

Healthy lifestyle behavior and risk of long duration troublesome neck pain or low back pain among men and women: results from the Stockholm Public Health Cohort

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Background: The role of healthy lifestyle behavior (HLB) in terms of physical activity, alcohol intake, smoking, and diet put together has not yet been explored for the risk of low back pain (LBP) and neck pain (NP). Our aim was to study if an HLB is protective against the onset of long duration troublesome LBP and NP in men and women.

Methods: Two cohorts from the Stockholm Public Health Cohort, free from LBP (n=12,483) and NP (n=10,539), respectively, in 2006, were surveyed with questionnaires. Baseline information about physical activity, alcohol intake, diet, and smoking were dichotomized into being healthy/not healthy and combined in a categorical variable according to the number of healthy behaviors present. Binomial regression analyses were used to evaluate the role of HLB for the outcomes 4 years later.

Results: When men with three or four healthy lifestyles were compared to men with none or one, the risk ratio (RR) of LBP was 0.63 (95% confidence interval [CI]: 0.39–1.02). The corresponding RR for LBP in women was 0.86 (95% CI: 0.56–1.32). When men with three or four healthy lifestyles were compared to men with none or one, the RR for NP was 1.13 (95% CI: 0.74–1.71). The corresponding RR for NP in women was 0.52 (95% CI: 0.35–0.77).

Conclusion: An HLB seems to be protective for long duration troublesome LBP in men, and for long duration troublesome NP in women.

Keywords: neck pain, low back pain, lifestyle, physical activity, smoking, alcohol, healthy diet, prevention, musculoskeletal

Introduction

Neck pain (NP) and low back pain (LBP) are huge public health problems due to their high incidence, long duration, and social and economic impact.¹ The 1-year prevalence of NP ranges between 16.7% and 75.1% (mean 37.2%) according to a global review² and the prevalence of troublesome (activity limiting) NP lies between 1.7% and 11.5%.³ For LBP, the calculated 1-year prevalence is around 38% (0.8–82.5%).⁴

Interest in studying the role of healthy lifestyle behaviors (HLBs) started in the sixties and an early study from the US explored how a number of behaviors correlated with better general health.⁵ Further, the impact of lifestyle behavior on health outcomes has been widely studied, mainly in the field of cardiovascular⁶ and cancer⁷ epidemiology, and it has been shown to be a risk factor for all-cause mortality.⁸ Explored risk factors or risk indicators for LBP and NP include among others, female sex, age, psychological distress, depression, and job characteristics.^{3,9–15} We have published a study

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exploring the role of an HLB for the prognosis of occasional LBP showing its importance as a protective factor for long duration troublesome back pain in women.¹⁶

Evidence for the role of lifestyle as a risk factor for these conditions is, in general, scarce and the body of literature exploring such associations consists mainly of cross-sectional studies. Analyses from the National Health and Nutrition Examination Survey showed that smoking was the strongest predictor of LBP, once analyzed with different strata of body mass index (BMI), and that moderate physical activity as well as sedentarism were associated with pain at this location.¹⁷ Another national cross-sectional study from the US shows that physical activity (even at low levels), tobacco use, alcohol intake, sleep quality, and BMI are all associated with LBP.¹⁸ Similarly, studies conducted at a national level in Iran¹⁹ and Canada²⁰ on LBP, and in Spain on NP,²¹ suggest the importance of lifestyle behavior. However, longitudinal studies have shown either weak or nonsignificant associations.^{22–24} Understanding the role of HLB in the risk of LBP and NP may potentially have high impact implications for public health, since this can provide information on prevention strategies for the public.

