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ORIGINAL ARTICLE

Are respiratory disorders risk factors for troublesome neck/shoulder pain? A study of a general population cohort in Sweden

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Abstract

Purpose The etiology of neck/shoulder pain is complex. Our purpose was to investigate if respiratory disorders are risk factors for troublesome neck/shoulder pain in people with no or occasional neck/shoulder pain.

Methods This prospective cohort study was based on the Stockholm Public Health Cohorts (SPHC) 2006/2010 and the SPHC 2010/2014. We included adults who at baseline reported no or occasional neck/shoulder pain in the last six months, from the two subsamples (SPHC 06/10 $n = 15\,155$: and SPHC 2010/14 $n = 25\,273$). Exposures were self-reported asthma at baseline in SPHC 06/10 and Chronic Obstructive Pulmonary Disease (COPD) at baseline in SPHC 10/14. The outcome was having experienced at least one period of troublesome neck/shoulder pain which restricted work capacity or hindered daily activities to some or to a high degree during the past six months, asked for four years later. Binomial regression analyses were used to calculate risk ratios (RR) with 95% confidence intervals (95% CI).

Results Adjusted results indicate that those reporting to suffer from asthma at baseline had a higher risk of troublesome neck/shoulder pain at follow-up four years later (RR 1.48, 95% CI 1.10–2.01) as did those reporting to suffer from COPD (RR 2.12 95%CI 1.54–2.93).

Conclusion Our findings indicate that those with no or occasional neck/shoulder pain and reporting to suffer from asthma or COPD increase the risk for troublesome neck/shoulder pain over time. This highlights the importance of taking a multi-morbidity perspective into consideration in health care. Future longitudinal studies are needed to confirm our findings.

Keywords Asthma · COPD · Disorder · Multi-morbidity · Prognosis · Spinal pain

Background

Musculoskeletal pain in the neck and upper body is common and has a considerable impact on the individual's work ability and the health care systems [1–3]. In 2015, neck pain together with low back pain also was the leading cause of disability in most countries measured in years lived with disability (YLD) as measured in the Global Burden of Disease study [4, 5]. The estimated one-year incidence of neck pain is around 20% with a higher incidence noted in office and computer workers and reportedly higher in women [1, 2]. Chronic neck pain (> 3 months) has increased > 20% during the last decade and a reason for this may be an aging population around the world [5].

Several determinants of neck pain have been suggested. A study on the long-term prognosis of neck pain showed that biomechanical exposures such as manual handling and working with the hands above shoulder level have negative influences on the prognosis of neck pain [6]. In addition,

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the importance of lifestyle factors as well as job-related factors such as job strain has been highlighted for no or occasional neck and shoulder pain to become troublesome [7–10]. Further, individuals who lose time at work due to sick leave because of neck pain seem to be at higher risk for subsequent episodes of lost time at work and prolonged disability due to neck pain [11].

The prevalence of chronic neck and back pain in people suffering from respiratory disorders has recently been reported [12–14]. de Miguel-Díez et al. [12] investigated a cohort suffering from chronic obstructive pulmonary disease (COPD) and 40% of those reported chronic neck pain while 45% reported chronic low back pain. Aligning with that, Bentsen et al. (2020), found that 47% of a Norwegian cohort of peoples with COPD reported neck/back pain and raised the question that more knowledge is needed how pain interferes with the lives of those suffering from COPD. A recent cross-sectional study that investigated risk factors for the development of neck and shoulder pain suggested that exercises that enhance breathing and heart rate were associated with a reduced risk of experiencing neck or shoulder pain, but there was no association between general physical activity and upper body pain [10]. The diaphragm and other important breathing muscles are suggested to play a role in postural control [15] as well as in spinal stiffness [16]. It has in addition been suggested that people with neck pain have an impaired respiratory dysfunction due to the thoracic mobility and the functions of the neck muscles [17–20]. A recent review further reported a significant difference in maximum inspiratory and expiratory pressures in patients with chronic neck pain compared to asymptomatic subjects [21]. Among respiratory disorders, COPD is a chronic condition that leads to a pathologic degeneration of the respiratory system [22–24]. Moreover, in people suffering from asthma, hyperventilation is a problem affecting the breathing muscles and consequently the neck, shoulder, and the thoracic region [25, 26]. During an asthma attack there is an increase in the use of the respiratory muscles as well as in the maintenance of adequate ventilation in daily life activities and the association between head and shoulder position and peak expiratory flow rate has been reported in people with asthma [27].

