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Development of self-assessed work ability among middle-aged asthma patients—a 10 year follow-up study

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ABSTRACT

Objective: The prevalence of asthma has been growing among working age people over the last decades. In this study, we examine the development of Work Ability Score (WAS) among middle-aged asthmatics in a longitudinal setting, in order to find risk factors for poor development.

Methods: We followed the development of WAS trends during 10 years in a cohort of 529 middle-aged asthmatics, who were active in working life. Follow-up questionnaires were mailed in years 1, 2, 4, 6, 8, and 10. To study the development of WAS over time, we computed the discrete Frechet distance, which describes the similarity between the shapes of WAS curves.

Results: Sixty-eight percent of the patients' WAS remained good or excellent throughout the follow-up period, while 24% of the patients WAS trend remained moderate. However, in 8%, the WAS was poor already in baseline and decreased further throughout the study. Using logistic regression, the moderate/poor development was associated significantly with high body mass index (BMI), pack years, adult onset asthma, physically strenuous work, number of co-morbidities, especially in psychiatric conditions, hypertension, and gastroesophageal reflux disease (GERD). When the model was adjusted for age and gender, adulthood onset of asthma and pack years lost their significance. Based on medication (high dose of inhaled corticosteroids (ICS) and second controller in use), 8% of the patients had severe asthma.

Conclusion: In the great majority of middle-aged asthma patients WAS remained stable throughout the follow-up period. However, 8% of the patients, who had more severe asthma and multiple co-morbidities, showed significantly poorer outcomes.

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Introduction

Even though asthma is considered as a common, non-progressive, easy to treat disease, it presents a major public health concern as its prevalence has been growing among working age people in all industrialized countries, being 10% in Finland (1,2). The relationship between asthma and work is complex. Work related asthma symptoms are common but occupational asthma is seldom confirmed. Poorly treated or unstable asthma can also prevent the employee to fully perform their job-related duties. Overall, asthma usually has a negative impact on work productivity

(3) which is one reason for the high economic burden of the disease (4).

Work disability is common among asthmatics (5–9). Disability pension and long-term sickness absence are the most serious outcomes, while loss of work days, job changes and limitation in job duties due to respiratory symptoms represent milder forms of the disability. In previous studies both work and disease related factors, like occupational exposures and the severity of disease, have shown to increase the risk of work disability (5–8,10,11). Asthma is often a contributing factor in decreased work ability, but

seldom the main or only reason. In 2015, only 0.4% of all disability pensions in Finland were due to asthma (12). After all, personal and psychosocial factors determine how a person experiences their disease and ability to work, i.e., there is a difference between having a chronic disease and being disabled (13).

Work ability is a multidimensional concept and its weakening is important to recognize early. Subjective assessment has shown to be valuable in predicting possible future disabilities. Work Ability Score (WAS) is a self-reported, simple and validated measurement for work ability. It is scored from 0 (completely unable to work) to 10 (work ability at its best) and belongs to the widely used and validated survey instrument, called Work Ability Index (WAI) (14).

The aim of our study was to examine the development of the WAS among middle aged asthmatics in a longitudinal setting. The baseline characteristics were used to find asthma and other health related risk factors for poor development of WAS. Self-reported work life participation and WAS were requested six times over a 10-year follow-up. A further aim was to try to understand the association between WAS and health related quality of life-instruments; one asthma specific (AQ20 (15)) and one general (15D (16)).

Material and methods

Patient cohort

The study population represent a subpopulation of the Finnish Chronic Obstructive Airway Disease (CAD) cohort. The cohort enrolled through the Pulmonary Clinics of Helsinki and Turku University Hospitals during the years 2005–2007 (17). The patients were identified using ICD10 code J44.8 or J45. All patients between 18 and 75 years of age were invited to join the study through a two-phase mailing campaign. Their asthma diagnosis, including lung function tests, age at onset, and possible co-morbidities, were carefully evaluated by a pulmonologist by using the participants' medical records from all health care providers (hospitals, health care centers, outpatient clinics) that had treated the patient during the past 5 years. Social security numbers were used to combine the records from different data sources. All patients had given their informed consent for data collection and analysis.

As a baseline, we evaluated 10 common co-morbidities: hypertension, hyperlipidemia, cardiovascular disease (including coronary, cerebrovascular, and peripheral arterial disease), diabetes type 1 and 2, alcohol abuse, psychiatric conditions, cancer, hypothyroidism, atrial fibrillation, gastroesophageal reflux disease (GERD) (18).

Except for cancer and alcohol abuse, the co-morbidity was considered only when the patient used regular medication in baseline. The number of these diseases were summed up to describe the extent of co-morbidities. Finnish reference values for FEV1 and FVC were used (19). Any cases of asthma that were diagnosed later than age 20 were defined as adult onset asthma.

Patient reported outcomes

Health related quality of life (HRQoL)

When enrolling, all participants visited a research nurse, gave their written consent, donated a blood sample for DNA extraction, and filled in two validated HRQoL instruments (year 0). The 15D instrument (16) measures general, and the AQ20 instrument (15) airway related HRQoL, respectively. The 15D score sums up the 15-dimensional description of patient health status and is scaled from 0 (being dead) to 1 (no problem with any dimension, full HRQoL). Meanwhile, the AQ20-instrument contains 20 items and a summary score ranges from 0 (no airway symptoms) to 20 (multiple airway symptoms). The patients were followed up prospectively via a questionnaire in years 1, 2, 4, 6, 8, and 10 (Supplementary document 1). The postal addresses were updated using population registry.

Work ability

In the work ability section of the questionnaire, we first investigated patients' current working status, whether they were working (full or part time) or not (disability pension, retired due to age, student, unemployed, maternity/paternity leave, other). The rest of the questions were addressed only for the patients working full or part time. The work was classified as physical, mental, or combination of both. Furthermore, the patients were requested to evaluate their current work ability compared to their lifetime best on scale 0 (completely unable to work) to 10 (work ability at its best) (Work Ability Score, WAS) (14). The sickness absences during the last 12 months were categorized as: not at all, 1–9 days, 10–24 days, 25–99 days, or 100–365 days.

Smoking

Based on the baseline smoking status, participants were classified as nonsmokers, current smokers, and former smokers. The pack years were calculated, as described elsewhere (17,20).