Previous studies from our group have explored the role of physical activity in the risk²⁵ and recovery of NP and back pain,^{26,27} suggesting it as having a protective effect in women. Similarly, previous studies on the effect of smoking and alcohol consumption on sick leave due to unspecific LBP or NP showed that the former is associated with an increased risk and the latter suggested neither an association nor a protective effect.²⁸ Other studies have investigated the role of lifestyle by grouping HLBs (physical activity, smoking, BMI, healthy diet, and alcohol intake) in order to study a set of HLBs as one risk factor instead of treating them as individual exposures.^{16,29–31} A Swedish register-based cohort on the risk of atrial fibrillation combined information about BMI, physical activity, smoking, and alcohol intake and showed a significant protective effect for both men and women starting from three healthy behaviors.³⁰ Another study on pancreatic cancer combined five factors (BMI, healthy diet, smoking, alcohol intake, and physical activity) and showed a reduction of risk among men but not among women, starting from four behaviors.²⁹ Additionally, a meta-analysis examined the effect of different combinations of lifestyle behaviors on mortality, showing high heterogeneity of the definitions, that the effect varied depending on the reference category used, that the inclusion of BMI did not affect the main results, and that there were no differences between sexes.³¹

To the best of our knowledge, this way of grouping lifestyle factors into a behavior has not been used before in studies investigating associations with NP and there is only

one study on the association of back pain.³² The aim of this study was therefore to determine whether HLB is protective against the onset of long duration troublesome back pain and NP in adult men and women.

Materials and methods

Ethics

All participants provided written informed consent. The present study was approved by the ethics committee at Karolinska Institutet (diary nr 2013/497-32).

Source and study population

This study is based on the Stockholm Public Health Cohort, a population-based cohort study established within the framework of Stockholm County Council public health surveys. Participants filled in an extensive baseline questionnaire and were followed longitudinally for health, lifestyle, and social outcomes via follow-up surveys. A detailed description of this cohort has previously been published.³³ We included individuals (aged 18–84 years) who responded to the baseline questionnaire in 2006 and the follow-up questionnaire in 2010 for the analyses in the present study. The sample was filtered by using two questions from the 2006 questionnaire regarding NP and LBP to define “non-diseased” populations at risk.

In Cohort I, to identify potential participants to include in the study of the risk of long duration troublesome LBP, the question “During the past 6 months, have you had pain in the lower back?” with five possible answers (“no”, “yes, a few days in the past 6 months”, “yes, a few days per month”, “yes, a few days per week,” or “yes, every day”) was used. Those who answered “no” were considered to be free from LBP and therefore formed the study population at risk for LBP. For cohort II participants, to study the risk of long duration troublesome NP, the question “During the past 6 months, have you had pain in the neck, the shoulders, or the arms?” was used, with equal response options as for the question to identify cohort I. Those who answered “no” were considered to be free from NP and therefore formed the study population at risk for NP. Furthermore, those with incomplete information about the exposure were excluded from Cohorts 1 and 2. These two cohorts are not mutually exclusive (Figure 1): 55% of those in Cohort I had NP and 65% of those in Cohort II had LBP.

Exposure

Information about lifestyle behavior was collected from the baseline questionnaire in 2006, by grouping four lifestyle behaviors into being healthy/not healthy. Physical activity

