



Early View

Original research article

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Chronic cough in Germany: results from a general-population survey

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Abstract

Background. Chronic cough (CC) which is defined ≥ 8 weeks is a common condition in clinical practice. However, estimates of prevalence and associated comorbidities in German adults and key subgroups of age and gender are lacking.

Methods. Cross-sectional study based on a representative panel of 15,020 adult subjects of the general population who completed the German National Health and Wellness Survey, reporting chronic cough and questions about comorbidities. Lifetime and 12-month prevalence are presented as unweighted estimates.

Results. The lifetime CC prevalence was 6.5% (range across age groups, 5.1% - 8.3%) and the 12-month prevalence was 4.9% (range 3.7 - 5.7%). The prevalence of diagnosed CC was 2.8% (range, 0.9 - 4.1%) and the prevalence of persons currently on any prescription to treat CC was 0.6% (range 0.2 - 1.4%). Respondents who experienced CC were 52.0 ± 17.0 years old, with a higher prevalence in those aged 50 years and older. Persons with CC had higher morbidity scores and were diagnosed with an increased number of comorbidities, most frequently diagnoses of the respiratory system (71.0%), followed by digestive tract (34.0%) disorders and sleep disorders (37.6%).

Conclusions. In a broadly representative sample of German adults, lifetime and 12-month prevalence of CC was greatest in current and former smokers and those older ≥ 50 years of age. Comorbidities are frequent and may complicate management of these patients.

Keywords. Cough; quality of life; population surveillance; burden of disease; cross-sectional studies; patient health questionnaire; epidemiology

Introduction

Cough is one of the most common symptoms for patients seeking care from primary care specialists, allergists, otolaryngologists, or pulmonologists.¹ While its exact characteristics are not always precisely defined,^{2,3} the importance of cough as a global clinical problem has led multiple societies to publish guidelines on its diagnosis and management.

The German Respiratory Society guideline for chronic cough (DGP) similar to other societies have categorised cough based upon its duration.⁴⁻⁶ Acute cough is present for less than 3 weeks and most often due to acute viral upper respiratory tract infection. A cough that has been present longer than 3 weeks is either sub-acute (up to 8 weeks) or chronic (CC, over 8 weeks).^{7,8}

CC negatively impacts quality of life directly due to the effect of cough on physical, social or psychological functioning or indirectly through associated comorbidities such as urinary incontinence, cough syncope and dysphonia leading to social isolation, depression, and difficulties in relationships.⁹

CC often manifests in association with comorbidities, such as asthma, gastroesophageal reflux disease (GERD), and upper airway cough syndrome (previously called post-nasal drip syndrome).¹⁰ Zeiger et al. reported that among specialist-diagnosed CC patients 44.1% exhibited GERD, 31.2% asthma, 24.3% obesity, 20.4% upper airway cough syndrome and 19.4% common cough complications.¹¹

Certain patients may continue to cough despite thorough investigation and treatment, in cases where no cause can be determined (termed unexplained chronic cough, idiopathic chronic cough) or when cough persists despite treatment of existing underlying conditions (refractory chronic cough).¹² Increased exposure of the sensory nerve terminals to chemical irritants (e.g., PGE₂, ATP) or excess mucus may have a role in triggering cough.¹³ Further, neuronal hypersensitivity of airway sensory nerves has been considered to cause cough as many patients report singing, laughing, changes in temperature or noxious smells to trigger bouts of cough.¹³

There are currently no treatments approved by the European Medicines Agency for the treatment of refractory or unexplained chronic cough. Given the prolonged nature, significant morbidity, and lack of effective treatments, unexplained and refractory CC remains an unmet medical need.

