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Poor respiratory health outcomes associated with high illness worry and alexithymia: Eleven-year prospective cohort study among the working-age population

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ABSTRACT

Objective: Poor respiratory health outcomes have been associated with poorer physical health and higher psychological distress. The aim of this study was to investigate whether illness worry, alexithymia or low sense of coherence predict i) the onset of new respiratory disease, ii) respiratory symptoms or iii) lung function among the working-age population, independently of comorbidity mood-, anxiety, or alcohol abuse disorders.

Methods: The study was conducted among a nationally representative sample of the Finnish population (BRIF8901) aged 30–54 years ($N = 2310$) in 2000–2001 and was followed up in 2011. Individuals with a diagnosed respiratory disease or a severe psychiatric disorder at baseline were excluded. Lung function was measured by a spirometry test and psychiatric disorders were diagnosed using a structured clinical interview. Structured questionnaires were used to measure self-reported respiratory symptoms and diseases, illness worry, alexithymia, and sense of coherence.

Results: High illness worry predicted an 11-year incidence of asthma (OR 1.47, 95% CI 1.09–1.99, $p = 0.01$). Alexithymia predicted shortness of breath (OR 1.32, 95% CI 1.13–1.53, $p < 0.01$) and 11-year incidence of COPD (OR 2.84, 95% CI 1.37–5.88, $p < 0.01$), even after several adjustments for physical and mental health. Psychological dispositions did not associate with lung function in 2011.

Conclusions: In the general population, psychological factors that modify health behaviour predicted adverse respiratory health outcomes independently of lung function after 11 years of follow-up. This indicates that considering them part of personalized treatment planning is important for promoting health-related behaviour among the working-age population.

1. Introduction

Self-reported respiratory symptoms are common in the general population [1–3]. However, symptoms correlate only weakly with physiological measurements of airway obstruction among healthy individuals [4–6], among patients with asthma [7–9] and the general population [3]. This discrepancy between self-reported respiratory outcomes and biological factors demonstrates that the associations of biological factors and respiratory outcomes are not fixed but rather develop in the dynamics of various psychosocial factors.

In addition to several well-known biological factors, anxiety and depression have been found to influence poor respiratory outcomes in terms of an increased risk of respiratory disease or impaired control of the disease [10–14]. These disorders have been associated with the

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severity of perceived respiratory symptoms such as dyspnoea [15,16], even after controlling for clinical respiratory status [14,15]. These associations have emerged in cross-sectional as well as longitudinal population-based studies that have examined both the status of the respiratory disease and symptoms without the disease [16,17].

Several suggestions have been made regarding the pathways between anxiety and depression and poor respiratory status: for example, depression may induce unhealthy behaviours (e.g. smoking, physical inactivity [18,19]) that result in poor respiratory outcomes. Together with biological effects on the immunological or autonomic function that impacts asthma control, anxiety and depression have also been shown to alter symptom perception by intensifying the subjective sensation of symptoms [16,20]. These suggestions, however, do not take into account the long-term dispositions factors that affect the self-regulation of health and symptom perception which influence both somatic and psychiatric health outcomes [21,22].

Various psychological dispositions such as pervasive tendency to worry or negative affectivity have been shown to influence how strongly people experience respiratory symptoms [23] or vice versa, prolonging stress-related physical activation that provokes symptoms [24,25]. Further, dispositions have been suggested to modify perceptual processes of respiratory sensations, i.e. an individual's interoceptive accuracy and influence coping with symptoms [4,26–31]. However, it is unclear whether psychological dispositions have predictive validity in explaining the onset of respiratory symptoms or diseases assessed by self-reports or physiological measures of lung function. Further, the magnitude of their role in the respiratory burden at the population level is unclear.

Our previous study demonstrated that respiratory symptoms without signs of problems in lung function or respiratory diseases are common in the general population [3]. Dispositions of excessive illness worry or anxiety, low sense of coherence, and alexithymia, i.e. difficulty to identify and describe feelings and externally orientated thinking style, were associated with a higher probability of perceiving respiratory symptoms without respiratory diseases or problems in lung function. These factors explained almost half of the higher rates of physician visits among individuals with normal lung function and respiratory symptoms than among individuals without symptoms and normal lung functioning [3].

This study, therefore, aimed to examine whether the same dispositional factors predicted the 11-year incidence of i) respiratory diseases, ii) respiratory symptoms or iii) lung function among the working-age population as assessed using self-reports and lung function examined by spirometry. Based on previous studies, we hypothesized that these psychological dispositions would be associated with poor respiratory health outcomes.