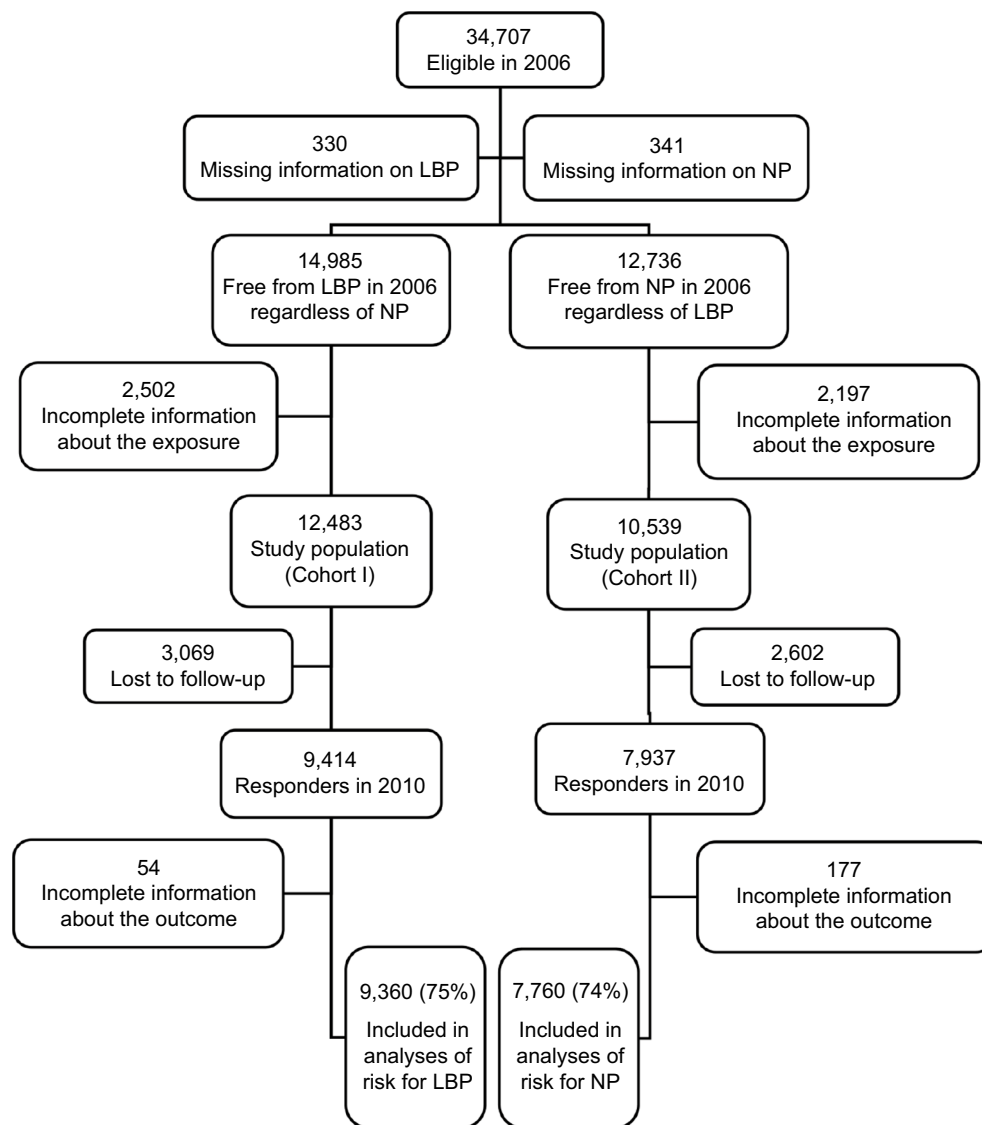


Figure 1 Flow chart of participants of the Stockholm Public Health Cohort between 2006 and 2010 and sample included in the study populations.
Abbreviations: LBP, low back pain; NP, neck pain.

was dichotomized using 150 minutes of physical activity at moderate intensity or 75 minutes at high intensity per week, or a combination of these as cutoff points based on two questions: the first one asking for the level of intensity of physical activity and the other one using the number of days of physical activity per week.³⁴ Smoking was assessed by asking whether the person smoked daily or not.³⁵ Alcohol intake was evaluated with various questions: the person was asked to fill in the amount, type, and frequency of average consumption of various alcoholic drinks. The amount of grams of alcohol consumed per week was then calculated from these data. The value was dichotomized following World Health Organization recommendations on no risk consumption of alcohol (≤ 168 g 100% alcohol/week for men and ≤ 108 g 100% alcohol/week for women).³⁶ Consuming

alcohol corresponding to approximately half a bottle of spirits on the same occasion less than once a month was also classified as no risk drinking. Healthy diet was dichotomized using the cutoff point of four portions of fruits and vegetables per day.³⁷ Finally, a three categories variable was built according to the number of variables and regardless of the type of habit. These categories are none or one healthy behavior (reference category), two behaviors, and three and/or four healthy behaviors.

Outcomes

There are two outcomes in this study: long duration troublesome LBP and long duration NP. These categorizations were based on the following questions in the questionnaire from 2010: “During the past 6 months, have you had pain in the

lower part of the back” (Cohort I) and “During the past 6 months, have you had pain in the upper part of the back or neck?” (Cohort II). Those who answered “yes, a couple of days per week” or more often, and additionally reported at least some extent of interference in their daily activities including work were considered to have the outcomes of interest. The question was “Has such pain caused a decreased ability to work or impairment in daily activities?”. The answer alternatives were yes, to a high extent; yes, to some extent; and not at all.

