small shot or cocktail = 3 cl
1 cocktail = 6 cl
1 glass of wine = 5 cl
1 glass of wine = 20 cl
1 half-bottle of wine = 37 cl
1 bottle of wine = 75 cl
1 half-bottle of spirits = 35 cl
1 bottle of spirits = 70 cl
1 bottle of Alco pop = 27 cl
1 bottle/can of beer or strong cider - may contain 33 o 50 cl

For the day(s) you drink an alcoholic beverage, you should indicate in cl., how much you drink.
The boxes should only be filled in for the days when you drink a certain alcoholic beverage.

	Spirit	Wine	L.a. Wine	Beer	M.s.beer	Strong cider/ alcopop
Monday-Thursday						
Friday						
Saturdy						
Sunday						

Grams of 100% alcohol/week were calculated by summarizing the volume of each of the different alcoholic beverage consumed over the week, multiply this sum with the volume percentage of alcohol

for the specific beverage and finally summarize the volume percentage for all beverages.

As an example from above, the grams of 100% alcohol from strong beer was 150*0.053 (volume % in Swedish strong beer) = 7.95 g of 100% alcohol etc.

32. How often do you, on the same occasion, drink alcoholic beverages equivalent to at least:
– A half bottle of spirits
– or 2 bottles of wine
– or 6 cans of beer (8 bottles)
– or 12 bottles of medium-strong beer

1 ☐ Virtually every day (at least 5 days per week)
2 ☐ A few times per week (3–4 times per week)
3 ☐ Once or twice per week
4 ☐ 2–3 times per month
5 ☐ Once a month
6 ☐ 1–6 times per year
7 ☐ Never

Using a combination of question no.31 and no.32, "No risk consumption of alcohol" was theoretically defined as drinking; ≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, *AND* alternative 6 or 7 on question no.32 (= consuming alcohol corresponding to ≈ half a bottle of spirits on the same occasion less than once a month).

Recommended consumption of fruit and vegetables:

21. How often do you eat fruits or berries?
Think of the past 12 months. Count fresh, canned and frozen (for example 1 apple, 1 banana, 1 bunch of grapes, 1 glass of juice, 1 bowl of strawberries or 2 slices of pineapple).

I eat fruits or berries:

1 ☐ A few times per month or never	**0**
2 ☐ Around once a week	**0**
3 ☐ A few times per week	**0.5**
4 ☐ Virtually every day	**1**
5 ☐ 2 times per day	**2**
6 ☐ 3 or more times per day	**3**

22. How often do you eat a portion of vegetables/root vegetables?

Think of the past 12 months. Count fresh, frozen, canned, stewed in addition to dishes including vegetables (for example ½ bell pepper, 1 tomato, 1–2 dl. shredded carrot, 1–2 dl. mixed vegetables or 1 bowl of lentil soup).

I eat a portion of vegetables/root vegetables:

1	☐ A few times per month or never	**0**
2	☐ Around once a week	**0**
3	☐ A few times per week	**0.5**
4	☐ Virtually every day	**1**
5	☐ 2 times per day	**2**
6	☐ 3 or more times per day	**3**

The six answer alternatives on question no.21 and no.22 were assigned a score from 0 to 3. "Recommended consumption of fruit and vegetables" was theoretically defined as having a sum score from the two questions of ≥ 4. This was equal to eating fruit and vegetables every day and to a minimum of 4 servings per day (≈ 400 g/day).

Tony Bohman

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **p.1**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **p.2-3**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **p.4-5**
Objectives	3	State specific objectives, including any prespecified hypotheses **p. 5 paragraph 1 and 2**
Methods		
Study design	4	Present key elements of study design early in the paper **Method; paragraph 1**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **Methods; paragraph 1-2, fig. 1**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up **Methods; paragraph 1-2, fig. 1**
		~~(*b*) For matched studies, give matching criteria and number of exposed and unexposed~~
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **Methods; p. 6-7**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **Methods; p. 6-7**
Bias	9	Describe any efforts to address potential sources of bias **Methods; p.5 – random selection, stratification for gender and residential area**
Study size	10	Explain how the study size was arrived at **Methods; paragraph 1 and 2, p.5-6, fig.1**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **Methods; p.6-7, Appendix**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **Statistical methods; p.8**
		(*b*) Describe any methods used to examine subgroups and interactions **Statistical methods; p.8**
		(*c*) Explain how missing data were addressed **Fig. 1, table 1 and 2**
		(*d*) If applicable, explain how loss to follow-up was addressed **Methods, Study design and source population and fig. 1**
		(*e*) Describe any sensitivity analyses **Methods; p.8 last part of Statistical methods.**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **Fig. 1, table 1 and 2**
		(b) Give reasons for non-participation at each stage **– no information on reason**
		(c) Consider use of a flow diagram **Fig. 1**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **Table 1**
		(b) Indicate number of participants with missing data for each variable of interest

		Table 1
		~~(c) Summarise follow-up time (eg, average and total amount)~~
Outcome data	15*	Report numbers of outcome events or summary measures over time **Table 2**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **Table 2 and statistical methods**
		(*b*) Report category boundaries when continuous variables were categorized **Statistical methods; p. 8, Age categorised into 10 yr intervals. Results; table 1 and table 2.**
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Discussion		
Key results	18	Summarise key results with reference to study objectives **Discussion; first paragraph**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **p. 17 middle paragraph.**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **Discussion; last paragraph p. 17 and first paragraph p 18.**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Discussion; last paragraph.**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **Funding and Competing interests p. 18.**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Does healthy lifestyle behaviour influence the prognosis of low back pain among men and women in a general population? A population based cohort study.

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Tony Bohman

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Does healthy lifestyle behaviour influence the prognosis of low back pain among men and women in a general population? A population based cohort study.

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Figures: 3

Tables: 2

References: 41

Supplementary files: 2

Abstract

Objectives

To study the influence of healthy lifestyle behaviour on the prognosis of occasional low back pain among men and women in a general population.

Design

Cohort study with a four year follow-up.

Settings

General population in Stockholm County, Sweden.

Participants

The study sample comprised 3938 men and 5056 women, aged 18-84, from the Stockholm Public Health cohort reporting occasional low back pain in the baseline questionnaire 2006.

Measures

Lifestyle factors and potential confounders were assessed at baseline. The lifestyle factors smoking habits, alcohol consumption, leisure physical activity and consumption of fruit and vegetables, were dichotomized using recommendations for a health-enhancing lifestyle and combined to form the exposure variable “healthy lifestyle behaviour”. The exposure was categorised into five levels according to the number of healthy lifestyle factors met. The follow-up questionnaire in 2010 gave information about the outcome, long duration troublesome low back pain. Crude and adjusted binomial regression models were applied to estimate the association between the exposure and the outcome analysing men and women separately.

Results

The risk of developing long duration troublesome low back pain among women with occasional low back pain decreased with increasing healthy lifestyle behaviour (trend test: p=0.006). 21% (28/131) among women with no healthy lifestyle factor (reference) experienced the outcome compared to nine

percent (36/420) among women with all four factors. Compared to the reference group, the risk was reduced by 35% (RR: 0.65, 95% CI: 0.44 to 0.96) for women with one healthy lifestyle factor and 52% (RR: 0.48, 95% CI: 0.31 to 0.77) for women with all four healthy lifestyle factors. There were no clear associations found among men.

Conclusion

Healthy lifestyle behaviour seems to decrease the risk of developing long duration troublesome low back pain among women with occasional low back pain and may be recommended to improve the prognosis.

Article summary

Strengths and limitations of this study

- Strengths of this study are the large sample, the longitudinal design, the long term follow-up, robust analyses and the large number of potential confounding factors assessed.
- Possible limitations of this study were the potential risk of misclassification of the exposure variable and the relatively large loss to follow-up, although these limitations most probably lead to an underestimation of the associations studied. Further the results may have been affected by questionnaire items not fully validated.

Introduction

Lifestyle factors such as non-smoking, physical activity, healthy diet and moderate alcohol use seem to influence the risk and the prognosis in several diseases (e.g. cancer, type 2 diabetes mellitus, and cardiovascular disease) as well as mortality, especially when the factors are combined.[1-5]

Low back pain (LBP) is one of the most common health problems worldwide and comprises a large burden on individuals as well as on society.[6, 7] When estimating the global prevalence of activity-limiting LBP using 165 studies from 54 countries, Hoy and colleagues found the mean point- and 1 month prevalence to be 11.9 ± 2.0% and 23.2 ± 2.9% respectively.[6] Current knowledge of prognostic factors, e.g. lifestyle factors, for LBP is limited and the above mentioned facts support the need for more research on this topic.