Very little is known of the natural history of CC.⁵ However, in recent years, substantial evidence on the epidemiology of CC has been collected.¹⁴ The lack of reliable data on the prevalence of chronic cough in Germany was noted as an important knowledge gap in the most recent German guideline.⁶ Prevalence data has been particularly lacking in the general population as many previously reported estimates of prevalence are derived from settings which require timely contact with a physician. A meta-analysis estimated that chronic cough could impact as much as 12% of the European population,¹⁵ there are some prevalence estimates as low as 4% in certain regions.¹⁶

Furthermore, as there is no ICD-10 code for CC, the affected population is difficult to identify and has not been well studied. Therefore, in view of novel therapeutic approaches for CC, there is a need to better understand its prevalence as well as the characteristics, comorbidities, and quality of life of these patients.

Thus, our study aimed to provide prevalence estimates for CC in Germany and to describe the characteristics, treatment patterns, health care resource use, and quality of life and health state patient-reported outcomes (PROs) of chronic cough respondents in these countries relative to general population adults who have not experienced chronic cough.

Methods

The National Health and Wellness Survey (NHWS; Kantar LLC, New York, USA) is a self-administered, internet-based questionnaire conducted annually in 12 regions in the world including Germany. This survey collects data regarding demographics, health and wellness history, healthcare utilization, and incorporates validated patient-reported health outcome instruments measuring quality of life, anxiety, depression, and work productivity and activity impairment. In Germany, roughly 15,000 adults (aged 18+) take part in the survey each year. Quota sampling, with strata by age and gender, is implemented to ensure that the demographic composition of the NHWS sample is representative of the adult German population. Comparisons between NHWS and other established country sources have been published previously.¹⁷⁻¹⁹ All translations from US English to German were provided by GlobalLexicon (London, UK) and reviewed by Kantar Health.

The protocol and questionnaire for the NHWS was reviewed and approved by the Pearl Institutional Review Board (IRB). All respondents were informed of study details and provided their consent to participate. Each respondent was assigned a unique, anonymous code, and no identifiable personal information was collected.

Study sample

To be included in the German 2020 NHWS, respondents had to be ≥ 18 years, able to read and write in German, state their age and gender. Potential respondents were recruited through an existing, general-purpose (i.e., not healthcare-specific) web-based survey panel. The 2020 NHWS, fielded in Germany between December 30, 2019 – April 20, 2020, utilized a targeted quota sampling of strata according to age and gender to ensure a demographic composition of the German adult population. A cross-sectional design was used to estimate disease prevalence and a case-control design for comparisons to describe respondents with chronic cough. Respondents with and without chronic cough were those answering, respectively, 'yes' and 'no' to the question: 'Have you experienced daily chronic cough for 8 weeks or longer within the past 12 months?' or 'Have you ever experienced daily chronic cough for 8 weeks or longer?' Those respondents were further asked if they have ever been diagnosed with chronic cough by a physician or are currently using a prescription medication to treat their chronic cough. No medications nor therapeutic class lists were provided as prompts.

Study measures

To obtain a systematic overview of disease history, respondents were presented a comprehensive list of terms (partly with explanations). For example, the list comprised sleep conditions, with the terms “insomnia, narcolepsy, sleep apnoea, sleep difficulties (other)”. Respondents were presented with the terms and asked to select those they have ever experienced, those experienced in the past year, and those for which they have received a diagnosis. The full list of terms are presented with results in [Table 1](#).

Health-related quality of life was measured, e.g., the Medical Outcomes Study 12-item Short Form Survey v2 (SF-12v2; Quality Metric, Lincoln, RI).^{20,21} SF-12v2 physical and mental health component summary scores were calculated with the mean score set at 50 and the SD at 10; higher scores represent better health. Anxiety was measured with the General Anxiety Disorder 7-item scale (GAD-7), which measures the severity of symptoms of generalized anxiety over the prior 2 weeks.²² Respondents were asked to rate the frequency of anxiety symptoms on a Likert scale ranging from 0 (not at all) to 3 (nearly every day), with scores ranging from 0 to 21. Depression was assessed with the Patient Health Questionnaire 9-item scale (PHQ-9).²³ Respondents were asked to rate the frequency of symptoms of depression in the last 2 weeks on a scale of 0 (not at all) to 3 (nearly every day).