There seems to be an association between respiratory disorders and neck/shoulder pain and to the best of our knowledge, no study has investigated this association in a prospective design. As the scientific evidence of the importance of respiratory disorders for the develop neck/shoulder pain is scarce and new knowledge may improve clinical management and recommendation for the patients the individual patient, the current area is important to pursue. Our aim was to investigate if respiratory disorders reported are risk factors for reporting troublesome neck/shoulder pain four years later in people with no or occasional neck/shoulder pain at baseline.

Methods

Study design

This prospective cohort study is based on two subsamples from the Stockholm Public Health Cohort (SPHC): one with baseline in 2006 and followed up in year 2010 (SPHC 06/10) ($n = 25{,}173$) and one with baseline in 2010 and followed up in year 2014 (SPHC 10/14) ($n = 30{,}730$). SPHC is a population-based cohort set up by the Stockholm County Council to collect information about significant contributors to the burden of disease [28]. Details of the data collection and questionnaires are reported elsewhere [28]. The subsample of SPHC 06/10 was used to analyze if reported asthma at baseline was a risk factor, and the subsample SPHC 10/14 was used to analyze if reported COPD at baseline was a risk factor. Information about asthma was not available in the SPHC 10/14, and information about COPD was not available in the SPHC 06/10. The study was approved by the Regional Ethical Review Board in Stockholm, Sweden (2015/1204–32).

Study population

The flow of study persons in this study is displayed in Fig. 1. Eligible for inclusion in the current study was men and women (> 18 years old) who answered the SPHC 06/10 and the 10/14 survey, respectively. To form study populations at risk for troublesome neck/shoulder pain, the inclusion was based on a question in the SPHC survey; *"During the previous six months, have you experienced neck or shoulder pain?" ("No", "Yes, a couple of days in the last six months", "Yes, a couple of days each month, "Yes, a couple of days each week" and "Yes, everyday").* We included those who answered with either *"No" or "Yes, a couple of days last six months"* at baseline, here defined as a population with no or occasional neck/shoulder pain. Those with missing data at baseline on the questions on asthma ($n = 159$) in the SPHC 06/10 and in SPHC 2010/14 on COPD ($n = 254$) were excluded. As were those with no data on neck/shoulder pain (SPHC 06/10 $n = 237$, SPHC10/14 $n = 399$). Thus, our study population was $n = 15{,}155$ in SPHC 06/10 and in SPHC10/14 $n = 25{,}273$ (Fig. 1).

In SPHC 06/10 $n = 959$ (6%) reported asthma at baseline and in SPHC 10/14 $n = 498$ (2%) reported COPD at baseline.