In a "review of reviews" from 2009, Hayden and colleagues reported older age, negative cognitive characteristics, poor general health, increased psychological or psychosocial stress, poor relations with colleagues, physically heavy work, functional disability, sciatica, and the presence of worker´s compensation to be associated with poor outcomes of acute and sub-acute LBP.[8] Another 2009 review found recovery expectations to be associated with activity limitations or participation restrictions (e.g. return to work) in persons with non-chronic non-specific LBP.[9] In the review by Hayden and colleagues smoking was the only lifestyle factor included and found, by two studies, to have no association with poor outcomes of acute and sub-acute LBP.[8] Similarly, a recent review studying prognostic factors for recovery from chronic LBP found no association between smoking and the outcome pain and disability.[10] Moreover, reviewing observational studies on LBP patients Hendrick and colleagues found moderate evidence for sports, leisure and occupational physical activity not to be associated with LBP outcomes.[11]

Women seem to have higher prevalence, be more severely affected and have worse prognosis of LBP than men and some studies suggest that men and women should be assessed separately when studying risk and prognostic factors for LBP.[6, 12-14]

To our knowledge, it is not known if healthy lifestyle behavior, defined by a combination of lifestyle factors, is associated with the prognosis of LBP. Healthy lifestyle behaviour seems to have a larger

potential to affect health problems and mortality than separate lifestyle factors alone.[1-5] We hypothesized that healthy lifestyle behaviour would decrease the risk of a poor outcome among men and women with occasional low back pain. If healthy lifestyle behaviour affects the prognosis of LBP implementing this knowledge could potentially prevent transition into disabling LBP and thereby reduce the burden on the individual as well as on the society.

The aim of this study was to explore the influence of healthy lifestyle behaviour on the prognosis of occasional low back pain among men and women in a general population, hypothesizing that healthy lifestyle behaviour can improve the prognosis.

Methods

Study design and source population

In this study we used data from the Stockholm Public Health Cohort (SPHC).[15] The SPHC was set up by the Stockholm County Council and administered by Statistics Sweden and the Department of Public Health Sciences at Karolinska Institutet, Stockholm. The SPHC is a population based cohort established within the framework of Stockholm County Council public health surveys. In 2006, Stockholm County had an adult population of approximately 1.4 million individuals. From this population a total of 56 634 individuals (18-84 years old) were randomly selected, after stratification for gender and residential area, and received the baseline questionnaire, which 34 707 (61%) answered. The responders received a follow-up questionnaire in 2010, answered by 25 167 participants (73%). Compared to consensus data from Stockholm County the SPHC participants were more likely to be of female gender, be born in Sweden, have higher education and income and be more than 45 years old.[15]

Study sample

The study sample (n=8994) consisted of participants reporting occasional LBP at baseline in 2006 who answered the follow-up questionnaire in 2010 and provided complete information on outcome and exposure variables (Figure 1). Occasional LBP at baseline was defined as reporting having had LBP,

on average, up to a few days per month during the past 6 months (for the item used to define occasional LBP see Appendix 1). The information was based on a modified version of a question from the Standardized Nordic Questionnaire.[16]

Data collection and variables

The baseline and the follow-up questionnaires comprised self-reported information on lifestyle, demographic- and socioeconomic characteristics, physical and psychological health and work related factors. The self-reported data were supplemented with information from regional and national registers.[15] Four reminders were sent after the baseline questionnaire and three reminders after the follow-up questionnaire.

Exposure: healthy lifestyle behaviour (HLB)

Using baseline information we constructed four binary healthy lifestyle factors where cut-offs (healthy/not healthy) were set in accordance with recommendations for a health-enhancing lifestyle made by Swedish authorities and WHO.[17-20] The exposure variable "healthy lifestyle behaviour" (HLB) was a combination of these binary factors and was categorised into five levels according to the number of healthy lifestyle factors included, i.e. from none to four (HLB0 to HLB4). A healthy lifestyle behaviour with regard to each of the considered healthy factors was defined by: non-smoking, no risk consumption of alcohol (≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, and consuming alcohol corresponding to about half a bottle of spirits (35 cl) on the same occasion less than once a month), recommended level of leisure physical activity (at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities), and recommended consumption of fruit and vegetables (≥ a total of 4 servings of fruit and vegetables/day, equal to about 400 g/day) (see Appendix 2 for a description of the questions and how the variables were constructed).

Outcome variable: long duration troublesome low back pain (LTLBP)

Information on the outcome LTLBP was collected from the follow-up questionnaire in 2010 and defined as having had LBP that decreased workability or interfered with other daily activities to some

or to high degree, on average a few days per week or more often during the past 6 months (for the items used to define LTLBP see Appendix 1). The question used to measure LTLBP was modified from the Standardized Nordic Questionnaire and incorporated a dimension of disability suggested to be of importance when defining LBP.[16, 21]

Potential confounding factors

Potential confounders were chosen based on theoretic and empirical relevance, information from literature regarding the prognosis of spinal pain and availability in the questionnaire.[8, 22, 23] The following factors were considered: long-term illness (suffering from long-term illness, health problems following an accident, disability or other persistent health problems), neck pain and pain from hip, thigh or knee during the past 6 months (5 answer alternatives from "no pain" to "daily pain"), suffering from headache or migraine ("no", "somewhat", "severe"), rheumatoid arthritis diagnosed by a physician, living alone, living with children (children of all ages included) and hours of sleep a typical night during the workweek (dichotomized into "good sleep": 6-8 h and "poor sleep": <6 h or >8 h). The questionnaire also included the 12-item General Health Questionnaire were a sum score of ≥3 (using the recommended 0-0-1-1 scoring on the four answer alternatives) was used to asses psychological distress.[24, 25] The frequency of stress was measured by the question "How often do you feel stress?" with 5 answer alternatives from "never" to "most of the week". Personal support (having persons who can give support in handling personal problems or critical life events) was measured using a question from the Social Support-13 instrument (SS-13).[26] Furthermore, financial stress was assessed by the question "Did it during the previous 12 months happen that you ran out of money and had to borrow from relatives and friends to be able to pay for food or rent?" ("no", "yes, on one occasion", "yes, on several occasions"). A Swedish national register supplied information on civil status (married, unmarried, divorced, widow/widower), country of birth (Sweden, Nordic countries and Europe, outside Europe), socio-economic status (SES), annual individual disposable income (grouped in quintiles) and education.[27, 28] The level of education was categorized into, low (only compulsory education and vocational training), intermediate (secondary school) and high (university studies).

Statistical methods

We used generalized linear models with a binomial distribution to estimate the association between the exposure and the outcome analysing men and women separately. To determine the role of a potential confounding factor we included them, one at a time, into the crude model. Only factors that changed the estimated risk ratio (RR) by 10% or more were entered into the final model.[29-33] All final models were adjusted for age categorized into 10 year intervals. Age was categorized as it showed non-linearity with the outcome. We calculated relative risks (RR), using the log function, as well as risk differences (RD), using the identity function, with 95% confidence intervals (95% CI). A likelihood ratio test was used to assess clinically relevant effect measure modification between the exposure and possible confounders (age, education, SES, neck pain, long term illness and psychological distress) as well as between confounders included in the adjusted models (age and SES).[34] An effect measure modification significant at $p \leq 0.05$ was included in further analyses. [34] We used Wald test to evaluate potential trends in the associations between the exposure and the outcome, and a Chi-square test to assess if the overall adjusted risk differed between men and women.[34] The effect of attrition was assessed, using Chi-square tests, by comparing the distribution of the four healthy lifestyle factors included in the exposure, healthy lifestyle behaviour, in subjects who were lost to follow-up to the distribution in the study sample.

All p-values were two-sided, and analyses were completed using SAS® version 9.3 and STATA/IC® version 12.1.

Results

Baseline characteristics

The study sample (n=8994) consisted of 56% women. Participants were predominately middle aged, well educated, and born in Sweden. At baseline in 2006, about 15% of the participants were 65 years or older (men 17% and women 14%). Furthermore the majority were cohabitating, and about 35% had children living at home (Table 1). About three percent men and 10% women had an “optimal healthy lifestyle” (HLB4) whereas about five percent men and three percent women had an “unhealthy

lifestyle" (HLB0). Healthy lifestyle behaviour improved with increased level of education. Participants being married or having children living at home had a high proportion of healthy lifestyle behaviour while participants living alone, being psychologically distressed and financially stressed showed low proportions of healthy lifestyle behaviour (Table 1).

The other baseline variables assessed did not differ much between the categories of HLB, neither among men nor among women.

Table 1. Baseline characteristics by categories of the exposure healthy lifestyle behaviour (HLB0 - HLB4)* (n = 8994).