Potential confounders

A number of potential confounders obtained from the literature^{3,15,38–41} and from clinical considerations were considered for the association between exposure and outcome (Table 1).

Statistical analyses

Analyses were performed separately for each of the two sub-cohorts and stratified by sex. Cross-tabulation was done for

the variables of interest to describe the study subpopulations. Generalized linear models with a binomial link function were used to estimate the association between exposure and outcome, and to test for and adjust for confounding. The results are presented as risk ratio (RR) together with 95% confidence intervals (CI). Potential confounders were entered to the model one at a time. If a factor made a change of at least 5% on the RR, it was included in the final multivariable model. This procedure was performed separately for men and women and for each cohort. All the computations were executed with Stata v. 13.0 (StataCorp LP, College Station, TX, USA).

Results

Prevalence of HLBs at baseline

In Cohort I (risk of LBP), 23% (19% women and 27% men) reported no or one HLB at baseline. The prevalence of two HLBs was 42% (women 39%; men 44%), the prevalence of three was 28% (women 31%; men 26%), and the prevalence of four was 7% (women 11%; men 3%).

Table 1 Potential confounding variables

Potential confounder	Measurement	Categorization in the analysis
Socioeconomic status	Based on occupation and/or the number of years of study according to the classification from Statistics Sweden	Unskilled and semiskilled, skilled workers, assistant nonmanual, intermediate nonmanual, professional, or self-employed nonprofessional
Country of birth	Retrieved from Statistics Sweden	Sweden, other Nordic country, other European country or others
Personal support	“Do you have one or more persons who could give personal support to overcome personal problems or crisis in your life?”	Yes, always; yes, most of the time; no, not most of the time; or no, never
Practical support	“Can you get help from someone in case of disease or practical problems (eg, borrow things, help with repairing, to write a letter, get advice or information, or help with buying things)?”	Yes, always; yes, most of the time; no, not most of the time; or no, never
Economic stress	“During the past 12 months, has it happened that the salary or money has been spent and that you have been obliged to borrow money from relatives or friends to cover the cost of groceries or rent?”	No; yes, in one occasion; or yes, in various occasions
Living alone	Living alone vs any other cohabitation	Yes/no
Sleep disturbances	<7 hours in a normal night during a week was considered as having sleep disturbance	Yes/no
Age	Age at baseline	Continuous and in quartiles (18–36), (37–49), (50–62), and (62+)
Psychological distress	Based on the General Health Questionnaire-12. A sum score of ≥ 3 indicates psychological distress	Yes/no
Body mass index	Weight in kilograms divided by the squared height in meters	Continuous and categorical: normal or low (<25), overweight (25–29.9), or obesity (≥ 30)
LBP (in Cohort II) ^a	“During the past 6 months, have you had pain in the lower part of the back?”	No; yes, a few days in the past 6 months; yes, a few days per month; yes, a few days per week; yes, everyday
NP (in Cohort I) ^b	“During the past 6 months, have you had pain in the upper part of the back or neck?”	No; yes, a few days in the past 6 months; yes, a few days per month; yes, a few days per week; yes, everyday

Notes: ^aTested as confounder in Cohort II. ^bTested as confounder in Cohort I.

Abbreviations: LBP, low back pain; NP, neck pain.

In Cohort II (risk of NP), 23% (19% women and 27% men) reported no or one HLB at baseline. The prevalence of two HLBs was 41% (women 39%; men 44%), the prevalence of three was 28% (women 31%; men 25%), and the prevalence of four was 8% (women 11%; men 4%).

Risk of LBP

For cohort I (risk of LBP), women accounted for 50% of the population at risk and represented a higher proportion in the upper category of the exposure, and the mean age was 48

years. The most common social class corresponded to intermediate nonmanual employees and professionals (Table 2). The proportion that at the follow-up in 2010 had developed LBP that was long-lasting and troublesome was 3% (n=379) (3% of men and 4% of women).