Asthma medication

A structured section regarding the participant's current asthma medication and doses was added to the

questionnaire from the fourth year onwards. For comparison of different inhaled corticosteroids (ICS), all products were transformed into fluticasone propionate dose equivalents using the following transformation: Fluticasone propionate (dry powder inhaler (DPI), hydrofluoroalkane (HFA)) 1 µg equals to Fluticasone furoate (DPI) 0.18 µg, to Ciclesonide (HFA) 0.64 µg, to Mometasone furoate 0.8 µg, to Beclometasone dipropionate (HFA) 0.8 µg, to Budesonide 1.28 µg, to Budesonide (DPI) 1.60 µg, and to Beclometasone 1.60 µg, respectively (21).

The patients who reported use of oral corticosteroids (OCS) for exacerbation of asthma were classified into five categories: not at all, once, twice, three, or more times during the last year. Use of short-acting beta agonists when needed were classified in six categories: not at all, once a week or less, two to four times per week, every day, at least two times per day, or acute symptoms treated by long-acting beta-agonists alone; use of antihistamines in three categories: not at all, one packet/10–12 pills, two or more packets during the last year; and use of nasal cortisones in three categories: not at all, one dispenser, two or more dispensers during the last year.

The definition of severe asthma was based on medication and ERS/ATS guidelines: high dose of ICS (F.propionate $\geq 1,000$ µg) and with at least one second controller such as leukotriene receptor antagonist, theophylline, cromones, OCS, or biological drug in use (22). Asthma test was not included in the questionnaire.

This study approach was approved by the Coordinating Ethics Committee of the Helsinki and Uusimaa Hospital District, with permission to conduct this research granted by the Helsinki and Turku University Hospitals.

Statistical analysis

Statistical analysis of the data was carried out using IBM SPSS Statics for Mac, version 24.0 (SPSS Inc., Chicago, IL) and the R-package kmlShape version 0.9.5 (23,24). The data consisted of both continuous and categorical variables. The analysis of continuous variables were presented as means and standard deviations (SD), whereas categorical variables were shown as frequencies and percentages. For statistical comparisons, a Chi-squared test was conducted for categorical variables, and either a one-way-ANOVA or a Kruskal-Wallis test for continuous variables. If a significant difference was observed in the Kruskal-Wallis test, then a Mann Whitney U test was used for

pairwise comparison. All p values <0.05 were considered to be statistically significant.

To study the development of WAS over time, we computed the discrete Frechet distance (25), which describes the similarity between the shapes of WAS curves. Compared to some other approaches, it gives more conservative results, however, it has the advantage of not being harmed by the presence of missing values (26).

To assess risk factors for the potential of poor development of WAS, we used several baseline clinical characteristics of the patient cohort in logistic regression. We conducted both univariate, as well as age and gender adjusted multivariate, logistic regression analyses. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated.

The correlations between the WAS and HRQoL-instruments were analyzed using Spearman's correlation. The correlation coefficients with 95% confidence intervals (95% CI) are shown.

Results

Patient characteristics

To be able to analyze the development of the WAS over time, we included in the study all the patients who had reported at least three out of six questionnaires while being actively employed ($N=529$) (Table 1). Only patients with asthma fulfilled the criteria. In the cohort, 82 patients reported their WAS 3 times, 99 patients 4 times, 142 patients 5 times, and 206 patients 6 times. In total, 310 patients had reported WAS in the follow up years 1 and 10. Response rates were good through the study period, decreasing gradually from 98.7% to 88.3%. The average follow-up time from enrollment to last questionnaire or to death/withdrawal was 9.7 years (SD 1.2).

At baseline, the average age in the asthma cohort was 46 years (range 21–70), and the majority of patients were women (77%) (Table 1). Their lung functions were within normal range (mean FEV1 91.4% of predicted). On average, the study subjects were mildly overweight (mean BMI 26.3 kg/m²), and predominately had adult onset asthma (86.4%). Over half of the patients (55.6%) had at least one of the studied co-morbidities, most commonly psychiatric conditions (24.4%), hypertension (17.4%), and GERD (17.4%). The majority of the patients reported never smoking (54%), while 14% smoked daily. Of all participants, 52.9% reported doing predominantly mental work. One person died during the follow-up.

Table 1. Comparison of patients' baseline characteristics across the work ability groups.

Variable	Patients in total N = 529	Patient groups according to their work ability				p	Missing N (%)
		Group1 Excellent N = 168	Group2 Good N = 194	Group3 Moderate N = 126	Group4 Poor N = 41		
Men	121 (22.9)	43 (25.6)	42 (21.6)	30 (23.8)	6 (14.6)	0.47	0 (0)
Women	408 (77.1)	125 (74.4)	152 (78.4)	96 (76.2)	35 (85.4)		
Age, mean (SD)	45.8 (9.5)	42.4 (9.7)	46.3 (9.3)	49.2 (9.1)	47.3 (6.4)	<0.001	0 (0)
BMI, mean (SD)	26.3 (5.4)	24.7 (4.9)	26.0 (4.8)	27.6 (5.9)	29.3 (6.5)	<0.001	73 (13.8)
15D score, mean (SD)	0.91 (0.08)	0.95 (0.05)	0.92 (0.07)	0.86 (0.08)	0.86 (0.09)	<0.001	29 (5.5)
AQ20 score, mean (SD)	5.6 (4.1)	3.6 (3.0)	5.3 (3.6)	7.7 (4.4)	8.4 (4.7)	<0.001	2 (0.4)
FEV1% of predicted, mean (SD)	91.4 (14.2)	92.5 (14.7)	91.4 (16.8)	89.7 (12.9)	91.7 (12.0)	0.49	67 (12.7)
Diagnosis age of asthma, mean (SD)	35.7 (13.9)	30.7 (14.4)	37.1 (12.7)	39.1 (14.0)	39.6 (11.1)	<0.001	5 (0.9)
<20	67 (12.7)	36 (21.4)	17 (8.8)	12 (9.5)	2 (4.9)	<0.001	
≥20	457 (86.4)	130 (77.4)	174 (89.7)	114 (90.5)	39 (95.1)		
Smoking							
Never smoker	285 (53.9)	98 (58.3)	105 (54.1)	57 (45.2)	25 (61.0)	0.21	14 (2.6)
Former smoker	156 (29.5)	41 (24.4)	59 (30.4)	47 (37.3)	9 (22.0)		
Current smoker	74 (14.0)	25 (14.9)	24 (12.4)	18 (14.3)	7 (17.1)		
N of deaths	1 (0.2)	0 (0)	0 (0)	0 (0)	1 (2.4)		0 (0)
Co-morbidities							
Psychiatric condition	129 (24.4)	21 (12.5)	46 (23.7)	44 (34.9)	18 (43.9)	<0.001	5 (0.9)
Hypertension	92 (17.4)	19 (11.3)	28 (14.4)	33 (26.2)	12 (29.3)	0.001	2 (0.4)
GERD	92 (17.4)	8 (4.8)	38 (19.6)	36 (28.6)	10 (24.4)	<0.001	0 (0)
Hyperlipidemia	67 (12.7)	11 (6.5)	31 (16.0)	18 (14.3)	7 (17.1)	0.04	0 (0)
Atrial fibrillation	48 (9.1)	15 (8.9)	13 (6.7)	15 (11.9)	5 (12.2)	0.39	0 (0)
Hypothyroidism	26 (4.9)	6 (3.6)	11 (5.7)	8 (6.3)	1 (2.4)	0.58	2 (0.4)
Cancer	17 (3.2)	3 (1.8)	5 (2.6)	7 (5.6)	2 (4.9)	0.26	1 (0.2)
Diabetes	10 (1.9)	1 (0.6)	4 (2.1)	2 (1.6)	2 (4.9)	0.26	0 (0)
Alcohol abuse	7 (1.3)	1 (0.6)	2 (1.0)	4 (3.2)	0	0.20	3 (0.6)
CVD	6 (1.1)	1 (0.6)	3 (1.5)	1 (0.8)	1 (2.4)	0.69	0 (0)
Co-morbidities per patient, mean	0.95 (1.09)	0.51 (0.85)	0.96 (1.00)	1.34 (1.21)	1.46 (1.27)	<0.001	0 (0)
Work type							
Mental	280 (52.9)	93 (55.4)	111 (57.2)	60 (47.6)	16 (39.0)	0.03	46 (8.7)
Physical	28 (5.3)	5 (3.0)	7 (3.6)	12 (10.6)	4 (9.8)		
Combination	175 (33.1)	53 (31.5)	62 (32.0)	41 (36.3)	19 (46.3)		