Baseline characteristics (%)	Men All (n=3938)	Men HLB0 (n=181)	Men HLB1 (n=958)	Men HLB2 (n=1747)	Men HLB3 (n=936)	Men HLB4 (n=116)	Women All (n=5056)	Women HLB0 (n=174)	Women HLB1 (n=897)	Women HLB2 (n=2080)	Women HLB3 (n=1416)	Women HLB4 (n=489)	Internal drop-out M/W (n)
Proportion of study sample	44						56						
Mean age, years (SD)	50(15)	49(14)	48(15)	49(15)	51(15)	50(14)	46(16)	43(17)	47(15)	46(16)	47(15)	46(14)	0/0
Education													234/287
Low	16	30	19	14	14	8	14	22	17	13	12	9	
Intermediate	43	43	46	44	40	35	41	57	46	42	38	34	
High	41	27	35	42	46	57	45	21	37	45	50	57	
Civil status													0/1
Married	54	42	49	56	56	65	47	27	41	46	53	53	
Unmarried	33	38	36	32	31	29	36	49	37	37	33	32	
Divorced/Widow/Widower	13	20	15	12	13	6	17	24	22	17	14	15	
SES[a]													292/398
Unskilled/semiskilled worker	14	22	17	13	12	9	16	23	19	16	14	10	
Skilled worker	15	25	16	14	15	8	10	22	12	9	9	11	
Assistant non-manual employees	8	8	10	9	7	5	20	22	21	22	18	15	
Intermediate non-manual	25	14	25	24	27	24	29	23	23	29	31	35	

employees													
Employed/self-employed professionals	25	17	18	28	28	34	19	7	17	18	21	24	
Self-employed (other than professionals)	13	14	14	12	11	20	6	3	8	6	7	5	
Poor sleep[b]													34/27
<6 or >8 hours/night	9	17	9	10	7	9	10	14	11	11	9	7	
Living alone	17	31	19	16	14	9	19	24	21	19	17	17	10/16
Living with children	34	24	31	35	34	42	38	27	32	39	41	41	10/16
Psychological distress[c]	13	18	15	13	11	5	21	33	23	22	19	17	38/37
Financial stress[d]	7	15	10	5	4	3	9	23	13	9	7	6	17/24

* HLB0 = no healthy lifestyle factor, HLB1 = 1 of 4 healthy lifestyle factors, HLB2 = 2 of 4 factors, HLB3 = 3 of 4 factors, HLB4 = all 4 healthy lifestyle factors.

[a] Socio-economic status. For the economically active population SES was based on current occupation and education. For the non-active population SES was based on previous occupation, current education or the occupation of spouses.

[b] Hours of sleep a typical night during the workweek (dichotomized into "good sleep": 6-8 h and "poor sleep": <6 h or >8 h).

[c] From the 12-item General Health Questionnaire (GHQ-12) were a sum score ≥ 3 was used to asses psychological stress.

[d] Financial stress: Had to borrow money from relatives and friends to be able to pay for food or rent on several occasions during the previous 12 months.

The majority of both men and women were non-smokers and did not exceed risk consumption of alcohol. About 40% of both men and women reached recommended levels of leisure physical activity while 26% of the women consumed recommended levels of fruit and vegetables compared to seven percent for men (Figure 2).

Outcome

At follow-up in 2010, nine percent men and 11% women in the study sample reported LTLBP. Table 2 shows the crude and adjusted binomial regression estimations of the association between healthy lifestyle behaviour and the outcome.

Table 2. Association* between healthy lifestyle behaviour and long duration troublesome low back pain (LTLBP) in men and women with occasional LBP at baseline in 2006.

	MEN (n=3646)[a]				WOMEN (n=4658)[a]			
		Crude	Adjusted (Age, SES)[b]			Crude	Adjusted (Age, SES)[b]	
Healthy lifestyle behaviour[c]	**LTLBP/ no LTLBP[d] (n/n)**	**RR (95% CI)**	**RR (95% CI)**	**RD (95% CI)**	**LTLBP/ no LTLBP[d]**	**RR (95% CI)**	**RR (95% CI)**	**RD (95% CI)**
HLB0	14/155	1.0	1.0	0.0	28/131	1.0	1.0	0.0
HLB1	71/812	0.97 (0.56, 1.68)	1.02 (0.59, 1.76)	-0.01 (-0.06, 0.03)	94/735	0.64 (0.44, 0.95)	0.65 (0.44, 0.96)	-0.05 (-0.12, 0.01)
HLB2	133/1476	1.00 (0.59, 1.69)	1.05 (0.62, 1.78)	-0.01 (-0.05, 0.04)	181/1721	0.54 (0.38, 0.78)	0.54 (0.38, 0.78)	-0.07 (-0.13, -0.01)
HLB3	60/818	0.82	0.85	-0.02	125/1187	0.54	0.55	-0.07

		(0.47, 1.44)	(0.48, 1.48)	(-0.06, 0.02)		(0.37, 0.79)	(0.38, 0.81)	(-0.13, -0.01)
HLB4	6/101	0.68	0.75	-0.03	36/420	0.45	0.48	-0.08
		(0.27, 1.71)	(0.30, 1.89)	(-0.07, 0.01)		(0.28, 0.71)	(0.31, 0.77)	(-0.15, -0.02)

*note: *Log- binomial regression estimating the risk ratio (RR) and the risk difference (RD) with 95% confidence interval (95% CI).*

[a] Reduced number of observations due to missing information about socio-economic status (SES) (men n=292 and women n=398).

[b] Adjusted for age in 10 year categories and socio-economic status (SES) in six categories.

[c] HLB0 = no healthy lifestyle factor, HLB1 = 1 of 4 healthy lifestyle factors, HLB2 = 2 of 4 factors, HLB3 = 3 of 4 factors, HLB4 = all 4 healthy lifestyle factors. Healthy lifestyle factors included in HLB: non-smoking, no risk consumption of alcohol (≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, and consuming alcohol corresponding to ≈ half a bottle of spirits on the same occasion less than once a month), recommended level of leisure physical activity (at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities), and recommended consumption of fruit and vegetables (≥ 4 servings of fruit and vegetables/day).

[d] Numbers of participants with and without LTLBP at follow-up in 2010.

There was a decreased risk for LTLBP at follow-up for women with a healthy lifestyle behaviour compared to women with unhealthy lifestyle behaviour (test for trend: p=0.006). Twenty-one percent of women with no healthy lifestyle factor (HLB0) experienced LTLBP at follow-up compared to nine percent of women with all four factors (HLB4). A five percent lower proportion of women with one healthy lifestyle factor, and an eight percent lower proportion of women with all four factors had LTLBP, in comparison to the reference group (HLB0).Women with one healthy lifestyle factor and women with all four healthy lifestyle factors had a 35% and a 52% lower risk for LTLBP, respectively, compared to women with unhealthy lifestyle behaviour (HLB0). There were no clear associations between healthy lifestyle behaviour and LTLBP found among men.

SES was the only variable found to be a confounder, so the final log-binomial analyses were adjusted by SES and age in 10 year categories. There was no clinically relevant effect measure modifications found.

Figure 3 shows the adjusted risk to develop LTLBP for men and women with occasional LBP by categories of healthy lifestyle behaviour. Women had an overall higher adjusted risk for LTLBP than men (p=0.001).

The subjects lost to follow-up (n=4552) had significantly lower proportions of healthy lifestyle factors than the study sample ($p < 0.01$ for all four factors). The differences in proportions were eight percent for non-smoking, 16% for no risk consumption of alcohol, six percent for leisure physical activity and five percent for consumption of fruit and vegetables.

Discussion

In this cohort study we found that healthy lifestyle behaviour had a positive influence on the prognosis of occasional low back pain among women. Healthy lifestyle behaviour comprised four healthy lifestyle factors: non-smoking, no risk consumption of alcohol, recommended level of leisure physical activity and recommended consumption of fruit and vegetables. Compared to women with no healthy lifestyle factor, the risk for development of long duration troublesome low back pain (LTLBP) decreased by 35% among women with one healthy lifestyle factor and by 52% among women with all

four healthy lifestyle factors. In absolute terms, the proportion of women with LTLBP at follow-up was five percent lower if they had one healthy lifestyle factor and eight percent lower if they had four healthy lifestyle factors when compared to women with unhealthy lifestyle behaviour. These associations were not confirmed among men but the results indicated the same tendency.

Further, compared to women, men had an overall lower adjusted risk for LTLBP, and a low risk even in the unhealthy reference group (Figure 3). Men with unhealthy lifestyle behaviour had about the same risk for LTLBP as women with optimal healthy lifestyle behaviour. These findings were not aimed to be addressed in the present study and needs to be further investigated.

We found no studies concerning the effects of healthy lifestyle behaviour, defined as a combination of healthy lifestyle factors, on the prognosis of LBP or other types of spinal pain. Nevertheless, considering the risk of developing chronic back pain Pronk and colleagues showed results in line with our study.[2] Studying employees, the authors found that an "optimal lifestyle" decreased the 2-year risk of chronic LBP by 66% compared to employees with an unhealthy lifestyle. Having optimal lifestyle was equal to having all four of the healthy lifestyle factors similar to the ones included in our study: non-smoking, adequate physical activity, five servings of fruit and vegetables per day and limited or no alcohol consumption.

Strengths and limitations

To our knowledge this is the first study concerning the influence of healthy lifestyle behaviour (HLB) on the prognosis of LBP assessing men and women separately. Measuring the exposure prior to the outcome and the dose-response relationship found supports the validity of the associations between HLB and LTLBP found among women.[32] We believe the use of a complete study sample, the large sample size and the large number of potential confounders assessed strengthens the internal validity, though we cannot rule out residual or unmeasured confounding, for example information on health care services.[32] The questions used in this study have, since 1975, been used in several Swedish national and local public health surveys. They have on several occasions been tested (e.g. cognitive testing) and improved by Statistics Sweden's test centre and several questions have shown to have

acceptable psychometric properties. Moreover, information on education, disposable income, SES, country of birth and marital status were collected from Swedish national registers known to have high quality. The questions concerning leisure physical activity and consumption of fruit and vegetables have shown to have acceptable validity and reliability, and the method to measure alcohol consumption has been recommended by Romelsjö and colleagues.[35-38] Despite this the measurements used may not have been optimal in terms of validity and reliability.