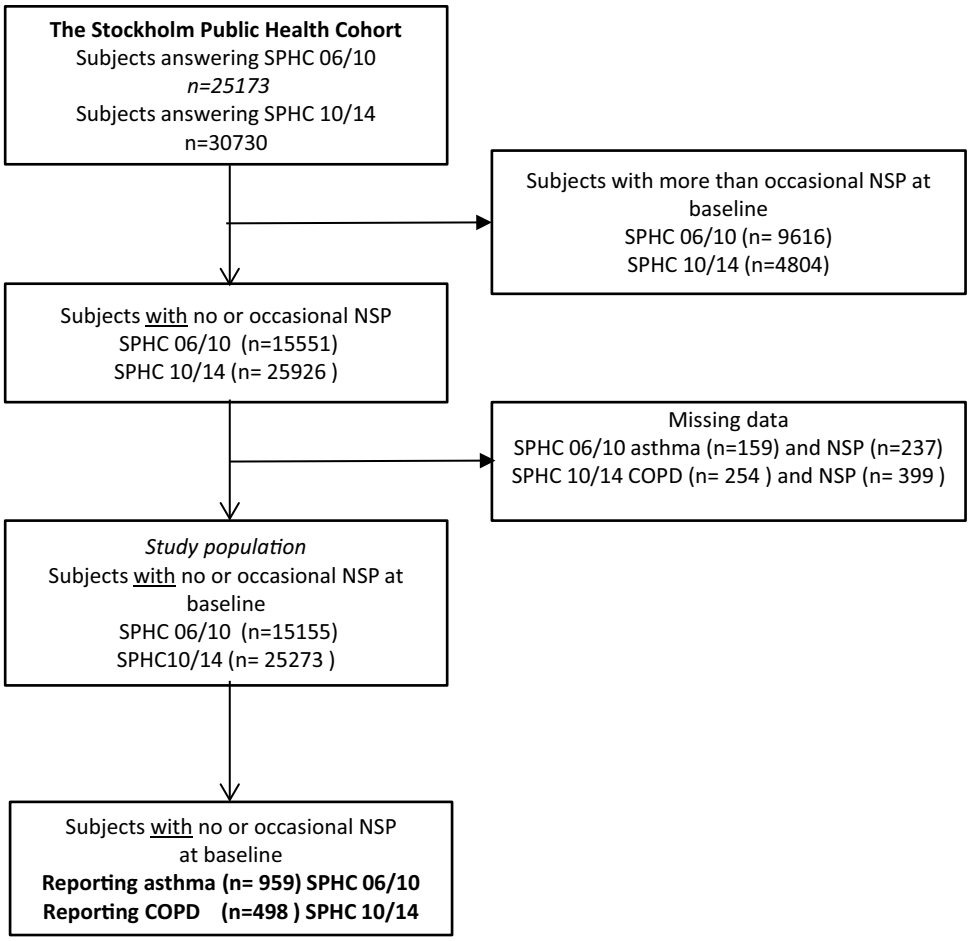

Fig. 1 Inclusion process and progress of subjects into the study population

Baseline questionnaire and exposure

Baseline data were elicited with questions regarding demographic characteristics, physical health, psychological health, psychosocial factors, socioeconomic factors, lifestyle, and social factors. These questions were included in the 2006 and 2010 survey, respectively, as reported previously [28].

Exposure

Potential factors of importance for the incidence of troublesome neck/shoulder pain were self-reported asthma and COPD. The questions to measure this were: (i) Do you suffer from asthma? Answered by no/ yes (SPHC 06/10), (ii) Do you suffer from chronic obstructive pulmonary disease? Answered by no/ yes (SPHC10/14).

Potential confounders

Potential confounding factors were considered in accordance with previous research on risk factors for neck pain, clinical considerations, and availability, after careful discussion about if they instead possibly could be intermediators or colliders. A directed acyclic graph (DAG) was used for this consideration (Fig. 2). Potential confounders reported at baseline in the present study were; age (continuous and dichotomized into < 22, 23–31, 32–41 and > 41); sex (men/women); weight (kg); height (cm); smoking habits (yes, daily); low back pain experienced the previous six months (yes; more than two days); socioeconomic class (unskilled and semiskilled workers, skilled workers, assistant non-manual employee, intermediate non-manual employees, and employed/ self-employed/professional); main physical workload in the past 12 months in the SPCH 06/10 cohort (sedentary, light, moderately heavy, and heavy) and main physical activity load in the past 12 months in the SPHC10/14 (sedentary, light, moderately heavy, and heavy); time spent on household work per week in the SPCH 06/10 (yes > 10 h) and time spent on household work per day in the SPCH 10/14 (yes > 2 h); experience of stress in the SPCH 06/10 (yes, once/month or more), and perceived stress in the SPCH 10/14 (yes, more and much more than usual); country of birth (Sweden/elsewhere); and leisure physical activity level (sedentary < 2 h per week).