Data is presented as *n* (%) unless otherwise stated. SD = Standard Deviation; BMI = Body mass index; 15D = 15-dimensional, general HRQoL instrument; AQ20 = Airway Questionnaire 20, disease specific HRQoL instrument; FEV1 = Forced expiratory volume in 1 s; GERD = Gastro Esophageal Reflux Disease; CVD = Cardio Vascular Diseases.

p values shows statistical significance for differences found in comparisons between all four identified clusters.



Figure 1. Middle-age asthma patients' work ability development during 10-year follow-up. Four groups identified based on patients' longitudinal Work Ability Scores.

Identification of patients with differently developing WAS over time

To study the development of the patient's WAS trend over time we used the Frechet distance (25). By

manual inspection of the average WAS behaviors inside the clusters, a suitable number of clusters was chosen to be four. In three out of four clusters the trajectories were stable through-out the follow-up period with either excellent, good, or moderate WAS trends. In the fourth group WAS was poor from the beginning and decreased further during the follow-up period (Figure 1, Table 1). The number of missing values did not differ between the clusters.

Group 4, with the poorest WAS trend, most frequently had adult onset asthma, the highest BMI, poorest HRQoL, and the highest number of co-morbidities (especially psychiatric disorders). However, they showed no differences in smoking habits when compared to the other groups (Table 1).

Prediction of risk factors for poorly developing WAS

To analyze the potential risk factors for poor development of WAS, logistic regression was applied using multiple baseline clinical characteristics as predictors.

Table 2. The relation of clinical characteristics with of poor work ability and poor or moderate work ability among asthma patients during 10 year follow -up. Odds Ratios (OR) and 95% CI of the clinical characteristics explaining decreased WAS.

	Risk of having							
	Poor work ability (Group 4 vs Groups 1, 2, and 3)				Either moderate or poor work ability (Groups 3 and 4 vs. Groups 1 and 2)			
	Crude model		Adjusted model ^a		Crude model		Adjusted model ^a	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Baseline age	1.02 (0.98–1.05)	0.31			1.05 (1.03–1.07)	<0.001		
Men gender	0.56 (0.23–1.36)	0.20			0.90 (0.58–1.39)	0.62		
Increase of BMI (kg/m ²)	1.10 (1.04–1.16)	<0.001	1.09 (1.04–1.15)	0.001	1.09 (1.05–1.13)	<0.001	1.08 (1.04–1.12)	<0.001
Adult onset asthma ^b	3.03 (0.71–12.8)	0.13	2.66 (0.60–11.72)	0.20	1.91 (1.03–3.54)	0.04	1.23 (0.64–2.38)	0.54
FEV1% of predicted	1.00 (0.98–1.02)	0.88	1.00 (0.98–1.03)	0.76	0.99 (0.98–1.01)	0.27	1.00 (0.98–1.01)	0.62
Smoking								
Pack years	0.98 (0.94–1.02)	0.33	0.98 (0.94–1.02)	0.31	1.02 (1.01–1.04)	0.01	1.02 (1.00–1.03)	0.06
Current smoker ^c	1.09 (0.45–2.62)	0.85	1.10 (0.46–2.66)	0.83	1.26 (0.73–2.18)	0.40	1.30 (0.75–2.28)	0.35
Former smoker ^c	0.64 (0.29–1.40)	0.26	0.63 (0.28–1.40)	0.26	1.39 (0.92–2.10)	0.12	1.24 (0.81–1.91)	0.32
Co-morbidities								
Co morbidities per patient	1.50 (1.16–1.93)	0.002	1.46 (1.11–1.91)	0.01	1.67 (1.41–1.99)	<0.001	1.54 (1.28–1.84)	<0.001
Psychiatric conditions	2.62 (1.37–5.04)	0.004	2.42 (1.24–4.70)	0.01	2.59 (1.72–3.91)	<0.001	2.37 (1.55–3.12)	<0.001
Hypertension	2.10 (1.03–4.29)	0.04	1.93 (0.91–4.08)	0.09	2.46 (1.55–3.89)	<0.001	1.90 (1.18–3.06)	0.01
GERD	1.60 (0.75–3.39)	0.22	1.51 (0.71–3.24)	0.29	2.61 (1.65–4.13)	<0.001	2.34 (1.46–3.75)	<0.001
Atrial fibrillation	1.44 (0.54–3.85)	0.47	1.35 (0.50–3.62)	0.56	1.62 (0.89–2.97)	0.12	1.55 (0.83–2.88)	0.17
CVD	2.42 (0.28–21.18)	0.43	2.00 (0.23–17.66)	0.54	1.09 (0.20–5.98)		0.85 (80.15–4.76)	0.85
Hypothyroidism	0.46 (0.06–3.49)	0.45	0.39 (0.05–2.95)	0.36	1.15 (0.50–2.64)	0.74	0.99 (0.42–2.32)	0.98
Diabetes	3.08 (0.63–14.99)	0.16	2.92 (0.59–14.43)	0.19	1.46 (0.41–5.23)	0.57	1.65 (0.45–6.13)	0.45
Cancer	1.66 (0.36–7.52)	0.51	1.50 (0.32–6.94)	0.60	2.54 (0.96–6.70)	0.06	1.82 (0.68–4.90)	0.24
Work type								
Physical ^d	2.75 (0.85–8.88)	0.09	2.87 (0.88–9.36)	0.08	3.58 (1.62–7.91)	0.002	3.62 (1.61–8.64)	0.002
Combination ^d	2.01 (1.00–4.02)	0.049	1.76 (0.87–3.56)	0.12	1.40 (0.93–2.11)	0.11	1.25 (0.82–1.90)	0.31

^aRegression model was adjusted for age and gender.^bChildhood onset asthma referent.^cNever smoker referent.^dMental work referent.