Our study also has limitations. Self-reported exposure information may be hampered by low accuracy. For example, some participants may wish to present themselves in a favourable light and overestimate their healthy lifestyle (social desirability) or some may have difficulties understanding the questions and therefore report less well.[32, 39, 40] This could lead to misclassification of the exposure which may result in an under- or overestimation of the association. As this potential misclassification is likely to be non-differential it would probably dilute a true association, at least when comparing extremes.[32] Moreover, if men tend to misclassify their healthy lifestyle factors to a greater extent than women this may partly explain why we did not find any associations among men. For example, Dyrstad and colleagues found that men overestimated their self-reported physical activity when compared to accelerometer-measures to a greater extent than women.[41] As we studied a population between 18-84 years old a large proportion of the participants did not provide work related information why we did not assess potential confounding effects from work related variables, something that may have affected the results. About 34% of participants in the baseline survey were not part of the study sample due to attrition and exclusion (Figure 1). Compared to the study sample the 34% missing had the same proportion of men and women, were younger (mean age for both sexes were 43 years) and both men and women had a slightly lower level of education as well as SES. Further, they had significantly lower proportions of healthy lifestyle factors than the study sample. This difference may have introduced selection bias to our results if the attrition and the loss to follow-up are related to the exposure as well as to the outcome. If selection bias is present, we believe that it probably leads to an underestimation of the associations, since these subjects to a higher extent may have developed LTLBP.

Considering strengths and limitations in our study we regard our result as a valid contribution to the body of research showing that a healthy lifestyle affects health problems.[1-5] Our study results showing that healthy lifestyle behaviour influences the prognosis of LBP are new and important knowledge with the potential to have an impact on a very common public health problem and have implications both in a public-health and a clinical perspective. Even though the association for healthy lifestyle behaviour to affect LBP among men was not clear, the results showed the same tendency as for women. Considering this together with the obvious effect of healthy lifestyle on other health problems the work to encourage both men and women to adapt to healthy lifestyle should certainly be continued.

Conclusion

Healthy lifestyle behaviour, defined as combinations of non-smoking, no risk consumption of alcohol, recommended level of leisure physical activity and recommended consumption of fruit and vegetables, seems to decrease the risk of developing long duration troublesome low back pain among women with occasional low back pain. There were no clear associations found among men.

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Transparency: The lead author (TB) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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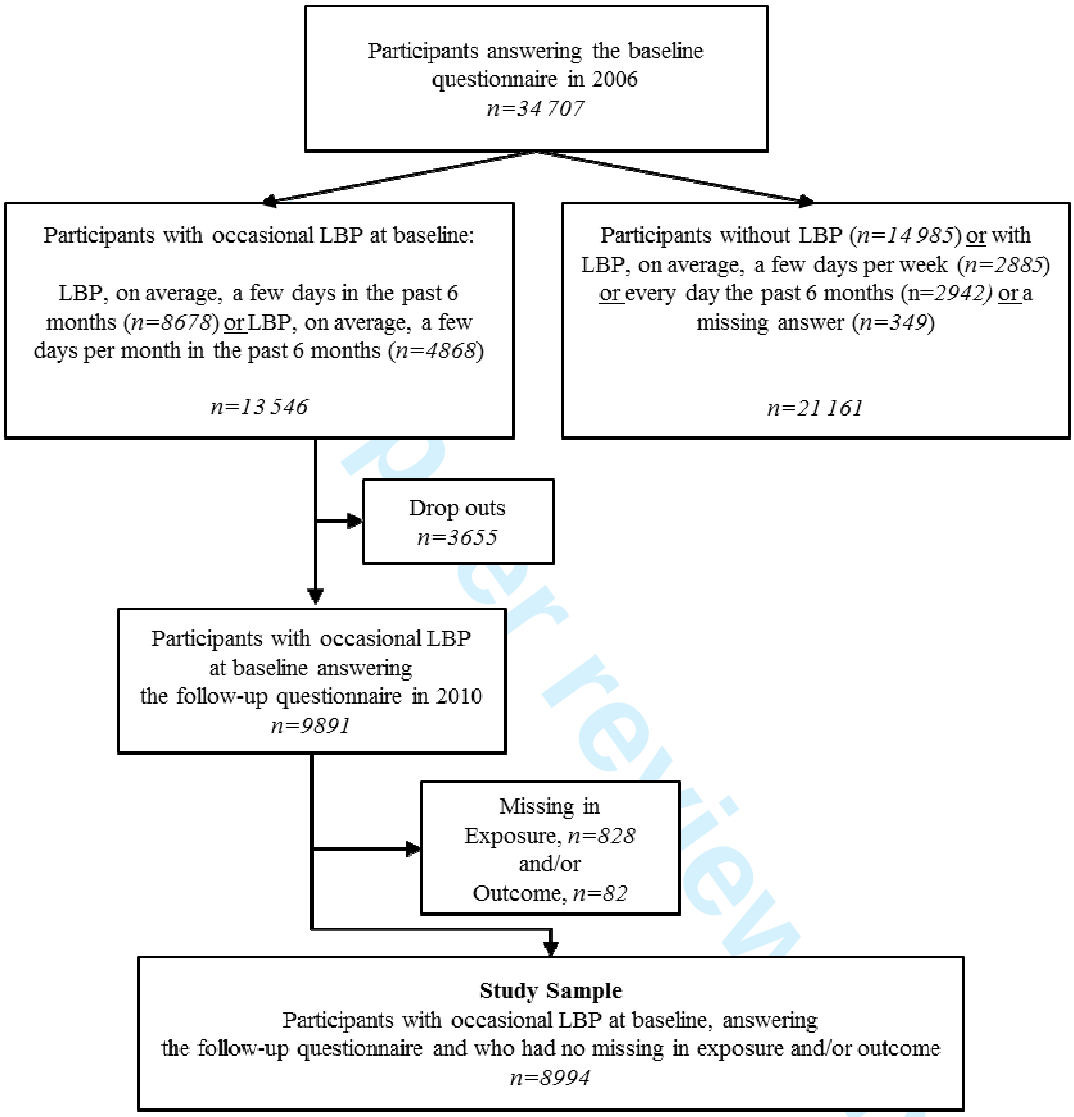
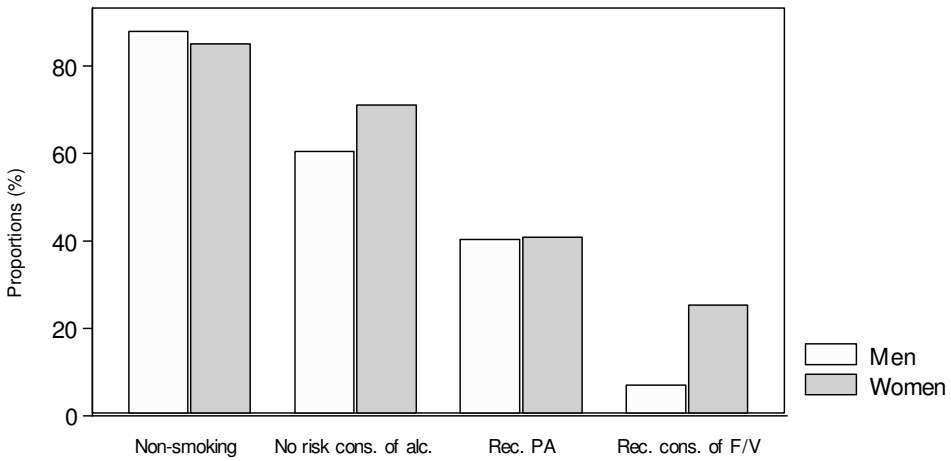
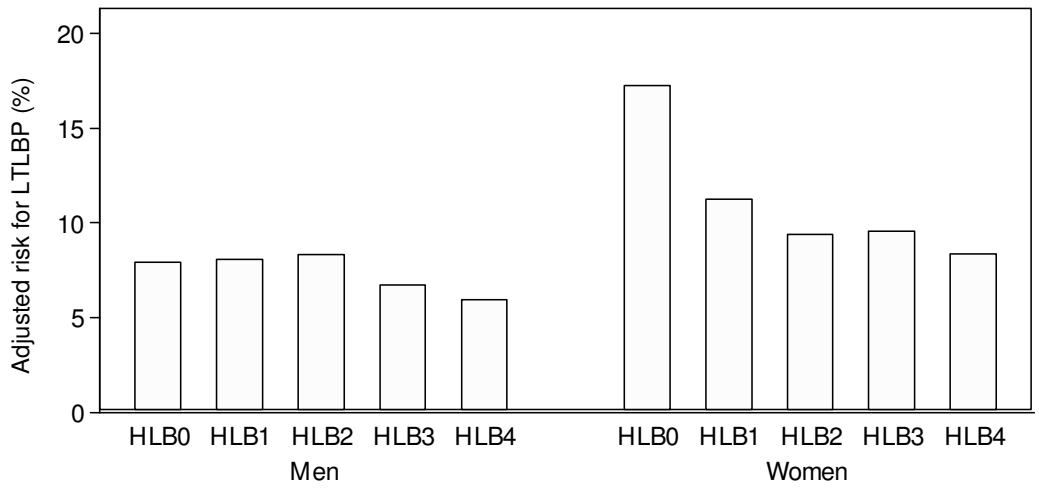
Figure 1. Flowchart of the inclusion process for the study sample. LBP: low back pain.