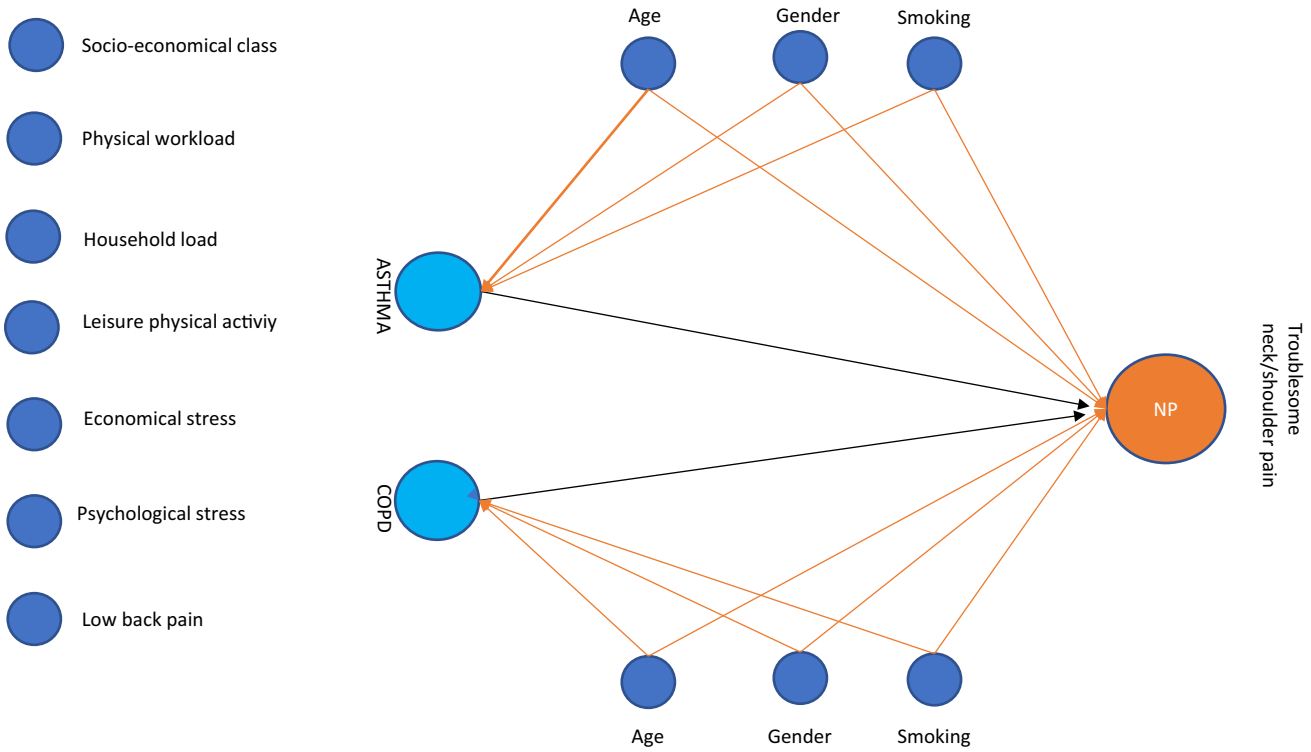

Fig. 2 Directed acyclic graph (DAG) of the outcome troublesome neck/shoulder pain, exposures Asthma and COPD and possible confounding factors age, gender and daily smoking

Outcome

The outcome was based on questions in the surveys sent four years after the baseline; the 2010 follow-up survey for Asthma and the 2014 follow-up survey for COPD. The outcome was based on the questions on having experienced at least one period of troublesome neck/shoulder pain during the past six months. Participants who answered "yes" to both of the following questions were defined as having had experienced troublesome neck/shoulder pain: "*During the past six months, have you felt pain, (at least a couple of days per week) in your neck or shoulder*? *If so, have these restricted your work capacity or hindered you in daily activities to some degree or to a high degree?"*

Statistical analysis

For the analyses of associations between the prognostic factors and the outcome, binomial regression models were used. The results are presented as risk ratios (RR), along with 95% confidence intervals (95% CI).

Potential confounding factors were identified by directed acyclic graph (DAG) (Fig. 2). The identified potential confounding factors were then added one at a time to the crude regression model. As described by Rothman and Greenland [29], a possible confounding factor that changed the crude RR by 10% or more was considered a confounder and was entered into the final and adjusted model.

Results

Among people reporting asthma at baseline 2006 ($n=959$), 44 persons (5%) reported troublesome neck/shoulder pain in 2010 and among persons reporting COPD at baseline 2010 ($n=498$), 35 persons (7%) reported troublesome neck/shoulder pain in 2014. Approximately 50 % of the cohorts were women (SPHC 06/10 51% ($n=7732$) and SPHC 10/14 52 % ($n=13{,}221$). Mean age of the cohorts was 49 (SD16) and 50 years (SD18), respectively, and for those suffering from asthma, 45 (SD16) years or for COPD 50 (SD18) years. The demographics of the study population stratified by those who suffered from asthma and COPD at baseline are presented in Table 1.