Data analysis

Chronic cough prevalence was calculated as a proportion of the 15,020 German 2020 NHWS respondents and in demographic subgroups (male, female, age categories 18-29, 30-39, 40-49, 50-64, 65-74 and ≥ 75 years), and by smoking status (use of cigarettes or other tobacco products: never smoked, or current/former smoker).

CC prevalence estimates were defined as follows.

- Lifetime prevalence: Report ever having had a chronic cough (cough of ≥ 8 weeks)
- 12-month prevalence: Reporting of cough daily for ≥ 8 weeks in the past 12 months

Total and subgroup prevalence estimates by age, gender, smoking status, and geographic regions (South: Baden Wuerttemberg, Bavaria; East: Berlin, Brandenburg, Lower Saxony, Mecklenburg-Western Pomerania Saxonia, Saxonia-Anhalt, Thuringia; North: Bremen, Hamburg, Schleswig-Holstein; West: Hessen, North Rhine-Westphalia, Rhineland-Palatinate,

Saarland) were calculated as unweighted and weighted estimates. As a sensitivity analysis, weighting was applied post-data collection using the Horvitz-Thompson method to align sample with age and gender composition of the German adult population using data reported in the 2019/2020 International Data Base of the US Census Bureau.²⁴ As weighted values did not relevantly differ from the unweighted values, only the latter are presented in this publication.

Propensity scores were used to match NHWS respondents with chronic cough at a 1:3 ratio to respondents without CC. Propensity scores were calculated using age (as a continuous variable), gender, the NHWS Charlson Comorbidity Index modified to exclude chronic obstructive pulmonary disease (because it may contribute to chronic cough), marital status, household income, interaction term of marital status x household income. The interaction term was included as a reflection of socio-economic status, e.g., possible synergistic benefits from dual-income / partnered households, to control for the influence of an individual's ability to work irrespective of spousal income. Eligible controls were matched using a nearest neighbour approach on the logit with a caliper = 0.25.

Results are presented as either N (%) or mean (SD). Between-group comparisons were conducted using two-tailed independent samples t-tests (Welch's t-test for unequal variances) for analysis of continuous variables, or the chi-square tests for analysis of categorical variables. Respondents with CC in the past 12 months were compared to those without CC in terms of comorbidities and the named health-related quality of life scores.

Results were considered statistically significant at $p < .05$. All analyses were performed by Kantar Health LLC in SPSS (v.23), R (v.4.0.2) and/or SAS (v.9.4).

Results

Prevalence estimates

Out of the NHWS general population sample of 15,020 German respondents, 981 (6.5%) reported chronic cough at any time during their lifetime. Across all (adult) age groups, the lifetime prevalence ranged from 5.1 to 8.3% ($p < 0.001$) (Table 1). Past/present smokers reported a higher prevalence than non-smokers (8.0 versus 4.8%, $p < 0.001$). By the geographic region, prevalence rates ranged from 5.6 to 7.4% ($p = 0.008$) with prevalence highest in western Germany. The diagnosed prevalence 2.8% (range 0.9 to 4.1%, $p < 0.001$), and the current CC prescription medication user prevalence was 0.6% (range 0.2 to 1.4%, $p < 0.001$). The 12-month prevalence of CC in this sample was 4.9% (ranging from 3.7% to 5.7% across age groups, $p < 0.001$),

Respondent characteristics

Comparisons between respondents with and without chronic cough in the past 12 months are presented in Table 2. Matched respondents reporting CC were in average older than respondents without CC (52.1 ± 17.0 versus 51.8 ± 17.7 ; $p = 0.62$). The proportion of females was similar across groups (53.8% with CC and 56.3% without, $p = 0.240$). Differences between groups were noted for employment status (respondents with CC were less often employed), income (a similar proportion of respondents were in the middle income stratum but more respondents with CC were in the lower income stratum, $p < 0.001$), region and health insurance (see Table 2).