Figure 2. Distribution of healthy lifestyle factors. PA: Leisure physical activity. F/V: Fruit and vegetables.

Figure 3. Estimated risk for LTLBP, adjusted for SES and age. Men (n=3646), women (n=4658).




Proportions (%)
0
20
40
60
80
Non-smoking
No risk cons. of alc.
Rec. PA
Rec. cons. of F/V
Men
Women



Appendix 1

Item in the baseline questionnaire in 2006 used to define individuals with occasional low back pain forming the study sample:

Have you had any pain in your lower back in the past 6 months?

If you have experienced pain on several occasions, try to estimate an average and put an X in the most appropriate box.

1. ☐ No
2. ☐ Yes, a few days in the past six months
3. ☐ Yes, a few days per month
4. ☐ Yes, a few days per week
5. ☐ Yes, every day

Included in the study sample were individuals answering; Yes, a few days in the past six months *OR* Yes, a few days per month.

Items in the follow-up questionnaire in 2010 used to define the outcome long duration troublesome low back pain (LTLBP):

a) Have you had pain in your lower back in the past 6 months?

If you have experienced pain on several occasions, try to estimate an average and put an X in the most appropriate box.

☐ No

☐ Yes, a few days per month or more seldom

☐ Yes, a few days per week or more often

If Yes;

b) Have these problems decreased your workability or interfered with other daily activities?

☐ Yes, to a high degree

☐ Yes, to some degree

☐ No, not at all

LTLBP was defined by answering; Yes, a few days per week or more often in a) *AND* Yes, to a high degree *OR* Yes, to some degree in b).

Appendix 2

Construction of the binary lifestyle factor variables incorporated in the exposure variable "healthy lifestyle behaviour" (HLB), based on questions from the baseline questionnaire in 2006 (Health Survey 2006, Stockholm County Council).

Non-smoking:

26. Do you smoke daily?

1 ☐ No

2 ☐ Yes

Recommended level of leisure physical activity:

24. How much have you exercised and exerted yourself physically in *the past 12 months*?

If your activity for example varies between summer and winter, try to state an average. Indicate one alternative.

1 ☐ Sedentary leisure time
You spend most of your time reading, watching TV, going to movie theatres or carrying out some other form of sedentary activity. You take walks, cycle or exercise in some other way for less than 2 hours per week.

2 ☐ Moderate leisure time exercise
You take walks, cycle or exercise in some other way for at least 2 hours per week, usually without sweating. This also includes walks, ordinary garden chores, fishing, table tennis and bowling.

3 ☐ Moderate, regular leisure time exercise
You exercise regularly 1–2 times per week for at least 30 minutes each time by jogging, swimming, playing tennis, badminton or through another activity that makes you sweat.

4 ☐ Regular leisure time exercise and training
You, for example, jog, swim, play tennis or badminton or carry out gymnastics or the like and which makes you sweat an average of at least 3 times a week. Each occasion lasts at least 30 minutes..

25. How many days in **an average week** do you devote to at least 30 minutes of physical activity that makes you grow warm?

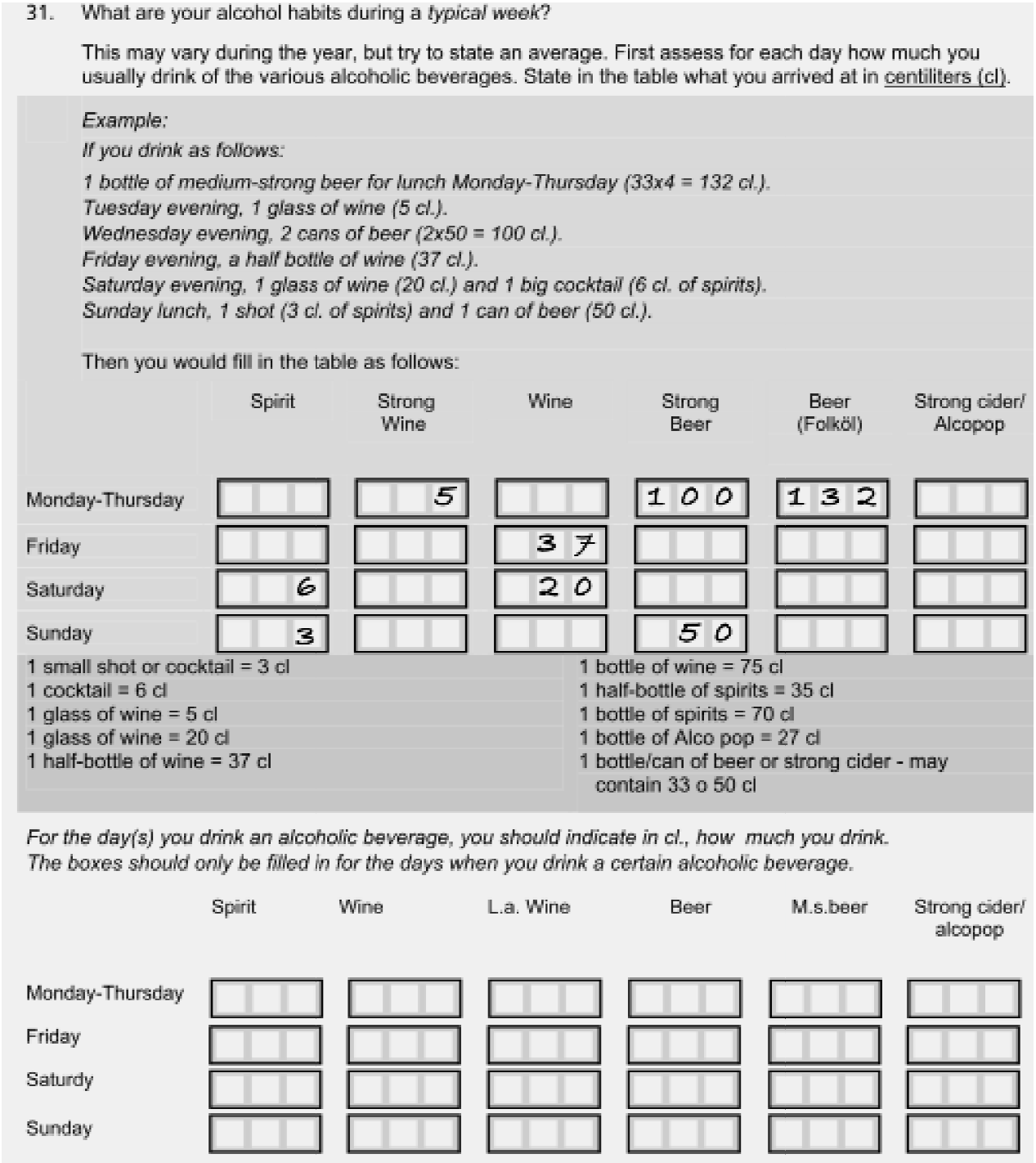
Count fitness training as well as brisk walks, gardening work, heavy household work, cycling, swimming and the like. This may vary during the year, but try to state an average.

☐ days a week

"Recommended level of leisure physical activity" was theoretically defined as performing leisure physical activity at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities. This was equal to alternative 4 in question no.24 *OR* ≥ 5 days a week

in question no.25 *OR* a combination of alternative 3 in question no.24 and 3 or 4 days a week in question no.25.

No risk consumption of alcohol:



31. What are your alcohol habits during a *typical week*?

This may vary during the year, but try to state an average. First assess for each day how much you usually drink of the various alcoholic beverages. State in the table what you arrived at in centiliters (cl).

Example:

If you drink as follows:

1 bottle of medium-strong beer for lunch Monday-Thursday (33x4 = 132 cl.).
Tuesday evening, 1 glass of wine (5 cl.).
Wednesday evening, 2 cans of beer (2x50 = 100 cl.).
Friday evening, a half bottle of wine (37 cl.).
Saturday evening, 1 glass of wine (20 cl.) and 1 big cocktail (6 cl. of spirits).
Sunday lunch, 1 shot (3 cl. of spirits) and 1 can of beer (50 cl.).

Then you would fill in the table as follows:

	Spirit	Strong Wine	Wine	Strong Beer	Beer (Folköl)	Strong cider/ Alcopop
Monday-Thursday		5		100	132	
Friday			37			
Saturday	6		20			
Sunday	3			50		

1 small shot or cocktail = 3 cl
1 cocktail = 6 cl
1 glass of wine = 5 cl
1 glass of wine = 20 cl
1 half-bottle of wine = 37 cl
1 bottle of wine = 75 cl
1 half-bottle of spirits = 35 cl
1 bottle of spirits = 70 cl
1 bottle of Alco pop = 27 cl
1 bottle/can of beer or strong cider - may contain 33 o 50 cl

For the day(s) you drink an alcoholic beverage, you should indicate in cl., how much you drink.
The boxes should only be filled in for the days when you drink a certain alcoholic beverage.

	Spirit	Wine	L.a. Wine	Beer	M.s.beer	Strong cider/ alcopop
Monday-Thursday						
Friday						
Saturdy						
Sunday						

Grams of 100% alcohol/week were calculated by summarizing the volume of each of the different alcoholic beverage consumed over the week, multiply this sum with the volume percentage of alcohol

for the specific beverage and finally summarize the volume percentage for all beverages.