Age, gender, and smoking emerged as confounding factors for the analyses of asthma and COPD. Adjusted results indicate that those suffering from asthma at baseline 2006 have an increased risk to experience troublesome neck/shoulder pain at follow-up in year 2010 (RR 1.48, 95% CI 1.10–2.01) as do those suffering from COPD at baseline

Table 1 Baseline demographic and psychosocial characteristics stratified for those suffering from Asthma ($n=959$) and those with no asthma ($n=14{,}196$) in SPHC 2006/10, and those suffering from COPD (n = 498) and those with no COPD ($n=24{,}775$) in SPHC 2010/14

Cohort SPHC 06/10 $n=15\,155$					Cohort SPHC 10/14 $n=25\,273$				
	No Asthma $n=14\,196$		Asthma $n=959$			No COPD $n=24\,775$		COPD $n=498$	
	N	%	*n*	%		*n*	%	*n*	%
Age (year) mean (SD)	49 (16)		45 (16)		Age (year) mean (SD)	50 (18)		67 (15)	
Weight (kg) mean (SD)	75 (15)		74 (15)		Weight (kg) mean (SD)	75 (20)		73 (16)	
Height (cm) mean (SD)	173 (10)		172 (10)		Height (cm) mean (SD)	172 (11)		169 (18)	
BMI mean (SD)	25 (5)		25 (5)		BMI mean (SD)				
Sex					Sex				
Men	7003	49	420	44	Men	11,802	48	250	50
Women	7193	51	539	56	Women	12,973	52	248	50
Country of birth					Country of birth				
Sweden	12,241	86	841	88	Sweden	20,695	84	399	80
Elsewhere	1955	14	118	12	Elsewhere	4080	16	99	20
Socioeconomic class*					Socioeconomic class*				
Unskilled and semiskilled workers	1659	13	121	14	Unskilled and semiskilled workers	3231	14	88	20
Skilled workers	1352	11	99	12	Skilled workers	2671	12	65	15
Assistant non-manual employees	1849	14	136	16	Assistant non-manual employees	3439	15	82	18
Intermediate non-manual employees	3519	7	245	28	Intermediate non-manual employees	6153	27	88	20
Employed/self-employed professionals, civil servants and executives	3329	6	189	22	Employed/self-employed professionals, civil servants and executives	4977	22	85	19
Self-employed (other than professionals)	1209	9	70	8	Self-employed (other than professionals)	2255	10	35	8
Workload					Physical activity load				
Sedentary	4220	43	251	37	Sedentary	7233	30	148	31
Light	2962	30	219	32	Sedentary/Light	7884	32	175	36
Moderately heavy	2931	20	157	23	Moderately	8599	35	140	29
Heavy	637	7	48	7	Heavy	594	2	9	2
Perceived stress (> some time per month)	4582	32	300	32	Perceived stress (> more/much than usual last weeks)	3559	15	57	12
Household work > 10 h/week	4276	38	302	37	Household work > 2 h/day	5302	22	121	25
Comorbidity Low back pain (> a couple of days during last 6 months)	6178	44	493	51	Comorbidity Low back pain (> a couple of days during last 6 months)	7843	32	138	28
Smoking habits (daily)	1532	11	114	12	Smoking habits (daily)	2641	11	127	27
Leisure physical activity level					Physical activity level				
Sedentary	1162	8	83	9	Sedentary	15,117	62	323	67

SD standard deviation BMI body mass index

2010 at follow-up in year 2014 (RR 2.12, 95% CI 1.54–2.93) (Table 2).

Discussion

Our findings show that those who reported no or occasional neck/shoulder pain and reported to suffer from asthma or COPD at baseline, indeed had a higher risk to experience troublesome neck/shoulder at the follow-up four years later. To the best of our knowledge this is the first study investigated this in a longitudinal design. It has previously been reported that an association exists between neck pain and respiratory functions and that interventions to deal with respiratory function might be of value [21]. These findings are presented in studies with a cross-sectional design, thus not specifying the causal effect. A recent review studied factors such as physical activity, sleep disorder and lifestyle factors

Table 2 Associations between suffering from asthma or COPD and the risk of experiencing at least one episode of troublesome neck/shoulder pain at follow-up, presented as crude and adjusted risk ratios (RR) and 95% confidence intervals (95% CI)

Exposure	Exposed cases/ Non-exposed cases	Crude RR (95% CI)	Adjusted RR (95% CI)	*P*
Asthma (Cohort 06/10)	44/440	1.48 (1.09–2.00)	1.48* (1.10—2.01)	0.01
COPD (Cohort 10/14)	35/791	2.57 (1.87–3.53)	2.12* (1.54—2.93)	0.000

*Adjusted for age, gender and smoking, *COPD*: Chronic obstructive pulmonary disorder

proposed to associate with pain but was not able to find any sure causal association between the investigated risk factors and neck/shoulder pain [10]. Their results however indicated that exercises enhancing breathing and heart rate were associated with a reduced risk for chronic neck/shoulder pain [10]. It has in addition been reported that people with neck pain may improve pain and pulmonary functions with such exercises [30].