Current medical conditions and comorbidities. Table 3 provides an overview on diseases and conditions in last 12 months as reported by respondents. In terms of organ systems, persons with CC reported most frequently medical diagnoses of the respiratory system (71.0% vs 29.9%, $p < 0.001$), also diagnoses by the digestive tract, the heart and blood system and sleep disorders were more common than in persons without CC (Table 3).

Body mass index and comorbidity scores. Mean body mass index was slightly higher in respondents with CC compared to those without $27.9.0$ versus 27.0 kg/m^2 ($p = 0.004$). Also, the number of days with vigorous exercise was lower (5.0 versus 5.8 days, $p = 0.023$). Various patient-reported outcomes and scores are shown in Table 4. In respondents with CC, the mean Charlson Comorbidity Score without COPD, the PHQ-9 score, the GAD-7 score and SF-12 PCS and MCS were significantly higher in persons with CC compared to those without (Table 4).

Discussion

According to this cross-sectional study, the 12-month prevalence of CC among adult respondents from a representative sample in Germany is 4.9%. Of these, almost half have been diagnosed by a physician and one tenth were currently using prescription treatment. Typically, respondents with CC have comorbidities, most frequently of the respiratory system; approximately one third have sleep disorders.

The present survey adds to a substantial body of evidence on CC. However, studies differ in terms of setting, age group, and prevalence of smoking. We used a cut-off of 8 weeks or greater for the CC definition, which is largely consistent with the recommended CC definition of >8 weeks in current North American and European clinical guidelines.^{5, 25} Other studies applied other periods such as ≥ 3 months, which might limit comparability of results.

Among the recently published studies on CC, the Rotterdam Study Group - a cohort of 9824 subjects aged ≥ 45 years - found a self-reported prevalence of CC (daily coughing for at least 3 months during the preceding 2 years) of 10.9%.²⁶ In adult patients in the UK who were enrolled in a *Helicobacter pylori* screening program, a prevalence of 12% was reported.²⁷ A Canadian study showed in subjects aged 45 to 85 years self-reported prevalence of chronic cough (coughed most days in the previous 12-months) was 15.8% at baseline and 17.1% at three-year follow-up.²⁸ In the US, based on 75,000 National Health and Wellness Survey adult (≥ 18 years) respondents, 5.0% had experienced chronic cough (daily cough at least 8 weeks) in the previous 12-months.²⁹

Another study in Denmark (14 669 subjects, median age 58 years) found a point prevalence of 4%¹⁶ and a study in Finland (mean age 51 years) of 7.2%.³⁰ The Respiratory Health in Northern Europe (RHINE) III cohort (n=13 500), a multi-centre study, reported non-productive CC in 7% and productive CC in 9%.³¹ Based on a systematic review and meta-analysis, Song et al. estimated the global CC prevalence of 10%, and the prevalence in Europe of 12%.¹⁵ However, there is no insight in the included data for the meta-analysis. As described above there are notable differences in the design and population of mentioned studies that explain differences observed in CC prevalence.

When considering the age groups, we found the highest CC prevalence in the oldest (50+) and youngest (18-29 years) surveyed. Other studies have also reported higher rates of CC as persons age (Copenhagen¹⁶, Rotterdam²⁶, Korea³²). Interestingly, CC was more prevalent

among 18-29 year olds than among those aged 30-49 years. In other studies, the youngest adults have been reported in combination with persons in their 30s and sometimes with those up to age 49. For instance, Colak et al. reported a nominally higher prevalence among the Danish 20-39 year olds than among those in their 40's.¹⁶ Similarly, prior to adjusting for diagnostic procedures and other co-variables, a higher unadjusted prevalence was shown in Korea among 18-39 year olds than those aged 40-64 years.³² Combining the youngest adults with those in their 3rd decade may temper the prevalence rate. Our study results were not stratified by age other than as reported for prevalence. It is therefore possible that owing to poorer economic circumstance and/or lower utilization of healthcare services, this younger adult population has not addressed associated underlying conditions and/or that their behavioural choices, e.g., smoking, may impact the rate of reported chronic cough. The reasons for our observed higher prevalence rate among 18-29 year olds remain unclear and could be assessed in future studies.