As an example from above, the grams of 100% alcohol from strong beer was 150*0.053 (volume % in Swedish strong beer) = 7.95 g of 100% alcohol etc.

32. How often do you, on the same occasion, drink alcoholic beverages equivalent to at least:
– A half bottle of spirits
– or 2 bottles of wine
– or 6 cans of beer (8 bottles)
– or 12 bottles of medium-strong beer

1 ☐ Virtually every day (at least 5 days per week)
2 ☐ A few times per week (3–4 times per week)
3 ☐ Once or twice per week
4 ☐ 2–3 times per month
5 ☐ Once a month
6 ☐ 1–6 times per year
7 ☐ Never

Using a combination of question no.31 and no.32, "No risk consumption of alcohol" was theoretically defined as drinking; ≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, *AND* alternative 6 or 7 on question no.32 (= consuming alcohol corresponding to ≈ half a bottle of spirits on the same occasion less than once a month).

Recommended consumption of fruit and vegetables:

21. How often do you eat fruits or berries?
Think of the past 12 months. Count fresh, canned and frozen (for example 1 apple, 1 banana, 1 bunch of grapes, 1 glass of juice, 1 bowl of strawberries or 2 slices of pineapple).

I eat fruits or berries:

1 ☐ A few times per month or never	**0**
2 ☐ Around once a week	**0**
3 ☐ A few times per week	**0.5**
4 ☐ Virtually every day	**1**
5 ☐ 2 times per day	**2**
6 ☐ 3 or more times per day	**3**

22. How often do you eat a portion of vegetables/root vegetables?

Think of the past 12 months. Count fresh, frozen, canned, stewed in addition to dishes including vegetables (for example ½ bell pepper, 1 tomato, 1–2 dl. shredded carrot, 1–2 dl. mixed vegetables or 1 bowl of lentil soup).

I eat a portion of vegetables/root vegetables:

1 ☐ A few times per month or never	**0**
2 ☐ Around once a week	**0**
3 ☐ A few times per week	**0.5**
4 ☐ Virtually every day	**1**
5 ☐ 2 times per day	**2**
6 ☐ 3 or more times per day	**3**

The six answer alternatives on question no.21 and no.22 were assigned a score from 0 to 3. "Recommended consumption of fruit and vegetables" was theoretically defined as having a sum score from the two questions of ≥ 4. This was equal to eating fruit and vegetables every day and to a minimum of 4 servings per day (≈ 400 g/day).

~~Healthy lifestyle behaviour improves the prognosis of low back pain in women: A population based cohort study.~~

Does healthy lifestyle behaviour influence the prognosis of low back pain among men and women in a general population? A population based cohort study.

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Key words: back pain, epidemiology, life style, cohort studies, public health

Word count: ~~3247~~3392

Figures: 3

Tables: 2

References: 41

Supplementary files: ~~1~~2

Abstract

Objectives

To study the influence of healthy lifestyle behaviour on the prognosis of occasional low back pain among men and women in a general population.

Design

Cohort study with a four year follow-up.

Settings

General population in Stockholm County, Sweden.

Participants

The study sample comprised 3938 men and 5056 women, aged 18-84, from the Stockholm Public Health cohort reporting occasional low back pain in the baseline questionnaire 2006.

Measures

Lifestyle factors and potential confounders were assessed at baseline. The lifestyle factors smoking habits, alcohol consumption, leisure physical activity and consumption of fruit and vegetables, were dichotomized using recommendations for a health-enhancing lifestyle and combined to form the exposure variable "healthy lifestyle behaviour". The exposure was categorised into five levels according to the number of healthy lifestyle factors met. The follow-up questionnaire in 2010 gave information about the outcome, long duration troublesome low back pain. Crude and adjusted binomial regression models were applied to estimate the association between the exposure and the outcome analysing men and women separately.

Results

The risk of developing long duration troublesome low back pain among women with occasional low back pain decreased with increasing healthy lifestyle behaviour (~~test for trend~~trend test: p=0.006). 21% (28/131) among women with no healthy lifestyle factor (reference ~~group~~) experienced the

outcome compared to nine percent (36/420) among women with all four factors. Compared to the reference group, the risk was reduced by 35% (RR: 0.65, 95% CI: 0.44 to 0.96) for women with one healthy lifestyle factor and 52% (RR: 0.48, 95% CI: 0.31 to 0.77) for women with all four healthy lifestyle factors. There were no clear associations found among men.

Conclusion

Healthy lifestyle behaviour seems to decrease~~s~~ the risk of developing long duration troublesome low back pain among women with occasional low back pain and may be recommended to improve the prognosis.

Article summary

Strengths and limitations of this study

- Strengths of this study are the large sample, the longitudinal design, the long term follow-up, robust analyses and the large number of potential confounding factors assessed.
- Possible limitations of this study were the potential risk of misclassification of the exposure variable and the relatively large loss to follow-up, although these limitations most probably lead to an underestimation of the associations studied. Further the results may have been affected by questionnaire items not fully validated.

Introduction

Lifestyle factors such as non-smoking, physical activity, healthy diet and moderate alcohol use seem to influence the risk and the prognosis in several diseases (e.g. cancer, type 2 diabetes mellitus, and cardiovascular disease) as well as mortality, especially when the factors are combined.[1-5]

Low back pain (LBP) is one of the most common health problems worldwide and comprises a large burden on individuals as well as on society.[6, 7] When estimating the global prevalence of activity-limiting LBP using 165 studies from 54 countries, Hoy and colleagues found the mean point- and 1 month prevalence to be 11.9 ± 2.0% and 23.2 ± 2.9% respectively.[6] Current knowledge of prognostic factors, e.g. lifestyle factors, for LBP is limited and the above mentioned facts support the need for more research on this topic.

In a "review of reviews" from 2009, Hayden and colleagues reported older age, negative cognitive characteristics, poor general health, increased psychological or psychosocial stress, poor relations with colleagues, physically heavy work, functional disability, sciatica, and the presence of worker´s compensation to be associated with poor outcomes of acute and sub-acute LBP.[8] Another 2009 review found recovery expectations to be associated with activity limitations or participation restrictions (e.g. return to work) in persons with non-chronic non-specific LBP.[9] In the review by Hayden and colleagues smoking was the only lifestyle factor included and found, by two studies, to have no association with poor outcomes of acute and sub-acute LBP.[8] Similarly, a recent review studying prognostic factors for recovery from chronic LBP found no association between smoking and the outcome pain and disability.[10] Moreover, reviewing observational studies on LBP patients Hendrick and colleagues found moderate evidence for sports, leisure and occupational physical activity not to be associated with LBP outcomes.[11]

Women seem to have higher prevalence, be more severely affected and have worse prognosis of LBP than men and some studies suggest that men and women should be assessed separately when studying risk and prognostic factors for LBP.[6, 12-14]

To our knowledge, it is not known if healthy lifestyle behavior, defined by a combination of lifestyle factors, is associated with the prognosis of LBP. Healthy lifestyle behaviour seems to have a larger

potential to affect health problems and mortality than separate lifestyle factors alone.[1-5] We hypothesized that healthy lifestyle behaviour would decrease the risk of a poor outcome among men and women with occasional low back pain. If healthy lifestyle behaviour affects the prognosis of LBP implementing this knowledge could potentially prevent transition into disabling LBP and thereby reduce the burden on the individual as well as on the society.

The aim of this study was to explore the influence of healthy lifestyle behaviour on the prognosis of occasional low back pain among men and women in a general population, hypothesizing that healthy lifestyle behaviour can improve the prognosis.

Methods

Study design and source population

In this study we used data from the Stockholm Public Health Cohort (SPHC).[15] The SPHC was set up by the Stockholm County Council and administered by Statistics Sweden and the Department of Public Health Sciences at Karolinska Institutet, Stockholm. The SPHC is a population based cohort established within the framework of Stockholm County Council public health surveys. In 2006, Stockholm County had an adult population of approximately 1.4 million individuals. From this population a total of 56 634 individuals (18-84 years old) were randomly selected, after stratification for gender and residential area, and received the baseline questionnaire, which 34 707 (61%) answered. The responders received a follow-up questionnaire in 2010, answered by 25 167 participants (73%). Compared to consensus data from Stockholm County the SPHC participants were more likely to be of female gender, be born in Sweden, have higher education and income and be more than 45 years old.[15]

Study sample

The study sample (n=8994) consisted of participants reporting occasional LBP at baseline in 2006 who answered the follow-up questionnaire in 2010 and provided complete information on outcome and exposure variables (Figure 1). Occasional LBP at baseline was defined as reporting having had LBP,

on average, up to a ~~couple of~~few days per month during the past 6 months (for the item used to define occasional LBP see Appendix 1). The information was based on a modified version of a question from the Standardized Nordic Questionnaire.[16]

Data collection and variables

The baseline and the follow-up questionnaires comprised self-reported information on lifestyle, demographic- and socioeconomic characteristics, physical and psychological health and work related factors. The self-reported data were supplemented with information from regional and national registers.[15] Four reminders were sent after the baseline questionnaire and three reminders after the follow-up questionnaire.