2. Materials and methods

2.1. Sample

The Health 2000 survey is a nationally representative survey of Finnish adults aged 30 and over conducted by the Finnish Institute for Health and Welfare. The data were collected in Finland in 2000 and 2001 ([32] for a detailed description of the sampling procedure). The base sample comprised 8028 subjects, of whom 6005 participated in a clinical health examination focusing on lung function, and in a structured interview covering respiratory symptomatology, respiratory diseases and common depressive, anxiety and alcohol-use disorders, in line with the Munich version of the Composite International Diagnostic Interview (CIDI) [33,34]. All members of the Health 2000 survey sample alive and living in Finland and willing to participate were invited to the Health 2011 survey, which is a follow-up study of the Health 2000 Survey [35]. The sample analysed for this study was restricted to the participants who were 53 years old or younger at baseline ($n = 4397$), and thus still working aged during the follow-up assessment in 2011, and who had been included in our baseline study. This means that they had complete information on lung function and self-reported respiratory symptoms at baseline. Further, 1) participants with any psychotic disorder [3,36], 2) those who either reported a diagnosed respiratory disease (asthma, COPD, chronic bronchitis, other) or 3) who had missing information on these items at baseline were excluded from the analysis. See [3] for further information on baseline study sampling. For this study, the included participants had information on at least one outcome measurement in 2011: 1) information on self-reported respiratory symptoms, 2) self-reported respiratory disease diagnosed by a medical doctor (onset during follow-up) or 3) information on lung function assessed by spirometry. Fig. 1. shows the outline of our study participant flow.

2.2. Measures

2.2.1. Lung function and symptoms

In the Health 2000 survey, a Vitalograph bellow spirometer was used (Vitalograpf Ltd. Buckingham, UK) and in the 2011 Survey Medikro's® Spirometry System, which included the Medikro® SpiroStar flow-volume spirometer and Medikro ® Spiro2000 software (validation between the devices [37]). The lower limit of normal for the FEV1/FVC -ratio (*Z*-score) [38] was used as a continuous variable. Acceptable spirometry results were obtained from 831 males (54% of the base sample) and 1009 females (62% of the base sample) included in this study who had not been diagnosed with respiratory disease or psychosis in 2000.

Further, information on respiratory symptoms and physician-diagnosed diseases (asthma, COPD and chronic bronchitis, their outbreak and treatment) was based on self-reports based on a structured clinical interview [35]. Respiratory symptoms collected in Health 2000 and 2011 surveys were assessed in line with WHO-recommended sets of relevant questions [39,40]: 'Do you cough or bring up phlegm on most days?' (in 2000) and 'Do you become short of breath when you are hurrying on level ground or walking up a slight hill?' 'Do you feel breathless when walking with people of the same age on level ground, or do you have to stop for breath when walking at your own pace on level ground?' (in 2000 and 2011). In cases of positive answers to any of the dichotomous (yes-no) questions, the subjects were classified as having self-reported respiratory symptoms.

2.2.2. Psychological dispositions assessed in 2000

Sense of coherence was assessed by 12 items of the Finnish SOC-13 scale compiled from the original SOC-29 scale, which is widely used to assess the protective factors of health [41–43]. Item 9 was not included in the final questionnaire of the Health 2000 Survey. The score is the sum score of responses to all 12 items and a high score indicates a strong sense of coherence. Cronbach's alpha for the total scale was 0.87 in this study population. The psychometric properties of the SOC have proved to be good, and the measurements have been validated in both normal populations and several clinical populations [43,44].

2.2.3. Alexithymia: Toronto Alexithymia Scale-20 (TAS-20)

Characteristics of alexithymia were assessed using the Finnish version of the 20-item version of the Toronto Alexithymia Scale (TAS-20) [45,46]. The score is the sum of the responses to all 20 items, and a high score indicates alexithymic characteristics. A study based on the Health 2000 sample [47] obtained a Cronbach's alpha coefficient of 0.85 for TAS-20. The psychometric properties of the Finnish version of TAS-20 have proved to be good [45,46,48,49], and this measurement has been validated in the general population and several patient populations [46,50–53].

2.2.4. Health anxiety: the Whiteley Index

The Whiteley Index (WI) is an instrument that is widely used for measuring health anxiety, i.e. extensive health-related worries and