BMI = Body mass index; FEV1 = Forced expiratory volume in 1 s; GERD = Gastro Esophageal Reflux Disease; CVD = Cardio Vascular Diseases.

First, we compared the poorest performing group 4 to the best groups 1, 2, and 3. We then, compared the two poorest performing groups, 3 and 4, to the two best performing groups, 1 and 2 (Table 2).

In the univariate analysis, the poor WAS trend (group 4) was significantly associated with psychiatric conditions, hypertension, combination of mental and physical work load, number of co-morbidities and BMI. Physical work increased the risk of belonging to the poor or moderate WAS groups nearly fourfold. In addition, poor and moderate WAS trends were associated significantly with GERD, adult onset asthma, age

and pack years. When the model was adjusted for age and gender, hypertension and the combination of mental and physical work load lost significance in the first model, while adult onset asthma and pack years lost significance in the latter.

Association of work history, retirement rates, sick days, and severity of asthma to work ability

In all clusters, the majority of patients had full time jobs in baseline (Table 3). However, part time jobs were more common in the two poorest clusters (21/

Table 3. Patients' work status at baseline and changes during the follow-up.

Variable	Patients in total N = 529	Patient groups according to their work ability				p
		Group1 Excellent N = 168	Group2 Good N = 194	Group3 Moderate N = 126	Group4 Poor N = 41	
Work status at baseline						
Full time job	442 (83.6)	142 (84.5)	171 (88.1)	98 (77.8)	31 (75.6)	0.045
Part time job	38 (7.2)	9 (5.4)	8 (4.1)	15 (11.9)	6 (14.6)	0.01
Unemployed	6 (1.2)	2 (1.2)	2 (1.1)	2 (1.6)	0	
Retired due to age	1 (0.2)	0	0	1 (0.8)	0	
Maternity/paternity leave	5 (1.0)	3 (1.8)	1 (0.5)	1 (0.8)	0	
Student	8 (1.5)	5 (3.0)	2 (1.0)	1 (0.8)	0	
Other	17 (3.2)	5 (3.0)	5 (2.6)	4 (3.2)	3 (7.3)	
Data missing	12 (2.3)	2 (1.2)	5 (2.6)	4 (3.2)	1 (2.4)	
Work changes during the follow-up						
Retired due to age	93 (18.3)	18 (10.7)	40 (20.6)	30 (26.2)	5 (14.6)	0.01
Retired due to disability	19 (3.4)	2 (1.2)	3 (2.6)	6 (4.8)	8 (19.5)	<0.001
Unemployed at least once	33 (6.2)	10 (6.0)	11 (5.7)	11 (8.7)	1 (2.4)	0.48
Mean retirement age of						
old age pension (SD)	65.2 (2.2)	65.9 (2.3)	65.2 (2.0)	65.0 (2.5)	63.8 (1.3)	0.23
disability pension (SD)	59.3 (5.4)	60.0 (4.2)	60.3 (5.5)	62.8 (4.7)	56.1 (5.0)	0.17
Mean sick days per year during follow-up period						
0–9 days	297 (56.1)	131 (78.0)	117 (60.3)	45 (35.7)	4 (9.8)	<0.001
10–24 days	165 (31.2)	31 (18.5)	65 (33.5)	55 (43.7)	14 (34.1)	
25–99 days	64 (12.1)	6 (3.6)	12 (6.2)	26 (20.6)	20 (48.8)	
>99	3 (0.6)	0	0	0	3 (7.3)	

Data is presented as *n* (%) unless otherwise stated. SD = Standard deviation.

p values shows statistical significance for differences found in comparisons between all four identified clusters.

167 vs. 17/306 vs. $p < 0.01$). During the follow-up, 19.5% (8/41) of the patients in Group 4 retired due to disability, which was a significantly higher proportion than the rest of the groups (30/488, $p < 0.001$). Similar trends were also found in the number of sick days. Over half of the patients in Group 4 (23/41), and 20.6% (26/126) of the patients in Group 3 had an average of >24 sick days per year throughout the follow-up, while only 5% (18/362) of patients in Groups 1&2 had as many sick days ($p < 0.001$).

We also compared the patients' reported data on their use of asthma medication in different WAS groups (Supplementary Table 1). Patients' current medication was reported from the fourth follow-up year onwards. In the fourth follow-up year, 81.4% (407/500) of the patients used ICS, with their mean daily dose being 570 µg (SD 355) in fluticasone propionate equivalents. There were significantly more ICS (144/159 vs 273/341, $p = 0.003$), OCS (70/159 vs 76/341, $p < 0.001$), and LABA (99/159 vs 146/341 $p < 0.001$) users and ICS doses (682 vs 507 µg, $p < 0.001$) were higher in Groups 3 and 4 when compared to Groups 1 and 2. Based on medication, 7.6% (38/500) of all patients fulfilled the criteria of severe asthma. In Group 4 the corresponding proportion was 25% ($p < 0.001$). Use of antihistamines or nasal corticosteroids showed no difference between the clusters. When we evaluated the usage of the patients' asthma and allergy medication in the later follow-up years, no significant changes were detected in comparison to those reported in year 4 (data not shown).

Correlation between HRQoL and WAS results

At the baseline, general HRQoL (15D) was lower in three and four WAS groups (mean 0.86) than in WAS groups 1 and 2 (mean 0.93, $p < 0.001$). A similar association was observed in respiratory specific HRQoL scores (AQ20, 7.9 vs. 4.5, $p < 0.001$) (Table 1).

Both HRQoL-instruments had significant, but rather weak, correlation to WAS during the follow-up (Supplementary Table 2). The correlations were stronger between 15D and WAS (Spearman's $r = 0.61$ to 0.65) than between AQ20 and WAS (Spearman's $r = -0.43$ to -0.51).