An RR of 0.72 (95% CI: 0.53–0.98) was observed for those with three or four HLBs in comparison to those with none or one, in the group of all individuals. In the sex-stratified analyses, the corresponding figure for men was 0.63 (95% CI: 0.39–1.02), and 0.86 (95% CI: 0.56–1.32) for

Table 2 Baseline characteristics of Cohort I (risk of LBP) in relation to number of HLBs

Characteristic	All		None or one HLB		Two HLBs		Three HLBs		Four HLBs	
	n	%	n	%	n	%	n	%	n	%
Women	6,225	50	1,190	41	2,425	47	1,918	54	692	77
Age, years, average (SD)	47.8 (16.7)		47.6 (16.4)		47.7 (17.1)		48.2 (16.7)		47.2 (15.5)	
Social class based on occupation										
Unskilled and semiskilled	1,415	13	428	17	550	12	364	11	73	9
Skilled worker	1,129	10	304	12	464	10	301	9	60	7
Assistant nonmanual employee	1,695	15	399	15	690	15	491	15	115	14
Intermediate nonmanual employee	2,952	26	604	23	1,191	26	885	28	272	31
Professional	3,008	26	564	22	1,304	27	881	28	259	31
Self-employed nonprofessional	1,102	10	282	11	469	10	282	9	69	8
Economic stress ^a										
No economic stress	10,983	89	2,357	82	4,571	89	3,201	92	854	92
Occasional economic stress	652	5	203	7	264	5	153	4	32	4
Often economic stress	785	6	302	11	296	6	155	4	32	4
Personal support ^b										
Always gets personal support	7,415	60	1,528	53	3,058	60	2,213	63	616	67
Often gets personal support	3,851	31	984	35	1,598	31	1,021	29	248	27
Rarely gets personal support	748	6	231	8	302	6	178	5	37	4
Never gets personal support	367	3	101	4	161	3	88	3	17	2
Practical support ^b										
Always gets help	7,735	63	1,657	58	3,166	62	2,280	66	632	70
Often gets help	3,880	31	982	35	1,642	32	1,017	29	239	26
Rarely gets help	503	4	136	5	200	4	136	4	31	3
Never gets help	227	2	67	2	98	2	49	1	13	1
Country of birth										
Sweden	8,339	89	1,775	87	3,440	88	2,436	89	688	90
Other Nordic country	392	4	91	5	154	4	119	4	28	4
Other European country	321	3	72	4	111	3	108	4	30	4
Other countries	362	4	74	4	180	5	91	3	17	2
Sleep disturbances (<7 hours)	2,808	23	717	25	1,170	23	744	21	177	19
Lives alone	2,396	19	656	23	945	18	629	18	166	18
Psychological distress ^c	1,663	13	472	16	687	13	393	11	111	12
Neck pain										
No	6,876	55	1,521	53	2,874	56	1,972	56	509	56
Yes, a couple of days per month or more seldom	4,233	34	1,013	35	1,721	33	1,174	33	325	35
Yes, a couple of days per week	1,353	11	241	12	558	11	370	11	85	9

Notes: ^aEach category corresponds to the answer provided to the question on economic stress as presented in Table 1: no in the last 12 months (no economic stress), in one occasion in the last 12 months (occasional economic stress), and in various occasions in the last 12 months (often economic stress). ^bSimilarly, personal and practical support correspond to the answers provided as presented in Table 1. Yes, always (always gets help/personal support); yes, most of the time (often gets help/personal support); no, not most of the time (rarely gets help/personal support); no, never (never gets help/personal support). ^cPsychological distress was calculated and dichotomized based on 12 questions from the General Health Questionnaire, using the scoring system 0–0–1–1, with ≥3 points indicating the presence of it.

Abbreviations: HLBs, healthy lifestyle behaviors; SD, standard deviation; LBP, low back pain.

women (Table 3). For individuals with two HLBs, the RR was 0.87 (95% CI: 0.65–1.16).

Risk of NP

For cohort II (risk of NP), women accounted for 43% of the population at risk and represented a lower proportion in the first two categories of the exposure. The mean age was 49 years. The most common social class corresponded to intermediate nonmanual employees and professionals (Table 4). The proportion that at the follow-up in 2010 had developed NP that was long-lasting and troublesome was 5% (n=464) (5% of men and 6% of women).