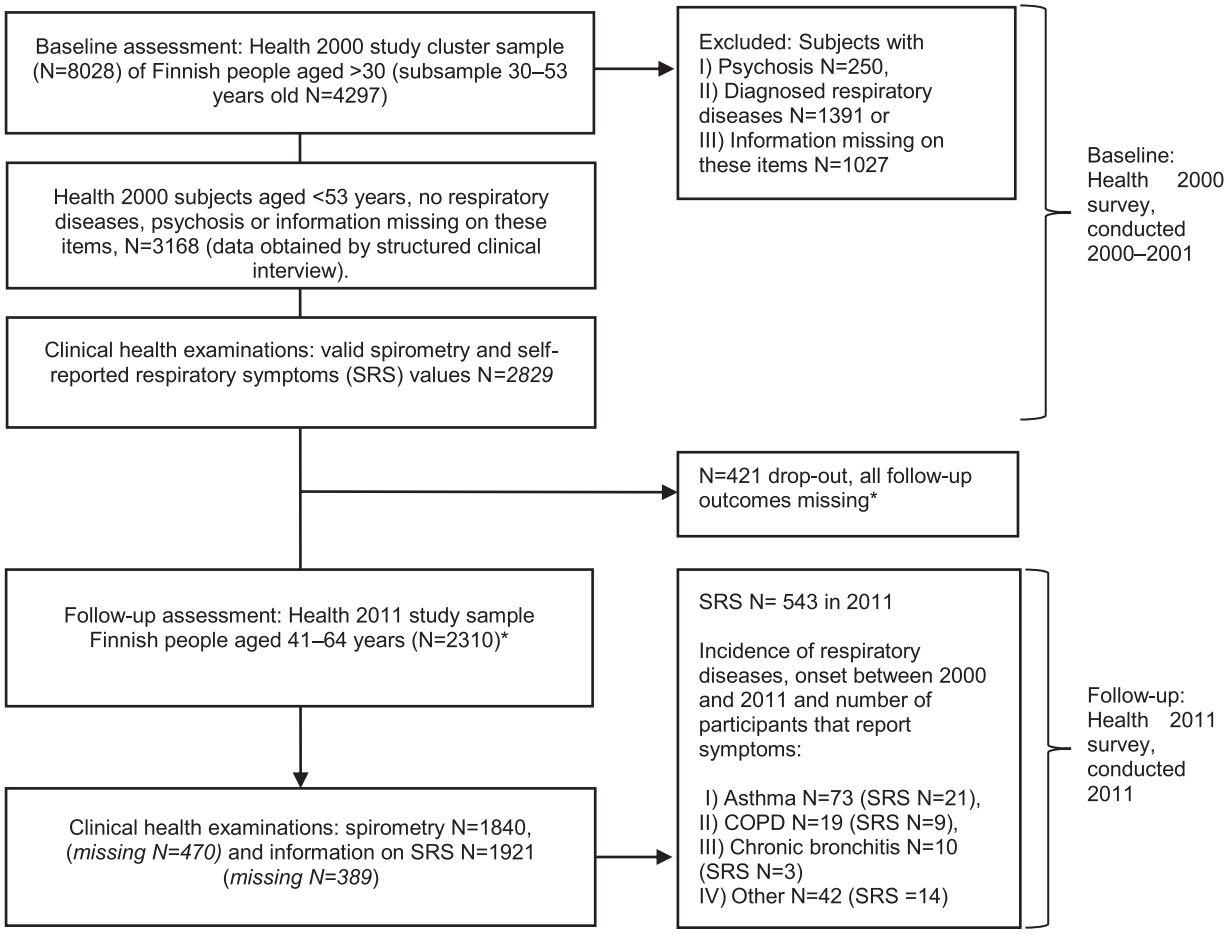

Fig. 1. Participant flow chart from Health 2000 sample to Health 2011 follow-up sample. SRS = self-reported respiratory symptoms, in 2000, questions on coughing, phlegm and shortness of breath and in 2011, questions on the shortness of breath. * Due to participation date in the follow-up survey, n = 98 participants had already turned 65 and were excluded from the follow-up analysis.

beliefs and convictions about illness. In this study, we used a seven-item measure rated on a five-point Likert scale (Whiteley-7, range 7–35) [54], adapted from the original 20-item WI [55]. A high score indicates a tendency towards health anxiety. The scale has proved to be reliable and to have high internal consistency [56]. In this study, Cronbach's alpha coefficient was 0.73 for the seven-item scale.

To make these three scales comparable we standardized the sum scores in the analysis to a mean of zero and a standard deviation of one. Factors were assessed at the baseline assessment point.

2.2.4.1. Demographic variables. We categorized age into two classes for the descriptive data analysis and used it as a continuous factor in the main analysis. Marital status was broken down into five categories: single, married, cohabiting, divorced/separated, and widowed. The information related to the socioeconomic position concerning education and main activity. The education variable comprised three levels (basic, secondary and higher education), and the main activity was divided into full-time employed, part-time employed, unemployed or laid off, retired, homemaker, student and other. Among the retired, the alternative grounds for retirement were old age, disability, unemployment, and other. Supplemental Table 1 shows the demographics of the study sample in 2011 and the demographics of the drop-out participants during the follow-up in comparison with the non-dropouts in 2000.