Discussion

In the present longitudinal study, we followed the development of WAS trends of a cohort of 529 middle-aged asthma patients for 10 years. During the study 18.3% of the patients retired due to age and 3.4% due to disability. Six percent suffered unemployment at some point during the follow-up. Using Frechet distance clustering, we identified four clusters of patients whose WAS developed significantly differently. In two thirds of the cohort, the patients' WAS remained good or excellent throughout the follow-up period. In 24% of the patients WAS trend remained moderate but stable, while in 8%, WAS was poor already in baseline and decreased further throughout the study. Using logistic regression, moderate/poor development was associated significantly with high BMI, number of pack years, adult onset of asthma, number of co-morbidities, especially in psychiatric conditions,

hypertension, and GERD. Physically strenuous work was also a significant risk factor. When the model was adjusted for age and gender, adulthood onset of asthma and pack years lost their significance.

Even though asthma, as such, is a rare cause of disability pension (12), the results of our study agree with previous studies in suggesting that asthma severity is associated with decreased WAS (6,8,27). Based on self-reported medication, severe asthma (the use of high dose of ICS with at least one controller) was significantly more frequently observed among the poor and moderate WAS groups than in the groups with good to excellent WAS. However, asthma test was not included in the questionnaire and these results need to be interpreted with caution. As previous studies have reported, sick leave is found to be more common among asthma patients than healthy controls (9,28). Here we could also note significant differences between different asthma clusters. A small number of previous studies have compared unemployment in asthmatics and controls, but no significant difference has been found (9,29). In our study, the unemployment rate varied between the follow-up years from 1 to 2%, which was less than the unemployment rate in general among middle-aged Finns (6%) (30).

In the cohort, most of the patients (86%) had adult onset asthma, which is usually non-allergic, more severe and has generally poorer prognosis (31). Adult onset asthma is often associated with female sex, obesity, smoking, occupational exposures, chronic rhinosinusitis, stressful life events, and respiratory infections (31). A recent report on adult onset asthma showed an increased risk for work disability, with the risk being higher the later the asthma was diagnosed (32). In our study, we also found some evidence of increased risk, however, in the final adjusted model the effect was no longer significant. There is some evidence that smoking can have a negative influence on work ability (6,8,33). In this study the number of current smokers was small and no significant risk could be shown. Similarly, pack years seemed not to have clear association to the decreased work ability. The number of pack years was a significant risk factor for moderate-poor WA in the univariate model. However, the mean age of cluster 3 was higher than the other clusters, which explains the loss of significance in the adjusted model.

High physical work load has previously been associated with poor work ability and our study showed similar findings (34). Physical work increased the risk of moderate-poor work ability over 3.5 fold. The risk was, however, not significant when comparing only the poor work ability group to the other groups. This

was likely because the two poorest groups did not differ greatly regarding physical work. Asthmatics might experience respiratory symptoms due to physical work load more easily, leading to a decrease in work ability.

Co-morbid conditions have shown to increase the risk of long-term work disability among asthma patients (35). In our study, many of the comorbidities, which were shown to be important for the development of WAS, were over-weight related. Previous studies have shown that being overweight is an important risk factor for asthma, and lately, obesity related-asthma has been considered as a separate endotype of asthma (36,37). In general, obese and overweight asthmatics have more respiratory symptoms, worse asthma control, reduced HRQoL, and respond less favorably to asthma therapy, especially for ICS (36,38). BMI has shown to associate negatively with work ability in the general population and we found the same association among asthma patients. Overall, comorbidities play an important role in asthma severity and thus affect patient's work ability. Diagnosis of existing diseases and patient's comprehensive treatment is essential (39).

Several common pathophysiological mechanisms, such as high systemic levels of inflammatory mediators, have been reported to explain the association of asthma and depression (31,40). The presence of asthma and depression together increases the risk of work disability (35,41). In the present study, we combined all of the psychiatric conditions requiring medication. Depression, however, was the most common. We found that among asthma patients, psychiatric conditions were an independent risk factor for poor WAS trend. In contrast, the prevalence of type 2 diabetes did not explain the poor development of WAS in any tested models. The patients' reported general HRQoL correlated better with WAS than the respiratory disease specific HRQoL. This further suggests that often asthma-related co-morbidities have a significant role in the development of the symptoms experienced by a patient.

Our study design had both prospective (patient reported outcomes) and retrospective (medical history) elements. The patients did not go through a clinical examination, but their baseline health status was reviewed based on comprehensive medical records. For all of them a pulmonologist verified the asthma diagnosis. The response rate remained high throughout the follow-up period of 10 years. We used validated questionnaires that were well suited for epidemiological studies. Due to study design we were not able to use multidimensional WAI as a final outcome measure. Although the WAI-instrument is often used in occupational health care and research to assess work ability of

employee, prior studies have shown that single-item WAS predicts the future work disability almost as well (42–44). This study has some limitations related to type of asthma. First, occupational asthma could not be evaluated because potential work related exposures were not recorded. Second, the evaluation of allergy was based on medication and we did not have data from allergy tests (e.g., prick test, IgE test). In addition, quality of work and sick leaves were based on self-reported questions, which is another limitation of the study.

Conclusion

In conclusion, more than 90% of middle-aged asthma patients' WAS remained stable throughout the 10-year follow-up period, but in less than 10% of the patients, who had either more severe asthma or common comorbidities, significantly poorer outcomes were recorded. To support these patients' work ability, comprehensive treatment of asthma and co-existing chronic diseases, as well as weight management, are needed.

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Declaration of interest

The authors report no conflict of interest.

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Supplementary Table 1. Patient's asthma and allergy medication at the fourth follow-up year when medication was required first time. In total 500 patients returned the questionnaire this follow-up year.