An RR of 0.79 (95% CI: 0.59–1.06) was observed for those with three or four HLBs in comparison to those with none or one, in the group of all individuals. In the sex-stratified analyses, the corresponding figure for men was 1.13 (95% CI: 0.74–1.71), and for women was 0.52 (95% CI: 0.35–0.77) (Table 5). For individuals with two HLBs, the RR was 1.05 (95% CI: 0.81–1.37).

Discussion

Our study indicates that HLB in a group free from pain in the lower back and neck, respectively, may protect against long duration troublesome pain in the back or neck 4 years later. The effect tends to differ between sexes, since sex-stratified analyses showed a more explicit protection from LBP in men and a more explicit protection from NP in women.

As stated in the “Introduction” section, the combined effect of lifestyle behaviors has not been widely studied in relation to the risk of LBP or NP. In our previously published study, also based on the Stockholm Public Health Cohort 2006–2010, we used similar definitions to operationalize the exposure (used “none” healthy behaviors instead of “none or one” as reference category and there were in total five instead of three categories) to study the prognosis of occasional LBP, for the risk of troublesome LBP.¹⁶ The study showed that women with healthier lifestyle behavior had a better prognosis compared to their male counterparts, and no significant association was observed among men. Even though the study concerned the risk of a worse prognosis instead of the risk of actually getting LBP, its results contrast those of the present study since no clear effect in women was found. A study by Pronk et al, that compared the combined effect of healthy behaviors on the risk of back pain, showed a protective effect for those in the category of four and three healthy behaviors;³² nonetheless, that study had a risk of selection bias due to the so-called healthy worker effect.

Table 3 RR of LBP (Cohort I) by number of HLBs together with 95% CI

Number of HLBs and risk of LBP	All			Men			Women		
	Cases/total	Crude RR	95% CI	Cases/total	Crude RR	95% CI	Cases/total	Crude RR	95% CI
None or one	78/2,004	1		44/1,126	1		34/878	1	
Two	132/3,859	0.88	0.67–1.16	56/1,997	0.72	0.49–1.06	76/1,862	1.05	0.71–1.57
Three	78/2,736	0.73	0.54–1.00	30/1,212	0.63	0.40–1.00	48/1,524	0.81	0.53–1.25
Four	25/761	0.84	0.54–1.31	4/182	0.56	0.21–1.55	21/579	0.94	0.55–1.60
Three or four	103/3,497	0.76	0.57–1.01	34/1,394	0.62	0.40–0.97	69/2,103	0.85	0.57–1.27

Notes: ^aAdjusted for socioeconomic status, age, and sex. ^bAdjusted for socioeconomic status, economic stress, and neck pain. ^cAdjusted for socioeconomic status. **Abbreviations:** RR, risk ratio; HLB, healthy lifestyle behavior; CI, confidence interval; LBP, low back pain.

Table 4 Baseline characteristics of Cohort II (risk of NP) in relation to number of HLBs

Characteristic	All		None or one HLB		Two HLBs		Three HLBs		Four HLBs	
	n	%	N	%	N	%	n	%	n	%
Women	4,566	43	873	35	1,782	40	1,412	48	499	71
Age, years, average (SD)	49.3 (17.5)		49.2 (17.1)		49.2 (18.0)		49.9 (17.6)		47.3 (15.9)	
Social class based on occupation										
Unskilled and semiskilled	1,220	13	366	15	477	12	311	12	66	10
Skilled worker	977	10	266	12	407	10	258	10	46	7
Assistant nonmanual employee	1,318	14	305	14	552	14	279	14	82	13
Intermediate nonmanual employee	2,505	27	501	24	1,033	26	750	28	221	34
Professional	2,491	26	500	23	1,087	28	722	27	182	28
Self-employed nonprofessional	938	10	246	12	392	10	245	9	55	8
Economic stress ^a										
No economic stress	9,388	89	2,066	84	3,935	89	2,736	92	651	93
Occasional economic stress	485	5	151	6	200	5	107	4	27	4
Often economic stress	607	6	241	10	239	6	105	4	22	3
Personal support ^b										
Always gets personal support	6,307	60	1,316	54	2,615	60	1,895	63	481	68
Often gets personal support	3,193	31	833	34	1,344	31	836	29	180	26
Rarely gets personal support	621	6	201	8	256	6	136	5	28	4
Never gets personal support	331	3	99	4	146	3	74	3	12	2
Practical support ^b										
Always gets help	6,577	63	1,433	59	2,742	63	1,927	66	475	68
Often gets help	3,175	31	807	33	1,343	31	841	29	184	26
Rarely gets help	439	4	124	5	177	4	110	4	28	4
Never gets help	207	2	73	3	83	2	40	1	11	2
Country of birth										
Sweden	7,084	89	1,510	89	2,997	90	2,061	89	516	89
Other Nordic country	301	4	73	4	110	3	93	4	25	4
Other European country	281	4	65	4	91	3	96	4	29	5
Other countries	271	3	57	3	132	4	68	3	14	2
Sleep disturbances (<7 hours)	2,401	23	626	26	996	23	645	22	134	20
Lives alone	2,115	20	569	23	853	19	552	19	141	20
Psychological distress ^c	1,258	12	376	15	516	12	295	10	71	10
Low back pain										
No	6,876	65	1,521	62	2,874	66	1,972	67	509	72
Yes, a couple of days per month or more seldom	2,925	28	751	31	1,229	28	778	26	167	24
Yes, a couple of days per week	704	7	193	8	282	6	203	7	26	4