2.2.4.2. Other covariates. In main analyses, we used the covariates measured at baseline in 2000. The standardized body mass index (BMI), spirometry FEV1/FVC (Z), the maximum hand-grip strength of the dominating hand and C-reactive protein (CRP) were used to measure general physical health condition and they were used as continuous explanatory variables. The categorical variables were gender and smoking, the latter categorized as a non-smoker (never smoker) and smoker (daily, occasionally or quit smoking). Psychiatric disorders were assessed in 2000 using the structured clinical interview called the Munich version of the Composite International Diagnostic Interview (M-CIDI) that uses the DSM-IV criteria for diagnoses. Twelve-month diagnoses of depressive (dysthymia or major depressive disorder), anxiety and alcohol-use disorders obtained from the M-CIDI interview were used as categorical explanatory variables [57]. The reliability of the interview was good [57].

2.3. Statistical analysis

First, summary statistics were used to describe the demographic characteristics of the participants at follow-up. We compared the demographic factors in 2000 of the drop-out participants during the follow-up and the participants who had data at both measurement points, and the full results of the attrition analysis are shown in Supplemental Table 1. Secondly, binary logistic regression analyses were conducted, with the incidence of asthma (Table 1.), COPD (Table 2.), and chronic bronchitis (Supplemental Table 4.) during the follow-up as dependent variables. Third, binary logistic regression was used with the reporting of respiratory symptoms (no symptoms–symptoms) at follow-up in 2011 as a dependent variable (Table 3). Fourth, linear regression was run to predict the lung function measured by a continuous

Table 1
Predictors of self-reported incidence of asthma among 41–64-year-old population between 2000 and 2011: results obtained from binary logistic regression.

	Model 1 $N = 2202$				Model 2 $N = 2081$				Model 3 $N = 2005$			
	OR	(95% C.I.for OR)		p	OR	(95% C.I.for OR)		p	OR	(95% C.I.for OR)		p
Grip Z	0.97	(0.60,	1.58)	0.91					0.96	(0.57,	1.62)	0.89
BMI Z	1.23	(0.96,	1.58)	0.10					1.19	(0.91,	1.57)	0.20
CIDI: Alco	0.74	(0.30,	1.83)	0.52					0.67	(0.25,	1.82)	0.44
CIDI: Mood	1.06	(0.43,	2.61)	0.90					1.43	(0.54,	3.79)	0.47
CIDI: Anxiety	1.12	(0.43,	2.94)	0.82					1.17	(0.42,	3.27)	0.76
Smoking	1.19	(0.72,	1.96)	0.50					1.26	(0.73,	2.18)	0.41
CRP	0.79	(0.52,	1.20)	0.27					0.87	(0.59,	1.28)	0.47
WI Z					1.45	(1.09,	1.93)	0.01	1.47	(1.09,	1.99)	0.01
SOC Z					1.20	(0.85,	1.69)	0.30	1.19	(0.82,	1.72)	0.35
TAS Z					0.88	(0.63,	1.24)	0.47	0.85	(0.60,	1.21)	0.37

All analyses are adjusted for Gender = females as the reference category, age, standardized spirometry FEV1/FVC ratio and respiratory symptoms (cough or bring up phlegm, shortness of breath or breathless when walking) in 2000; SOC = Sense of coherence; WI = Whiteley index; TAS 20 = Toronto Alexithymia Scale; GRIP = maximum hand-grip strength; BMI = Body Mass Index; CIDI Alcohol, alcohol-related disorders by Mental Health Composite International Diagnostic Interview (CIDI); CIDI Mood, mood disorders; CIDI Anxiety, anxiety disorders; no diagnosis as the reference category in all CIDI variables; Smoking = categorical predictor based on self-reported smoking, never smoked as the reference category; Predictors with ^{z} are used as standardized values. In model 1, Nagelkerke R2 = 0.06; model 2, Nagelkerke R2 = 0.07; in model 3, Nagelkerke R2 = 0.07; in model 4, Nagelkerke R2 = 0.08.

Table 2
Predictors of self-reported incidence of COPD among 41–64-year-old population between 2000 and 2011: results obtained from binary logistic regression.