Variable	Patients in total N=500	Patient groups according to their work ability				p
		Group1 Excellent N = 160	Group2 Good N = 181	Group3 Moderate N=119	Group4 Poor N=40	
Users of ICS						0.006
yes	407 (81.4)	117 (73.1)	146 (80.7)	105 (88.2)	39 (97.5)	
no	91 (18.2)	42 (26.3)	34 (18.8)	14 (11.8)	1 (2.5)	
unknown	2 (0.4)	1 (0.6)	1 (0.6)	0 (0.0)	0 (0.0)	
Mean used dose of ICS ¹ (µg)	570 (355)	475 (254)	532 (319)	641 (370)	785 (522)	<0.001
Users of LAMA	6 (1.2)	0 (0)	1 (0.6)	4 (3.4)	1 (2.5)	0.05
Users of LABA	245 (49.0)	59 (36.9)	87 (48.1)	68 (57.1)	31 (77.5)	<0.001
Users of other controllers ²	120 (24.0)	20 (12.5)	46 (25.4)	33 (27.7)	21 (52.5)	<0.001
Classified as having severe asthma based on medication ³	38 (7.6)	3 (1.9)	11 (6.1)	14 (11.8)	10 (25.0)	<0.001
Use of SABA						0.11
not at all	149 (29.8)	60 (37.5)	52 (28.7)	30 (25.2)	7 (17.5)	
once a week	215 (43.0)	64 (40.0)	86 (47.5)	50 (42.0)	15 (37.5)	
2-4 times per week	45 (9.0)	16 (10.0)	10 (5.5)	13 (10.9)	6 (15.0)	
at least once a day	25 (5.0)	6 (3.8)	6 (3.3)	10 (8.4)	3 (7.5)	
at least twice a day	17 (3.4)	4 (2.5)	5 (2.8)	5 (4.2)	3 (7.5)	
acute symptoms treated by long acting asthma medicine	26 (5.2)	6 (3.8)	10 (5.5)	6 (5.0)	4 (10.0)	
data missing	23 (4.6)	4 (2.5)	12 (6.6)	5 (4.2)	2 (5.0)	
Use of p.o. cortisone during the last year						<0.001
not at all	339 (67.8)	125 (78.1)	130 (71.8)	72 (60.5)	12 (30.0)	
once	65 (13.0)	16 (10.0)	25 (13.8)	16 (13.4)	8 (20.0)	
twice	39 (7.8)	10 (6.3)	11 (6.1)	13 (10.9)	5 (12.5)	
three or more times	42 (8.4)	4 (2.5)	10 (5.5)	14 (11.8)	14 (35.0)	
data missing	15 (3.0)	5 (3.1)	5 (2.8)	4 (3.4)	1 (2.5)	
Use of antihistamines during the last year						0.22
not at all	124 (24.8)	42 (26.3)	42 (23.2)	33 (27.7)	7 (17.5)	
10-12 pills	123 (24.6)	45 (28.1)	46 (25.4)	27 (22.7)	5 (12.5)	
>10-12pills	238 (47.6)	68 (42.5)	86 (47.5)	56 (47.1)	28 (70.0)	
data missing	15 (3.0)	5 (3.1)	7 (3.9)	3 (2.5)	0 (0)	
Use of nasal antihistamines/ corticosteroids during the last year						0.13
not at all	208 (41.6)	81 (50.6)	74 (40.9)	39 (32.8)	14 (35.0)	
one dispenser	135 (27.0)	35 (21.9)	50 (27.6)	37 (31.1)	13 (32.5)	
two or more dispensers	143 (28.6)	38 (23.8)	51 (28.2)	41 (34.5)	13 (32.5)	
data missing	14 (2.8)	6 (3.8)	6 (3.3)	2 (1.7)	0 (0.0)	

¹ ICS dose reported as Fluticasone Propionate equivalents. ² users of leukotriene receptor antagonists, theophyllines, cromones, OCS and/or biological drugs. ³ high dose of ICS and second controller in use.

ICS=inhaled corticosteroids; LAMA= long acting muscarinic antagonist; LABA=Long acting beta agonist; SABA=Short acting beta agonist; p.o.= per os.

P value shows statistical significance for differences found in comparisons between all four identified clusters.

Supplementary Table 2. Correlation between Work Ability Score (WAS) and instruments of health related quality of life (HRQoL; 15D^a, AQ20^b) during the different follow-up years.

	Correlation coefficient	p	Missing
WAS – 15D			
Follow-up 1	0.61	<0.001	78 (14.8)
Follow-up 2	0.65	<0.001	73 (13.8)
Follow-up 4	0.64	<0.001	70 (13.2)
Follow-up 6	0.63	<0.001	126 (23.8)
Follow-up 8	0.64	<0.001	165 (31.2)
Follow-up 10	0.60	<0.001	204 (38.6)
WAS – AQ20			
Follow-up 1	-0,43	<0.001	51 (9.6)
Follow-up 2	-0.47	<0.001	44 (8.3)
Follow-up 4	-0.51	<0.001	68 (12.9)
Follow-up 6	-0.48	<0.001	102 (19.3)
Follow-up 8	-0.44	<0.001	145 (27.4)
Follow-up 10	-0.46	<0.001	205 (38.8)
15D – AQ20			
Follow-up 1	-0.57	<0.001	43 (8.1)
Follow-up 2	-0.62	<0.001	47 (8.9)
Follow-up 4	-0.61	<0.001	36 (6.8)
Follow-up 6	-0.59	<0.001	65 (12.3)
Follow-up 8	-0.59	<0.001	83 (15.7)
Follow-up 10	-0.59	<0.001	83 (15.7)

WAS=Work Ability Score; 15D=15 dimensional, general HRQoL instrument; AQ20=Airway Questionnaire 20, disease specific HRQoL instrument.

Questionnaire (translated from Finnish to English)

1.QUALITY OF LIFE QUESTIONNAIRE (15D©)(1)

Please read through all the alternative responses to each question before placing a cross (x) against the alternative which best describes **your present health status**. Continue through all 15 questions in this manner, giving only **one** answer to each.

QUESTION 1. MOBILITY

- 1 () I am able to walk normally (without difficulty) indoors, outdoors and on stairs.
- 2 () I am able to walk without difficulty indoors, but outdoors and/or on stairs I have slight difficulties.
- 3 () I am able to walk without help indoors (with or without an appliance), but outdoors and/or on stairs only with considerable difficulty or with help from others.
- 4 () I am able to walk indoors only with help from others.
- 5 () I am completely bed-ridden and unable to move about.

QUESTION 2. VISION

- 1 () I see normally, i.e. I can read newspapers and TV text without difficulty (with or without glasses).
- 2 () I can read papers and/or TV text with slight difficulty (with or without glasses).
- 3 () I can read papers and/or TV text with considerable difficulty (with or without glasses).
- 4 () I cannot read papers or TV text either with glasses or without, but I can see enough to walk about without guidance.
- 5 () I cannot see enough to walk about without a guide, i.e. I am almost or completely blind.

QUESTION 3. HEARING

- 1 () I can hear normally, i.e. normal speech (with or without a hearing aid).
- 2 () I hear normal speech with a little difficulty.
- 3 () I hear normal speech with considerable difficulty; in conversation I need voices to be louder than normal.
- 4 () I hear even loud voices poorly; I am almost deaf.
- 5 () I am completely deaf.