Notes: ^aEach category corresponds to the answer provided to the question on economic stress as presented in Table 1: no in the last 12 months (no economic stress), in one occasion in the last 12 months (occasional economic stress), and in various occasions in the last 12 months (often economic stress). ^bSimilarly, personal and practical support correspond to the answers provided as presented in Table 1. Yes, always (always gets help/personal support); yes, most of the time (often gets help/personal support); no, not most of the time (rarely gets help/personal support); no, never (never gets help/personal support). ^cPsychological distress was calculated and dichotomized based on 12 questions from the General Health Questionnaire, using the scoring system 0–0–1–1, with ≥ 3 points indicating the presence of it.

Abbreviations: NP, neck pain; HLB, healthy lifestyle behavior; SD, standard deviation.

Some considerations should be made concerning the classification of exposures in our study when interpreting the results. A more detailed categorization of HLB has been used in previous studies,³¹ but that would require an even larger study population for sufficient statistical power. Although efforts were made to capture a valid measure of lifestyle behavior, measurement error and misclassification of exposure may be present. For instance, smoking was measured with a yes/no question about daily smoking, which is a rough measure of such exposure. By categorizing former

smokers as nonsmokers and smokers who only smoke a few cigarettes a day as smokers, we might have introduced a misclassification of this exposure, which most likely would be non-differential, thus diluting the associations.

One study derived from our literature review included diet as a potential risk factor. It considered animal protein intake instead of fruit and vegetable consumption and showed a negative association with LBP.⁴⁵ The rationale behind these findings is, however, not clear, but opens up the discussion on whether other components of diet such as fish, whole grains,

Table 5 RR of NP (Cohort II) by number of HLBs together with 95% CI

Number of HLBs and risk of NP	All						Men						Women						
	Cases/total		Crude		Adjusted ^a		Cases/total		Crude		Adjusted ^b		Cases/total		Crude		Adjusted ^c		
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	
None or one	87/1,673	1	1	1	1	1	41/1,042	1	1	1	1	1	46/631	1	1	1	1	1	1
Two	172/3,260	1.01	0.79–1.30	1.05	0.81–1.37	1.05	93/1,911	1.24	0.86–1.77	1.35	0.93–1.97	1.35	79/1,349	0.80	0.57–1.14	0.75	0.52–1.09	0.80	0.57–1.14
Three	96/2,258	0.82	0.62–1.08	0.77	0.57–1.05	0.77	44/1,149	0.97	0.64–1.48	1.03	0.67–1.60	1.03	52/1,109	0.64	0.44–0.95	0.52	0.34–0.80	0.64	0.44–0.95
Four	28/569	0.95	0.63–1.43	0.88	0.56–1.40	0.88	10/155	1.64	0.84–3.21	1.93	0.95–3.91	1.93	18/414	0.60	0.35–1.01	0.53	0.29–0.95	0.60	0.35–1.01
Three or four	124/2,827	0.84	0.65–1.10	0.79	0.59–1.06	0.79	54/1,304	1.05	0.71–1.57	1.13	0.74–1.71	1.13	70/1,505	0.63	0.44–1.14	0.52	0.35–0.77	0.63	0.44–1.14

Notes: ^aAdjusted for socioeconomic status, sex, and personal support. ^bAdjusted for socioeconomic status, age, and economic stress. ^cAdjusted for socioeconomic status.