	Model 1 $N = 2202$				Model 2 $N = 2080$				Model 3 $N = 2005$			
	OR	(95% C.I.for OR)		p	OR	(95% C.I.for OR)		p	OR	(95% C.I.for OR)		p
Grip Z	0.88	(0.36	2.15)	0.78					0.64	(0.22	1.86)	0.42
BMI Z	1.18	(0.74	1.88)	0.48					0.97	(0.52	1.83)	0.94
CIDI: Alco	1.82	(0.54	6.16)	0.33					1.74	(0.37	8.14)	0.48
CIDI: Mood	2.80	(0.86	9.11)	0.09					1.96	(0.41	9.35)	0.40
CIDI: Anxiety	1.75	(0.44	6.89)	0.43					0.87	(0.13	5.73)	0.88
Smoking	3.59	(0.99	13.00)	0.05					4.50	(0.93	21.78)	0.06
CRP	0.85	(0.42	1.72)	0.64					0.58	(0.17	2.00)	0.39
WI Z					1.02	(0.57	1.84)	0.94	1.08	(0.58	2.01)	0.81
SOC Z					0.94	(0.50	1.77)	0.84	1.22	(0.59	2.56)	0.59
TAS Z					2.84	(1.37	5.88)	<0.01	3.07	(1.47	6.42)	<0.01

All analyses are adjusted for Gender = females as the reference category, age, standardized spirometry FEV1/FVC ratio and respiratory symptoms (coughing or bringing up phlegm, shortness of breath or breathless when walking) in 2000; SOC = Sense of coherence; WI = Whiteley index; TAS 20 = Toronto Alexithymia Scale; GRIP = maximum hand-grip strength; BMI = Body Mass Index; CIDI Alcohol, alcohol-related disorders by Mental Health Composite International Diagnostic Interview (CIDI); CIDI Mood, mood disorders; CIDI Anxiety, anxiety disorders; no diagnosis as a reference category in all CIDI variables; Smoking = categorical predictor based on self-reported smoking, never smoking as the reference category; Predictors with ^{z} are used as standardized values. In model 1, Nagelkerke R2 = 0.13; model 2, Nagelkerke R2 = 0.19; in model 3, Nagelkerke R2 = 0.25; in model 4, Nagelkerke R2 = 0.30.

Table 3
Predictors of self-reported shortness of breath in 2011 among 41–64-year-old population: results obtained from binary logistic regression.

	Model 2 $N = 1858$				Model 2 $N = 1763$				Model 3 $N = 1705$			
	OR	(95% C.I.for OR)		p	OR	(95% C.I.for OR)		p	OR	(95% C.I.for OR)		p
Grip Z	0.87	(0.71,	1.07)	0.18					0.89	(0.72,	1.11)	0.31
BMI Z	1.54	(1.37,	1.73)	<0.01					1.51	(1.33,	1.71)	<0.01
CIDI: Alco	1.30	(0.91,	1.86)	0.15					1.23	(0.84,	1.81)	0.28
CIDI: Mood	0.89	(0.58,	1.37)	0.59					0.75	(0.47,	1.21)	0.24
CIDI: Anxiety	1.53	(0.99,	2.39)	0.06					1.22	(0.76,	1.96)	0.42
Smoking	1.40	(1.12,	1.75)	<0.01					1.47	(1.16,	1.86)	<0.01
CRP Z	1.03	(0.93,	1.15)	0.53					1.05	(0.94,	1.18)	0.40
WI Z					1.08	(0.95,	1.23)	0.25	1.09	(0.95,	1.25)	0.21
SOC Z					0.93	(0.81,	1.08)	0.35	0.98	(0.84,	1.14)	0.79
TAS Z					1.31	(1.14,	1.52)	<0.01	1.32	(1.13,	1.53)	<0.01

All analyses are adjusted for Gender = females as the reference category, age, standardized spirometry FEV1/FVC ratio and respiratory symptoms (cough or bring up phlegm, shortness of breath or breathless when walking) in 2000; SOC = Sense of coherence; WI = Whiteley index; TAS 20 = Toronto Alexithymia Scale; GRIP = maximum hand-grip strength; BMI = Body Mass Index; CIDI Alcohol, alcohol-related disorders by Mental Health Composite International Diagnostic Interview (CIDI); CIDI Mood, mood disorders; CIDI Anxiety, anxiety disorders; no diagnosis as the reference category in all CIDI variables; Smoking = categorical predictor based on self-reported smoking, never smoking as the reference category; Predictors with ^{z} are used as standardized values. In model 1, Nagelkerke R2 = 0.10; model 2, Nagelkerke R2 = 0.16; in model 3, Nagelkerke R2 = 0.13; in model 4, Nagelkerke R2 = 0.17.

spirometry FEV1/FVC (Z) value in 2011 as a dependent variable (Table 4). All analyses were adjusted for gender, age, spirometry FEV1/FVC (Z) value and respiratory symptoms in 2000 (results for all covariates are shown in supplemental tables 2.-6.). Given their potential clinical significance, analyses were further adjusted for baseline CIDI diagnosis, smoking, BMI, C-reactive protein (CRP) value, and grip strength in 2000 (Model 1 in the tables), separately for psychological factors (Model 2 in the tables) and mutually with clinical and

Table 4
The unstandardised and standardized regression coefficients for the variables predicting spirometry lower limit of normal (LLN) value in 2011.