QUESTION 4. BREATHING

- 1 () I am able to breathe normally, i.e. with no shortness of breath or other breathing difficulty.
- 2 () I have shortness of breath during heavy work or sports, or when walking briskly on flat ground or slightly uphill.
- 3 () I have shortness of breath when walking on flat ground at the same speed as others my age.
- 4 () I get shortness of breath even after light activity, e.g. washing or dressing myself.
- 5 () I have breathing difficulties almost all the time, even when resting.

QUESTION 5. SLEEPING

- 1 () I am able to sleep normally, i.e. I have no problems with sleeping.
- 2 () I have slight problems with sleeping, e.g. difficulty in falling asleep, or sometimes waking at night.
- 3 () I have moderate problems with sleeping, e.g. disturbed sleep, or feeling I have not slept enough.
- 4 () I have great problems with sleeping, e.g. having to use sleeping pills often or routinely, or usually waking at night and/or too early in the morning.
- 5 () I suffer severe sleeplessness, e.g. sleep is almost impossible even with full use of sleeping pills, or staying awake most of the night.

QUESTION 6. EATING

- 1 () I am able to eat normally, i.e. with no help from others.
- 2 () I am able to eat by myself with minor difficulty (e.g. slowly, clumsily, shakily, or with special appliances).
- 3 () I need some help from another person in eating.
- 4 () I am unable to eat by myself at all, so I must be fed by another person.
- 5 () I am unable to eat at all, so I am fed either by tube or intravenously.

QUESTION 7. SPEECH

- 1 () I am able to speak normally, i.e. clearly, audibly and fluently.
- 2 () I have slight speech difficulties, e.g. occasional fumbling for words, mumbling, or changes of pitch.
- 3 () I can make myself understood, but my speech is e.g. disjointed, faltering, stuttering or stammering.
- 4 () Most people have great difficulty understanding my speech.
- 5 () I can only make myself understood by gestures.

QUESTION 8. EXCRETION

- 1 () My bladder and bowel work normally and without problems.
- 2 () I have slight problems with my bladder and/or bowel function, e.g. difficulties with urination, or loose or hard bowels.
- 3 () I have marked problems with my bladder and/or bowel function, e.g. occasional 'accidents', or severe constipation or diarrhea.
- 4 () I have serious problems with my bladder and/or bowel function, e.g. routine 'accidents', or need of catheterization or enemas.
- 5 () I have no control over my bladder and/or bowel function.

QUESTION 9. USUAL ACTIVITIES

- 1 () I am able to perform my usual activities (e.g. employment, studying, housework, free- time activities) without difficulty.
- 2 () I am able to perform my usual activities slightly less effectively or with minor difficulty.
- 3 () I am able to perform my usual activities much less effectively, with considerable difficulty, or not completely.
- 4 () I can only manage a small proportion of my previously usual activities.

5 () I am unable to manage any of my previously usual activities.

QUESTION 10. MENTAL FUNCTION

1 () I am able to think clearly and logically, and my memory functions well

2 () I have slight difficulties in thinking clearly and logically, or my memory sometimes fails me.

3 () I have marked difficulties in thinking clearly and logically, or my memory is somewhat impaired.

4 () I have great difficulties in thinking clearly and logically, or my memory is seriously impaired.

5 () I am permanently confused and disoriented in place and time.

QUESTION 11. DISCOMFORT AND SYMPTOMS

1 () I have no physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.

2 () I have mild physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.

3 () I have marked physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.

4 () I have severe physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.

5 () I have unbearable physical discomfort or symptoms, e.g. pain, ache, nausea, itching etc.

QUESTION 12. DEPRESSION

1 () I do not feel at all sad, melancholic or depressed.

2 () I feel slightly sad, melancholic or depressed.

3 () I feel moderately sad, melancholic or depressed.

4 () I feel very sad, melancholic or depressed.

5 () I feel extremely sad, melancholic or depressed.

QUESTION 13. DISTRESS

1 () I do not feel at all anxious, stressed or nervous.

2 () I feel slightly anxious, stressed or nervous.

3 () I feel moderately anxious, stressed or nervous.

4 () I feel very anxious, stressed or nervous.

5 () I feel extremely anxious, stressed or nervous.

QUESTION 14. VITALITY

1 () I feel healthy and energetic.

2 () I feel slightly weary, tired or feeble.

3 () I feel moderately weary, tired or feeble.

4 () I feel very weary, tired or feeble, almost exhausted.

5 () I feel extremely weary, tired or feeble, totally exhausted.

QUESTION 15. SEXUAL ACTIVITY

1 () My state of health has no adverse effect on my sexual activity.

2 () My state of health has a slight effect on my sexual activity.

3 () My state of health has a considerable effect on my sexual activity. 4 () My state of health makes sexual activity almost impossible.

5 () My state of health makes sexual activity impossible.

2. Medication (Note! All new products on the market are added each year.)

2.1 My regular lung medicines at the moment. Please circle the right strength and write your daily dose (inhalation/tablets per day).

1. Inhaled long acting bronchodilators

Product	Strength		Inhalations per day
1. Serevent	25	50	
2. Oxis	6	12	
3. Foradil	12		
4. Formoterol	12		
5. Spiriva	2,5	18	
6. Cycloterol	12		
7. Fomeda	12		
8. Formaxa	12		
9. Onbrez	150	300	
10. Striverdi	2.5		
11. Eklira	322		
12. Seebri	44		

2. Inhaled corticosteroids

Product	Strength					Inhalations per day
1. Pulmicort	100	200	250	400		
2. Novopulmon	200	400				
3. Aerobec	50	100				
4. Beclomet	200	400				
5. Flixotide	100	125	200	250	500	
6. Alvesco	80	160				
7. Asmanex	200	400				
8. Budesonid	100	200	400			
9. Budesonide	250					
10. Flutide	250					

3. Inhaled combination therapy

Product	Strength						Inhalations per day
1. Seretide	25/50	25/125	25/250	50/100	50/250	50/500	
2. Symbicort turbuhaler	xx						
3. Symbicort turbuhaler Forte	xx						
4. Symbicort turbuhaler Mite	xx						
5. Innovair	100/6						
6. Bufomix	160/4,5	320/9					
7. Relvar	92/22	184/22					
8. Flutiform	50/5	125/5	250/10				
9. Ultibro	85/43						

4. Leukotriene receptor antagonist

Product	Strength	Tablet(s) per day
1. Singulair/Montelukast/Astecon	10 mg	
2. Accolate	20mg	

5. Theophylline

Product	Strength			Tablet(s) per day
1. Retafyllin	200mg	300mg		
2. Nuelin Depot	175mg	250mg	350mg	
3. Aminocont	225mg			
4. Daxas	500mg			