Abbreviations: RR, risk ratio; HLB, healthy lifestyle behavior; CI, confidence interval; NP, neck pain.

legumes, sweetened beverages, or sodium might play a more direct role in the pathophysiology of pain.

The time between the measurement of exposure and the outcome was 4 years, and lifestyle behaviors might have changed over this period. Since the study aimed to investigate the association between HLB in the previous 12 months and the risk of pain 4 years later, such changes of exposure status may not be considered a source of bias in this study. Nevertheless, information bias cannot be excluded, being likely non-differential in its nature, with a risk of dilution of a true association. Regarding this, we think it is unlikely that such potential bias differs by sex. In a similar way, and considering the fluctuating characteristic of NP and LPB, there is a risk of misclassification of the outcome, especially considering that some individuals might be indecisive between reporting “a couple of days per week” or “a couple of days per month”. Such misclassification of the outcome is most probably non-differential in its nature, leading to dilution of a true association.

One strength of this study is the relative large sample size which permitted exploring the risk along different levels of HLB. The longitudinal design allowed a temporal relation of risk between the studied exposure and the outcomes. We have considered a long row of potential confounders in this study, but we cannot rule out that there is unmeasured or residual confounding. These include passive smoking, which was not addressed in the Stockholm Public Health Cohort questionnaire and has been reported as a potential factor associated with pain in the knee, neck, and/or back;¹⁹ specific psychiatric diagnoses;⁴⁶ or specific occupations.⁴⁷

The response rate for the baseline questionnaire was 67% in women and 56% in men³³ and 2%–3% of the responders at baseline had missing values at questions about the exposure. Nonparticipation at baseline is not likely to create a selection bias in a prospective etiological study. The response rate between 2006 and 2010 was acceptable (around 75%), but there is still a risk for selection bias. By comparing those who did and did not respond to the follow-up questionnaire, we found that the former had a higher compliance to better lifestyle behavior (37% of those who remained in the cohorts had three or four HLBs in comparison to 30% in those who withdrew). If the nonresponders also had a higher occurrence of the outcome compared to the responders, our results may be somewhat underestimated.

A methodological consideration is that we have interpreted our results as the presence of an association between HLB and LBP/NP despite the results not always being statistically significant. Various authors have previously addressed

this discussion in epidemiological journals encouraging researchers to consider the interplay of factors beyond the results of statistical testing.^{48,49} Therefore, the authors consider that this study has enough elements to support the presence of an association.

No single explanation can be given to the potential mechanism behind the protective association between HLB and risk of developing NP or LBP, but rather it is likely that there is an interaction of emotional, biochemical, and mechanical components. For instance, individuals with a healthy lifestyle might feel more confident on their decreased risk of chronic diseases or their ability to overcome pain; the protective effect of HLB might be mediated by low-grade inflammation; and individuals with HLB are more likely to be fitter, less obese, and more self-conscious in general. Likewise, given that it is unknown how long the induction period for NP or LBP is, no theory provides sound support in this case.

It is hard to explain sex differences of the effect observed in this study. It is well known that differences between men and women exist in terms of pain characteristics and/or intensity for chronic nonspecific pain. In inflammatory arthritis, for example, women have more often peripheral instead of axial pain, and in disc herniation, they often have more radiating pain.^{13,42–44} However, such differences in the occurrence of pain does not explain why lifestyle may have a differential degree of protection by sex and pain location. This, however, might in fact just be a chance finding. Although a different cutoff point was used to define risky consumption of alcohol by sex, the cutoff follows international recommendations and does not explain the discordant results in this study.

Conclusion

A HLB seems to be protective for the risk of developing long duration troublesome LBP in men and long duration troublesome NP in women. Authors recommend the promotion of a healthy lifestyle for both men and women given the evidence regarding its benefits for these and other health conditions.

Disclosure

The authors report no conflicts of interest in this work.

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