	Model 1 $N = 1679$				Model 2 $N = 1776$				Model 3 $N = 1621$			
	β	(95% C.I.for β)		p	β	(95% C.I.for β)		p	β	(95% C.I.for β)		p
Grip Z					−0.02	(−0.07,	0.04)	0.64	−0.01	(−0.07,	0.05)	0.71
BMI Z					0.11	(0.07,	0.13)	<0.01	0.11	(0.06,	0.13)	<0.01
CIDI: Alco					0.01	(−0.08,	0.12)	0.70	0.01	(−0.07,	0.14)	0.53
CIDI: Mood					0.04	(0.00,	0.24)	0.05	0.03	(−0.03,	0.23)	0.14
CIDI: Anxiety					−0.01	(−0.18,	0.10)	0.56	−0.01	(−0.18,	0.11)	0.64
Smoking					−0.06	(−0.16,	−0.04)	<0.01	−0.07	(−0.18,	−0.06)	<0.01
CRP Z					0.01	(−0.02,	0.04)	0.51	0.00	(−0.04,	0.03)	0.82
WI Z	0.00	(−0.04,	0.03)	0.85					0.00	(−0.04,	0.03)	0.85
SOC Z	0.00	(−0.04,	0.04)	0.83					0.00	(−0.04,	0.04)	0.94
TAS Z	0.02	(−0.02,	0.06)	0.37					0.01	(−0.03,	0.05)	0.63

All analyses are adjusted for Gender = females as the reference category, age, spirometry FEV1/FVC (Z) ratio and respiratory symptoms (coughing or bringing up phlegm, shortness of breath or breathless when walking) in 2000; SOC = Sense of coherence; WI = Whiteley index; TAS 20 = Toronto Alexithymia Scale; GRIP = maximum hand-grip strength; BMI = Body Mass Index; CIDI Alcohol, alcohol-related disorders by Mental Health Composite International Diagnostic Interview (CIDI); CIDI Mood, mood disorders; CIDI Anxiety, anxiety disorders; no diagnosis as a reference category in all CIDI variables; Smoking = categorical predictor based on self-reported smoking, never smoked as reference category; Predictors with ^{z} used as standardized values. Unadjusted model $R = 0.65$, R2 = 0.42; Model 1: R = 0.65, R2 = 0.43; Model 2: $R = 0.66$, R2 = 0.44; Model 3: $R = 0.67$, R2 = 0.44; All models $p < 0.001$.

psychological factors (Model 3 in the tables). All covariates were used as standardized values. Fifth, linear regression analyses were performed to assess multicollinearity between predictors. No multicollinearity problems were detected (results for the variance inflation factors range are reported in the supplement). The results covered the participants who had no missing values in the outcome variables (self-reported respiratory symptoms, respiratory diseases, or spirometry FEV1/FVC (Z) value at follow-up). Finally, a sensitivity analysis was performed with multiple imputations to estimate missing values for those participants ($N = 3168$) who constituted the baseline sample for this follow-up study. Demographic variables, covariates, psychological factors, and outcomes were used as predictors of imputed values. Results for regression analyses conducted with imputed data are shown in supplemental Tables 7–11. Odds ratios (ORs), 95% confidence intervals (CIs) and p-values were presented. IBM-SPSS 27.0 for Windows (SPSS Illinois, Chicago, Illinois, USA) software was used for the statistical analyses.

3. Results

The mean age of the 2310 participants in the final sample in the Health 2011 survey was 52.8 ($SD = 6.8$) and 55% of these were women. Of the final study population, 37% had secondary and 45% had higher education, 79% were married or cohabiting, and 75% were full- or part-time employed. As regards health-related factors, 30% were overweight and 24% were obese, and smokers (current or quit) made up 42% of the study population. Twenty per cent had depression, anxiety or an alcohol-related disorder diagnosed in a CIDI interview. Detailed demographic characteristics of the study population measured in 2011 are shown in Supplemental Table 1.

3.1. Predictors of 11-year incidence of respiratory diseases

Tables 1 and 2 describe the predictors of the 11-year incidence of asthma and incidence of COPD during the follow-up. Illness worry predicted the incidence of asthma even after adjustment for the health-related variables at baseline (in 2000) (OR 1.47, 95% CI 1.09–1.99, $p = 0.01$) (Model 3., Table 1.). Alexithymia increased the risk of 11-year incidence of COPD during the follow-up after several adjustments (OR 3.07, 95% CI 1.47–6.42, $p < 0.01$) (Model 3., Table 2.) suggesting a 3.07-fold risk of new COPD when standardized alexithymia increased by one standard deviation. There were no significant associations between the 11-year incidence of chronic bronchitis and psychological factors at baseline (Supplemental Table 4).