5. Cromons

Product	Strength	Inhalations per day
1. Tilade	2mg	
2. Lomudal	5mg	

7. My other regular medicines (write freely) _____

2.2 When required (PRN) medicines, treatment of exacerbations and support medicines for asthma.

1. **Have you used short acting bronchodilators during the last year?** (products like: Airomir®, Atrodual®, Atrovent®, Atrovent Comp®, Bricanyl®, Buventol®, Ipramol®, Ipraxa®, Ipratropiumbromid®, Salbuvent®, Salipra®, Ventilastin®, Ventoline®)
☐ not at all
☐ on average once a week or less
☐ on average 2-4 times per week
☐ on average once a day
☐ on average at least two times per day
☐ I treat acute symptoms by using long acting beta agonist or combination medication (like products: Serevent®, Seretide®, Foradil®, Formoterol®, Oxis®, Symbicort®)
2. **Have you used oral corticosteroids for the worsening of asthma or COPD during the last year?** (products like: Medrol®, Prednisolon®, Prednison®)
☐ not at all
☐ once
☐ twice
☐ more than two times
3. **Have you used antihistamines during the last year?** (products like Aeries®, Alzyr®, Benadryl®, Cetimax®, Cetirizin®, Clarityn®, Gardex®, Geklimon®, Heinix®, Histanova®, Histec®, Histadin®, Kestine®, Kestox®, Levazyr®, Loratadin®, Revitelle®, Senirex®, Siterin®, Telfast®, Tuulix®, Xyzal®, Zyrtec®, Aerinaze®, Cirrus®, Clarinase®, Duact®)
☐ not at all
☐ yes, one packet (10-12 pills)
☐ yes, two or more packets
4. **Have you used nasal cortisone sprays, powders or drops for the treatment of rhinitis during the last year?** (products like Avamys®, Beclonasal®, Beconase®, Flixonase®, Nasacort®, Nasofan®, Nasonex®, Rhinocort®)
☐ not at all
☐ yes, one dispenser
☐ yes, two or more dispensers
5. **Have you used nasal cromones/antihistamines for the treatment of rhinitis during the last year?** (products like Glinor®, Lastin®, Livostin®, Lomudal®)
☐ not at all
☐ yes, one dispenser
☐ yes, two or more dispensers

3. Health related work ability

3.1 I am currently

- ☐ employed full time
- ☐ employed part time
- ☐ on a disability pension (go to question 4)
- ☐ an old-age pension (go to question 4)
- ☐ a full time student (go to question 4)
- ☐ unemployed (go to question 4)
- ☐ on maternity leave (go to question 4)
- ☐ having child care leave (go to question 4)
- ☐ other, what _____ (go to question 4)

3.2 Occupation or working duty _____

3.3 Are your main job requirements?

- ☐ mental
- ☐ physical
- ☐ combination of mental and physical

3.4 How is your current work ability compared with your life time best?

Assuming your work ability has got 10 points at its best, circle the score that you give for your current work ability.

0	1	2	3	4	5	6	7	8	9	10
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0 = unable to work

10 = work ability at its best

3.5 Sick leave days from gainful employment?

How many full days have you been away from work due to your health status (treatment and examination of any disease) in the last year (12 months)?

- ☐ not at all
- ☐ maximum 9 days
- ☐ 10-24 days
- ☐ 25-99 days
- ☐ 100-365 days

How many months have you been gainfully employed during the past 12 months?

- ☐ not at all
- ☐ 1-3 months
- ☐ 3-6 months
- ☐ 6-12 months

4.Smoking

4.1 Have you ever smoked regularly?

☐ never (go to question 5)

☐ I quit smoking

starting year _____

stopping year _____

☐ I still smoke

starting year _____

4.2 What and how much on average do you smoke or have you smoked?

☐ cigarettes _____ pcs/day

☐ cigar _____ pcs/day

☐ pipe _____ gr/week

☐ loose tobacco _____ gr/week

5.Shortness of breath

5.1 Which of the following statements describe best your current health?

☐ Shortness of breath occurs only under very heavy exertion

☐ Shortness of breath occurs only when rushing or uphill

☐ Because of shortness of breath, I have to walk slower than my age and stop sometimes when walking on a flat ground.

☐ Because of shortness of breath, I can only walk about 100m or few minutes before I have to stop.

☐ I have shortness of breath daily during normal activities, for example when I get dressed; I can't go out due to shortness of breath.

5.2 Chronic bronchitis

Have you had a cough where you bring up sputum/phlegm almost daily for at least 3 months a year?

☐ no

☐ yes

How long does the cough last?

☐ never as long as two consecutive years

☐ at least two consecutive years or more

6.The following questions refer to the effect of asthma or COPD in your daily life during the last month. (2)

Please, answer Yes or No or Does not apply for each item.

	yes	no	not apply
1. Do you cough often during the day?	☐	☐	☐
2. Does your chest trouble often make you feel restless?	☐	☐	☐
3. Does gardening make you breathless?	☐	☐	☐
4. Do you worry when going to a friend's house that there might be something there that will upset your chest?	☐	☐	☐
5. Do you get chest problems when you come into contact with strong smells, exhaust fumes, cigarette smoke, perfume etc?	☐	☐	☐
6. Does your partner find your chest trouble upsetting?	☐	☐	☐
7. Do you feel breathless when trying to sleep?	☐	☐	☐
8. Do you worry about the long term effects of the drugs you take for your chest trouble?	☐	☐	☐
9. Does getting emotionally upset make your chest trouble worse?	☐	☐	☐
10. Are there times when you have difficulty getting around the house because of your chest trouble?	☐	☐	☐
11. Does your chest problem make you breathlessness when you do things at work? (paid employment).	☐	☐	☐
12. Does walking upstairs make you breathless?	☐	☐	☐
13. Do you get breathless doing housework?	☐	☐	☐
14. Does your chest trouble make you go home sooner than others after a night out?	☐	☐	☐
15. Do you suffer from breathlessness when you laugh?	☐	☐	☐
16. Does your chest trouble often make you feel impatient?	☐	☐	☐
17. Do you think the fullness of your life is limited by your chest trouble?	☐	☐	☐
18. Do you feel drained after a cold because of your chest trouble?	☐	☐	☐
19. Do you have a feeling of chest heaviness?	☐	☐	☐
20. Do you worry a lot about your chest trouble?	☐	☐	☐

References

1. Sintonen H. 15D Instrument [Internet]. [cited 2017 Dec 11]. Available from: <http://www.15d-instrument.net/15d/>
2. Barley EA, Quirk FH, Jones PW. Asthma health status measurement in clinical practice: validity of a new short and simple instrument. *Respir Med.* 1998 Oct;92(10):1207–14.