Exposure: healthy lifestyle behaviour (HLB)

Using baseline information we constructed four binary healthy lifestyle factors where cut-offs (healthy/not healthy) were set in accordance with recommendations for a health-enhancing lifestyle made by Swedish authorities and WHO.[17-20] The exposure variable "healthy lifestyle behaviour" (HLB) was a combination of these binary factors and was categorised into five levels according to the number of healthy lifestyle factors included, i.e. from none to four (HLB0 to HLB4). A healthy lifestyle behaviour with regard to each of the considered healthy factors was defined by: non-smoking, no risk consumption of alcohol (≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, and consuming alcohol corresponding to about half a bottle of spirits (35 cl) on the same occasion less than once a month), recommended level of leisure physical activity (at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities), and recommended consumption of fruit and vegetables (≥ a total of 4 servings of fruit and vegetables/day, equal to about 400 g/day) (see ~~the Appendix~~ Appendix 2 for a description of the questions and how the variables were constructed).

Outcome variable: long duration troublesome low back pain (LTLBP)

Information on the outcome LTLBP was collected from the follow-up questionnaire in 2010 and defined as having had LBP that decreased workability or interfered with other daily activities to some

or to high degree, on average a ~~couple of~~few days per week or more often during the past 6 months (for the items used to define LTLBP see Appendix 1). The question used to measure LTLBP was modified from the Standardized Nordic Questionnaire and incorporated a dimension of disability suggested to be of importance when defining LBP.[16, 21]

Potential confounding factors

Potential confounders were chosen based on theoretic and empirical relevance, information from literature regarding the prognosis of spinal pain and availability in the questionnaire.[8, 22, 23] The following factors were considered: long-term illness (suffering from long-term illness, health problems following an accident, disability or other persistent health problems), neck pain and pain from hip, thigh or knee during the past 6 months (5 answer alternatives from "no pain" to "daily pain"), suffering from headache or migraine ("no", "somewhat", "severe"), rheumatoid arthritis diagnosed by a physician, living alone, living with children (children of all ages included) and hours of sleep a typical night during the workweek (dichotomized into "good sleep": 6-8 h and "poor sleep": <6 h or >8 h). The questionnaire also included the 12-item General Health Questionnaire were a sum score of ≥3 (using the recommended 0-0-1-1 scoring on the four answer alternatives) was used to asses psychological distress.[24, 25] The frequency of stress was measured by the question "How often do you feel stress?" with 5 answer alternatives from "never" to "most of the week". Personal support (having persons who can give support in handling personal problems or critical life events) was measured using a question from the Social Support-13 instrument (SS-13).[26] Furthermore, financial stress was assessed by the question "Did it during the previous 12 months happen that you ran out of money and had to borrow from relatives and friends to be able to pay for food or rent?" ("no", "yes, on one occasion", "yes, on several occasions"). A Swedish national register supplied information on civil status (married, unmarried, divorced, widow/widower), country of birth (Sweden, Nordic countries and Europe, outside Europe), socio-economic status (SES), annual individual disposable income (grouped in quintiles) and education.[27, 28] The level of education was categorized into, low (only compulsory education and vocational training), intermediate (secondary school) and high (university studies).

Statistical methods

We used generalized linear models with a binomial distribution to estimate the association between the exposure and the outcome analysing men and women separately. To determine the role of a potential confounding factor we included them, one at a time, into the crude model. Only factors that changed the estimated risk ratio (RR) by 10% or more were entered into the final model.[29-33] All final models were adjusted for age categorized into 10 year intervals. Age was categorized as it showed non-linearity with the outcome. We calculated relative risks (RR), using the log function, as well as risk differences (RD), using the identity function, with 95% confidence intervals (95% CI). A likelihood ratio test was used to assess clinically relevant effect measure modification between the exposure and possible confounders (age, education, SES, neck pain, long term illness and psychological distress) as well as between confounders included in the ~~final~~ adjusted models (age and SES).[34] An effect measure modification significant at $p \leq 0.05$ was included in further analyses. [34]

We used Wald test to evaluate potential trends in the associations between the exposure and the outcome, and a Chi-square test to assess if the overall adjusted risk differed between men and women.[34] The effect of attrition was assessed, using Chi-square tests, by comparing the distribution of the four healthy lifestyle factors included in the exposure, healthy lifestyle behaviour, in subjects who were lost to follow-up to the distribution in the study sample.

All p-values were two-sided, and analyses were completed using SAS® version 9.3 and STATA/IC® version 12.1.

Results

Baseline characteristics

The study sample (n=8994) consisted of 56% women. Participants were predominately middle aged, well educated, and born in Sweden. At baseline in 2006, about 15% of the participants were 65 years or older (men 17% and women 14%). Furthermore the majority were cohabitating, and about 35% had children living at home (Table 1). About three percent men and 10% women had an “optimal healthy lifestyle” (HLB4) whereas about five percent men and three percent women had an “unhealthy

lifestyle" (HLB0). Healthy lifestyle behaviour improved with increased level of education. Participants being married or having children living at home had a high proportion of healthy lifestyle behaviour while participants living alone, being psychologically distressed and financially stressed showed low proportions of healthy lifestyle behaviour (Table 1).

The other baseline variables assessed did not differ much between the categories of HLB, neither among men nor among women.

Table 1. Baseline characteristics by categories of the exposure healthy lifestyle behaviour (HLB0 - HLB4)* (n = 8994).

Baseline characteristics (%)	Men All (n=3938)	Men HLB0 (n=181)	Men HLB1 (n=958)	Men HLB2 (n=1747)	Men HLB3 (n=936)	Men HLB4 (n=116)	Women All (n=5056)	Women HLB0 (n=174)	Women HLB1 (n=897)	Women HLB2 (n=2080)	Women HLB3 (n=1416)	Women HLB4 (n=489)	Internal drop-out M/W (n)
Proportion of study sample	44						56						
Mean age, years (SD)	50(15)	49(14)	48(15)	49(15)	51(15)	50(14)	46(16)	43(17)	47(15)	46(16)	47(15)	46(14)	0/0
Education													234/287
Low	16	30	19	14	14	8	14	22	17	13	12	9	
Intermediate	43	43	46	44	40	35	41	57	46	42	38	34	
High	41	27	35	42	46	57	45	21	37	45	50	57	
Civil status													0/1
Married	54	42	49	56	56	65	47	27	41	46	53	53	
Unmarried	33	38	36	32	31	29	36	49	37	37	33	32	
Divorced/Widow/Widower	13	20	15	12	13	6	17	24	22	17	14	15	
SES[a]													292/398
Unskilled/semiskilled worker	14	22	17	13	12	9	16	23	19	16	14	10	
Skilled worker	15	25	16	14	15	8	10	22	12	9	9	11	
Assistant non-manual employees	8	8	10	9	7	5	20	22	21	22	18	15	
Intermediate non-manual	25	14	25	24	27	24	29	23	23	29	31	35	

employees													
Employed/self-employed professionals	25	17	18	28	28	34	19	7	17	18	21	24	
Self-employed (other than professionals)	13	14	14	12	11	20	6	3	8	6	7	5	
Poor sleep[b]													34/27
<6 or >8 hours/night	9	17	9	10	7	9	10	14	11	11	9	7	
Living alone	17	31	19	16	14	9	19	24	21	19	17	17	10/16
Living with children	34	24	31	35	34	42	38	27	32	39	41	41	10/16
Psychological distress[c]	13	18	15	13	11	5	21	33	23	22	19	17	38/37
Financial stress[d]	7	15	10	5	4	3	9	23	13	9	7	6	17/24

* HLB0 = no healthy lifestyle factor, HLB1 = 1 of 4 healthy lifestyle factors, HLB2 = 2 of 4 factors, HLB3 = 3 of 4 factors, HLB4 = all 4 healthy lifestyle factors.

[a] Socio-economic status. For the economically active population SES was based on current occupation and education. For the non-active population SES was based on previous occupation, current education or the occupation of spouses.

[b] Hours of sleep a typical night during the workweek (dichotomized into "good sleep": 6-8 h and "poor sleep": <6 h or >8 h).

[c] From the 12-item General Health Questionnaire (GHQ-12) were a sum score ≥ 3 was used to asses psychological stress.

[d] Financial stress: Had to borrow money from relatives and friends to be able to pay for food or rent on several occasions during the previous 12 months.

The majority of both men and women were non-smokers and did not exceed risk consumption of alcohol. About 40% of both men and women reached recommended levels of leisure physical activity while 26% of the women consumed recommended levels of fruit and vegetables compared to seven percent for men (Figure 2).

Outcome

At follow-up in 2010, nine percent men and 11% women in the study sample reported LTLBP. Table 2 shows the crude and adjusted binomial regression estimations of the association between healthy lifestyle behaviour and the outcome.

Table 2. Association* between healthy lifestyle behaviour and long duration troublesome low back pain (LTLBP) in men and women with occasional LBP at baseline in 2006.