3.2. Predictors of respiratory symptoms during follow-up

Alexithymia, High BMI and smoking at baseline in 2000 increased the risk of perceiving shortness of breath, i.e. dyspnoea even after several adjustments (Table 3.).

3.3. Lung function

There were no significant associations between any of the psychological factors at baseline and lung function measured by spirometry in 2011, whereas smoking and BMI showed significant associations with lung function (Table 4.).

3.4. Attrition during follow-up

There were significant differences between the study sample and the drop-out participants regarding the following demographic variables (Supplementary Table 1): drop-out participants included more men than women, they belonged to the youngest age group (30–44-year-olds) and they had lower education than the participants with valid data in 2011. The participants included in the study sample in 2011 were more often married and non-smokers than drop-out participants, whereas diagnosed alcohol-related disorders were more common among drop-out participants.

3.5. Missing value imputations

For most of the analyses performed with imputed data, estimates changed only slightly. For example, in the models predicting the incidence of asthma, results were very similar, except for SOC being near significant (Model 4, in the Supplemental Table 7.) when using imputed data (fully adjusted model 3. OR 1.34, 95% CI 0.97–1.84, $p = 0.07$) as opposed to nonimputed data (OR 1.19, 95% CI 0.82–1.72, $p = 0.35$). Similarly, alexithymia was near significant in the full model predicting COPD (Model 4, in the Supplemental Table 8) when using imputed data (OR 2.13, 95% CI 0.79–5.80, $p = 0.12$) and significant when using nonimputed data (OR 3.07, 95% CI 1.47–6.42, $p < 0.01$).

4. Discussion

The results of this population-based follow-up study showed that, when adjusted for baseline lung function assessed by spirometry and respiratory symptoms, psychological dispositions were associated with the incidence of asthma, COPD, and to a limited extend, shortness of breath, 11 years later. Alexithymia predicted self-reported shortness of

breath and COPD, while excessive illness worry predicted incidence of asthma. These associations remained even when adjusted for multiple clinical covariates at baseline. In contrast to some previous studies, psychiatric disorders at baseline were not associated with poor respiratory outcomes at follow-up.

Our results link psychological dispositions with the incidence of symptoms and disease but not with lung function, that however constitutes an essential part of the respiratory diagnostics together with patient-reported outcomes. These results might reflect the variability of the disease process but also the idiosyncratic nature of an individual's ability to identify and respond to bodily sensations. For example, excessive illness worry, i.e. health anxiety has repeatedly been shown to relate with the discrepancy between self-reported symptoms and physiological assessments of the body by modifying the perceptual processes of bodily sensations [6,58]. Such a process is suggested to associate with psychophysiological variation in lung function [59,60] and to increase poor somatic outcomes [61,62]. The results of this study suggest that illness worry also influences the risk of asthma that widens earlier results of psychological triggers of asthma control [63] to disease initiation. As a parallel mechanism, alexithymia has been shown to associate with a high number of somatic symptoms [47] and poor health outcomes [64,65]. However, studies conducted among patient populations with persistent somatic symptoms suggest that alexithymia is not a strong predictor of the symptom outcomes [66,67]. It has also been criticized as a construct for explaining the discrepancy between perceived symptoms and physiological measures [58]. As our results show some contrast to these studies, they require further consideration. Development and exacerbation of COPD are highly influenced by unhealthy behaviours, similarly to behavioural pathways between alexithymia and physical health [68,69]. Maladaptive health behaviours have been shown to associate with alexithymia [70] and alexithymia is also associated with poor control of chronic diseases such as asthma [53,71,72]. Behaviour modified by alexithymia characteristics could thus influence somatic outcomes in a long follow-up period in a parallel way that is suggested between illness perceptions and asthma outcomes [30]. Thus, our results suggest that alexithymia and illness worry could be covariates of physical health if they modify health behaviours. In further epidemiological studies, they could be used as a risk factor of somatic health outcomes.

So far, studies examining the associations between respiratory symptom reports and dispositions have focused on patient populations or a selection of healthy volunteers in experimental studies [7,26–28]. Furthermore, the discrepancy between self-reported and physiologically assessed respiratory health has further been linked with mood and anxiety disorders [13,14]. Interestingly, we found no such association between common psychiatric disorders at baseline and poor respiratory outcomes in 2011. These results contradict those of a 20-year follow-up study by Brunner et al. suggesting that depression is a risk for adult-onset asthma incidence [12]. The discrepancy between these findings could be explained by the chronicity of the disorders: our study included only those with evidence of psychiatric disorder during the past 12 months at the baseline that however might be treated during follow-up. Thus, our results provide new information regarding the magnitude of the long-term dispositions influencing respiratory outcomes at the general population level. Their interplay with chronic psychiatric disorders on respiratory outcomes should be the subject of interest of further research.