COPD is a disorder that is highly debilitating, and asthma is previously reported to have an impact on health-related quality of life [22, 24, 31]. Some previous studies have in addition reported that respiratory disorders are risk factors for developing troublesome low back pain over time [32, 33] Smith et al. [32] reported that women with respiratory problems developed low back pain over time and vice versa. In addition, a longitudinal cohort study from our research group found that respiratory disorders, both asthma and COPD, were risk factor for developing troublesome low back pain over time [33].

Several neurophysiological reasons behind the interrelationship between neck/shoulder pain and respiratory disorders have been discussed. The diaphragm muscle is reported to play an important role in the muscular respiratory system and in addition a key role in spinal stability and posture [15, 32, 34]. Bordoni et al. [22] discussed the association between a poor functioning diaphragm and COPD and reported that the diaphragm loses its function to contribute to the intra-abdominal pressure in COPD, thus impacting on the spinal stiffness or spinal posture [22]. For those suffering from asthma the physical mechanism seem to be similar as due to the presence of expiratory flow limitation and exercise-induced bronchoconstriction, thus dynamic lung hyperinflation is common [25]. Further, a decline in the inspiratory muscle strength in maximal breathing capacity may lead to a hypertension of the accessory breathing muscles connected to the rib cage and the neck, thus possible increasing the risk of neck pain [35].

Another possible explanation, taking the multi-morbidity perspective into consideration is the association between a sedentary lifestyle, respiratory disorders, and pain. People suffering from COPD reportedly have a lower daily activity level compared to healthy [36]. In our analyses we tested for several confounders including a sedentary lifestyle, which however did not emerge as a confounding factor. A recent study investigating comorbidity in chronic conditions with a sedentary behavior, reported that asthma, and chronic lung disease have been found to have an association with disability, mobility and with chronic back and joint pain [37]. Since the proportion of older people is increasing in the population, the study of multi-morbidity of physical disorders is important to decrease personal suffering and the socioeconomic costs and increase quality of life [38].

Strengths and limitations

A strength of the present study is its prospective design in a general population in which the exposures asthma and COPD were measured at baseline and prior to outcome. Several potential confounders were considered. In our analyses of the association between the exposures and the outcome, we adjusted for age, gender, and daily smoking. Even so, we cannot rule out the risk of unmeasured or residual confounding such as medication, ethnicity, lifestyle, and psychological distress and in addition of misclassification of confounding.

We used two subsamples of the Stockholm Public Health Cohort. The reason for this was that there was only question on either of the exposures in the subsamples. A limitation to the present study is that the questions on asthma and COPD were measured with a single question, which may lead to a misclassification of the exposure. However, since we have no reason to believe that a potential misclassification of the exposure is related to the outcome in a prospective cohort study, the most probable would be non-differential misclassification and a potential dilution of the true association between the exposures and the outcome. Another limitation might be the low power in our analyses as we had few exposed cases. Even so, our findings indicate a risk for people exposed to asthma and COPD to develop troublesome neck/shoulder pain at follow-up.

The response rate from baseline 2006 to follow-up 2010 was 73% and for SPHC 10/14 71%. This means in addition that there might be a risk of selection bias. We have no reason to believe though that the proportion that were exposed to asthma or COPD would differ between those who answered and those lost to follow-up. Therefore, we judge

the risk of selection bias to be low. However, the generalizability of our results extends only to cohorts considered comparable to ours.

Conclusion

Our findings indicate that those with no or occasional neck/shoulder pain and reporting asthma or COPD increase the risk for troublesome neck/shoulder pain over time. This highlights the importance of taking a multi-morbidity perspective into consideration in health care. Future longitudinal studies are needed to confirm our findings.

Author contributions All authors contributed to the study conception and design. Material preparation, and analysis were performed by ERB and ES. The first draft of the manuscript was written by ERB and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability Data may be available on request to https://www.folkhalsoguiden.se/halsa-stockholm/halsa-stockholm---for-forskare/.

Declarations

Conflict of interest None of the authors has any potential conflict of interest.

Ethical approval This study was approved by Stockholm's Regional Committee for Medical Research Ethics and conformed to the declaration of Helsinki.

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