	MEN (n=3646)[a]				WOMEN (n=4658)[a]			
		Crude	Adjusted (Age, SES)[b]			Crude	Adjusted (Age, SES)[b]	
Healthy lifestyle behaviour[c]	**LTLBP/ no LTLBP[d] (n/n)**	**RR (95% CI)**	**RR (95% CI)**	**RD (95% CI)**	**LTLBP/ no LTLBP[d]**	**RR (95% CI)**	**RR (95% CI)**	**RD (95% CI)**
HLB0	14/155	1.0	1.0	0.0	28/131	1.0	1.0	0.0
HLB1	71/812	0.97 (0.56, 1.68)	1.02 (0.59, 1.76)	-0.01 (-0.06, 0.03)	94/735	0.64 (0.44, 0.95)	0.65 (0.44, 0.96)	-0.05 (-0.12, 0.01)
HLB2	133/1476	1.00 (0.59, 1.69)	1.05 (0.62, 1.78)	-0.01 (-0.05, 0.04)	181/1721	0.54 (0.38, 0.78)	0.54 (0.38, 0.78)	-0.07 (-0.13, -0.01)
HLB3	60/818	0.82	0.85	-0.02	125/1187	0.54	0.55	-0.07

		(0.47, 1.44)	(0.48, 1.48)	(-0.06, 0.02)		(0.37, 0.79)	(0.38, 0.81)	(-0.13, -0.01)
HLB4	6/101	0.68	0.75	-0.03	36/420	0.45	0.48	-0.08
		(0.27, 1.71)	(0.30, 1.89)	(-0.07, 0.01)		(0.28, 0.71)	(0.31, 0.77)	(-0.15, -0.02)

*note: *Log- binomial regression estimating the risk ratio (RR) and the risk difference (RD) with 95% confidence interval (95% CI).*

[a] Reduced number of observations due to missing information about socio-economic status (SES) (men n=292 and women n=398).

[b] Adjusted for age in 10 year categories and socio-economic status (SES) in six categories.

[c] HLB0 = no healthy lifestyle factor, HLB1 = 1 of 4 healthy lifestyle factors, HLB2 = 2 of 4 factors, HLB3 = 3 of 4 factors, HLB4 = all 4 healthy lifestyle factors. Healthy lifestyle factors included in HLB: non-smoking, no risk consumption of alcohol (≤168 g 100% alcohol/week for men and ≤108 g 100% alcohol/week for women, and consuming alcohol corresponding to ≈ half a bottle of spirits on the same occasion less than once a month), recommended level of leisure physical activity (at least 150 minutes at moderate intensity or 75 minutes at high intensity per week or a combination of these activities), and recommended consumption of fruit and vegetables (≥ 4 servings of fruit and vegetables/day).

[d] Numbers of participants with and without LTLBP at follow-up in 2010.

There was a decreased risk for LTLBP at follow-up for women with a healthy lifestyle behaviour compared to women with unhealthy lifestyle behaviour (test for trend: p=0.006). Twenty-one percent of women with no healthy lifestyle factor (HLB0) experienced LTLBP at follow-up compared to nine percent of women with all four factors (HLB4). A five percent lower proportion of women with one healthy lifestyle factor, and an eight percent lower proportion of women with all four factors had LTLBP, in comparison to the reference group (HLB0).Women with one healthy lifestyle factor and women with all four healthy lifestyle factors had a 35% and a 52% lower risk for LTLBP, respectively, compared to women with unhealthy lifestyle behaviour (HLB0). There were no clear associations between healthy lifestyle behaviour and LTLBP found among men.

SES was the only variable found to be a confounder, so the final log-binomial analyses were adjusted by SES and age in 10 year categories. There was no clinically relevant effect measure modifications found.

Figure 3 shows the adjusted risk to develop LTLBP for men and women with occasional LBP by categories of healthy lifestyle behaviour. Women had an overall higher adjusted risk for LTLBP than men (p=0.001).

The subjects lost to follow-up (n=4552) had significantly lower proportions of healthy lifestyle factors than the study sample ($p < 0.01$ for all four factors). The differences in proportions were eight percent for non-smoking, 16% for no risk consumption of alcohol, six percent for leisure physical activity and five percent for consumption of fruit and vegetables.

Discussion

In this cohort study we found that healthy lifestyle behaviour had a positive influence on the prognosis of occasional low back pain among women. Healthy lifestyle behaviour comprised four healthy lifestyle factors: non-smoking, no risk consumption of alcohol, recommended level of leisure physical activity and recommended consumption of fruit and vegetables. Compared to women with no healthy lifestyle factor, the risk for development of long duration troublesome low back pain (LTLBP) decreased by 35% among women with one healthy lifestyle factor and by 52% among women with all

four healthy lifestyle factors. In absolute terms, the proportion of women with LTLBP at follow-up was five percent lower if they had one healthy lifestyle factor and eight percent lower if they had four healthy lifestyle factors when compared to women with unhealthy lifestyle behaviour. These associations were not confirmed among men but the results indicated the same tendency.

Further, compared to women, men had an overall lower adjusted risk for LTLBP, and a low risk even in the unhealthy reference group (Figure 3). Men with unhealthy lifestyle behaviour had about the same risk for LTLBP as women with optimal healthy lifestyle behaviour. These findings were not aimed to be addressed in the present study and needs to be further investigated.

We found no studies concerning the effects of healthy lifestyle behaviour, defined as a combination of healthy lifestyle factors, on the prognosis of LBP or other types of spinal pain. Nevertheless, considering the risk of developing chronic back pain Pronk and colleagues showed results in line with our study.[2] Studying employees, the authors found that an "optimal lifestyle" decreased the 2-year risk of chronic LBP by 66% compared to employees with an unhealthy lifestyle. Having optimal lifestyle was equal to having all four of the healthy lifestyle factors similar to the ones included in our study: non-smoking, adequate physical activity, five servings of fruit and vegetables per day and limited or no alcohol consumption.

Strengths and limitations

To our knowledge this is the first study concerning the influence of healthy lifestyle behaviour (HLB) on the prognosis of LBP assessing men and women separately. Measuring the exposure prior to the outcome and the dose-response relationship found supports the validity of the associations between HLB and LTLBP found among women.[32] We believe the use of a complete study sample, the large sample size and the large number of potential confounders assessed strengthens the internal validity, though we cannot rule out residual or unmeasured confounding, for example information on health care services.[32] The questions used in this study have, since 1975, been used in several Swedish national and local public health surveys. They have on several occasions been tested (e.g. cognitive testing) and improved by Statistics Sweden's test centre and several questions have shown to have

acceptable psychometric properties. Moreover, information on education, disposable income, SES, country of birth and marital status were collected from Swedish national registers known to have high quality. The questions concerning leisure physical activity and consumption of fruit and vegetables have shown to have acceptable validity and reliability, and the method to measure alcohol consumption has been recommended by Romelsjö and colleagues.[35-38] Despite this the measurements used may not have been optimal in terms of validity and reliability.

Our study also has limitations. Self-reported exposure information may be hampered by low accuracy. For example, some participants may wish to present themselves in a favourable light and overestimate their healthy lifestyle (social desirability) or some may have difficulties understanding the questions and therefore report less well.[32, 39, 40] This could lead to misclassification of the exposure which may result in an under- or overestimation of the association. As this potential misclassification is likely to be non-differential it would probably dilute a true association, at least when comparing extremes.[32] Moreover, if men tend to misclassify their healthy lifestyle factors to a greater extent than women this may partly explain why we did not find any associations among men. For example, Dyrstad and colleagues found that men overestimated their self-reported physical activity when compared to accelerometer-measures to a greater extent than women.[41] As we studied a population between 18-84 years old a large proportion of the participants did not provide work related information why we did not assess potential confounding effects from work related variables, something that may have affected the results. About 34% of participants in the baseline survey were not part of the study sample due to attrition and exclusion (Figure 1). Compared to the study sample the 34% missing had the same proportion of men and women, were younger (mean age for both sexes were 43 years) and both men and women had a slightly lower level of education as well as SES. Further, they had ~~These subjects had~~ significantly lower proportions of healthy lifestyle factors than the study sample. This difference may have introduced selection bias~~ed~~ to our results if the attrition and the loss to follow-up are related to the exposure as well as to the outcome. If selection bias is present, we believe that it probably leads ~~, most probably leading~~ to an underestimation of the associations~~.~~, since these subjects to a higher extent may have developed LTLBP.

Considering strengths and limitations in our study we regard our result as a valid contribution to the body of research showing that a healthy lifestyle affects health problems.[1-5] Our study results showing that healthy lifestyle behaviour influences the prognosis of LBP are new and important knowledge with the potential to have an impact on a very common public health problem and have implications both in a public-health and a clinical perspective. Even though the association for healthy lifestyle behaviour to affect LBP among men was not clear, the results showed the same tendency as for women. Considering this together with the obvious effect of healthy lifestyle on other health problems the work to encourage both men and women to adapt to healthy lifestyle should certainly be continued.

Conclusion

Healthy lifestyle behaviour, defined as combinations of non-smoking, no risk consumption of alcohol, recommended level of leisure physical activity and recommended consumption of fruit and vegetables, seems to decrease~~s~~ the risk of developing long duration troublesome low back pain among women with occasional low back pain. There were no clear associations found among men.

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Transparency: The lead author (TB) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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Figure 1. Flowchart of the inclusion process for the study sample. LBP: low back pain.

Figure 2. Distribution of healthy lifestyle factors. PA: Leisure physical activity. F/V: Fruit and vegetables.

Figure 3. Estimated risk for LTLBP, adjusted for SES and age. Men (n=3646), women (n=4658).