The strengths of this study were its considerably long follow-up period and population-based sample that included a comprehensive combination of data based on clinical health examinations, structured clinical interviews and patient-reported outcomes. Further, the variables used in this study were assessed in the same structured methods in both baseline and follow-up assessment points and in a relatively short time window. Thus far the information on the association of dispositional factors and respiratory symptoms and incidence rates of respiratory diseases among the general population have been scarce. Thus, our findings provide us with the opportunity to gain insight into the paths influencing respiratory health even eleven years later.

Also, limitations must be addressed. Psychological dispositions differed in how they predicted the incidence of respiratory diseases. In addition, the power of explanatory models remained modest and varied between the outcomes. Together these results suggest various mechanisms between the self-regulation of health and respiratory outcomes limiting the generalizability of the findings. Furthermore, measurements for respiratory outcomes available for this study were limited and based on self-reports. Thus, although self-reports on questions of physician-diagnosed diseases have been suggested to be reliable and the symptom questionnaire could be considered valid for the study focus [73], there might be recall bias on the outcomes. Similarly, we were unable to control such comorbid diseases that might influence breathlessness and thus influence self-reports in this study. In addition, we could not control for other dispositional factors, such as negative affectivity, that have repeatedly been shown to correlate with poor respiratory outcomes. Indeed, there is some evidence that negative affectivity might mediate illness-specific symptom-reports in cases of worry related to asthma [74]. Thus, further research should include more comprehensive measurements to assess the role of dispositional factors in respiratory outcomes further. Moreover, focusing on mainly white, working-age participants diminishes the possibility of generalizing the results to apply to older people, who generally have more health problems. Despite the robustness of the results based on imputed data, another potential limitation might be the relatively high attrition rate from baseline to follow-up which can affect generalizability. Drop-out participants were more likely younger, male, had lower education, and were smokers or suffered from alcohol use disorder more frequently at baseline than the participants who were included in this follow-up study. Thus, they might have more general health-related problems than the participants included in the study sample and the results might underestimate the incidence of new adverse health effects. Even though we adjusted for background factors that have clinical importance for respiratory health, the results of the analyses should still be interpreted with caution.

Earlier studies suggest that a single value of airway measurement is an imperfect measure of lung function and that contextual cues explain the discrepancy between physiological measurements and one's experiences of respiratory symptoms [6,7,9]. Our findings further show a burden of dispositions on adverse respiratory outcomes at the population level. To expand suggestions regarding respiratory disease control [20], we could assume that these dispositions influence non-adaptive behaviours and coping with somatic distress. Such dynamics between psychological dispositions and response to somatic sensations might result in poor respiratory outcomes reflecting the biopsychosocial model of health and illness [75]. However, explaining to a patient that some of the individuals' dispositions may modify their behaviour resulting in poor health outcomes might be challenging for clinicians. Further research is required to understand personalized treatment strategies for individuals that differ in their ways of interpreting and perceiving somatic sensations. Although such an approach should be implemented into in-person management strategies [76], our population-based results support considering a personalized approach also in a wider scope. Some data suggest that e-health intervention tailored to respiratory symptom profiles (e.g., coughing, runny nose) might support self-management and reduce the need to consult a medical doctor because of the symptoms [77]. In the further development of these interventions, a person-based approach has been recommended to enhance the feasibility of the interventions [78]. The core of such an approach is a comprehensive understanding of the symptomatic individual's biopsychosocial context to make the intervention more relevant to the patient in line with the recommendations of rehabilitation of chronic respiratory diseases [79]. From the viewpoint of our study results, this could mean that together with the symptom profile, personalized intervention could consider the individual dispositions influencing health behaviour.

5. Conclusions

These results suggest that together with biomedical and health behavioural factors, psychological functioning plays a significant role in respiratory outcomes. Both excessive health-related worries and alexithymia predicted the eleven-year incidence of poor respiratory outcomes among this working-age population. These factors could potentially be used in further epidemiological studies of risk factors for poor respiratory outcomes but should be confirmed in other population-based studies. Personalized interventions focusing on respiratory health should consider these factors in line with symptom profiles to increase the feasibility and relevance of the interventions for individuals.

Contributors

SS performed the statistical analysis and drafted the original manuscript. All authors have reviewed and edited the manuscript. All authors have seen and approved the final version of the manuscript.

Ethical approval

The study had approval from the Ethics Committee of the Hospital District of Helsinki and Uusimaa. Participants provided written informed consent.

Data statement

The present study has been conducted using the Finnish Institute for health and welfare Biobank resources that are available to researchers (https://thl.fi/en/web/thl-biobank/for-researchers/application-process/thl-biobank-application-portal).

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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