It has been reported that the cough reflex is more sensitive in women.³³ Some studies such as the Rotterdam study found a higher prevalence of CC in women.²⁶ In contrast we did not find a statistically significant difference in the prevalence of CC between men and women in Germany. The higher prevalence in women reported elsewhere could be due, in part, that women are more willing to seek care for chronic cough and are less likely to smoke. Interpreted with appropriate caution, our data suggests that patients with CC, on average, have a higher BMI as well as, and possibly correlated, fewer days of self-reported "vigorous exercise" than the general population.

In our study, the leading comorbidities in subjects with CC were respiratory disorders, which is consistent with the known epidemiology of cough and guideline-based evaluation recommendations. Typical conditions associated with CC are chronic obstructive pulmonary disease (e.g. the most important risk factor found in the Rotterdam study²⁶), asthma or bronchiectasis (both are among the three top risk factors in the Copenhagen study¹⁶). Among the digestive tract disorders, gastroesophageal reflux disease (GERD) has been identified as independent risk factor in the Rotterdam study²⁶, the Copenhagen study¹⁶, and the Korean National Health Survey.³² As listed in Table 3, subjects which reported CC also suffered from a relatively large variety of other medical conditions and comorbidities which have not necessarily previously been associated clinically with cough. The reasons for these observations remain speculative and cannot be derived from the available data. While an

increase in CC among people e.g. with “cancer”, “congestive heart failure”, “respiratory” conditions seems plausible, the increased prevalence in those with comorbid e.g. “migraine”, “chronic pain” or “liver diseases” could be investigated in future studies.

We also found a higher prevalence of sleep disorders in subjects with CC. Chronic cough can be the sole presenting symptom of obstructive sleep apnoea in about one third of affected patients.³⁴ Furthermore, the relationship of sleep complaints to respiratory symptoms is well established, and cough symptoms have been associated with day time somnolence in general population studies.³⁵

As reported in a previous study, chronic cough was accompanied by increased symptoms of depression.³⁶ A complex relationship between psych morbidity and chronic cough has been described and psychological issues may be an etiological factor in the development of chronic cough (previously termed “psychogenic cough”, now “somatic cough syndrome”).³⁷ Alternatively, psych morbidity may be a result of chronic cough in some respondents.

One of the strengths of our survey is the attempt to have an age and gender-representative sample. However, a few limitations need to be taken into consideration when interpreting the findings of our survey. Given the observational nature of the survey, no causal relationships between, e.g. chronic cough and the various comorbidities, can be made.³⁸ Like other internet-based, patient-reported surveys, the NHWS sample likely under-represents people without access to or familiarity with electronic media, including the elderly, institutionalized patients, and those with severe comorbidities and disabilities which could make access to and ability to participate in online survey panels more difficult. The self-reported nature of the NHWS and cough module is also associated with potential corresponding biases, such as recall and self-presentation biases. Such biases could introduce additional measurement error. We analysed the general CC population which includes, among others, smokers and patients on ACE inhibitors and did not confine the analysis to refractory or unexplained cough patients, which affects the reported prevalence estimates and gender ratios. Finally, as chronic cough was defined by period prevalence (lifetime, 12 months) and not by point prevalence, there is the possibility of recall bias.

In conclusion, CC is a prevalent condition in Germany among all age groups without gender preference, with highest rates in those 18-29 and 50 years and older and more frequent among those current or prior smokers. Comorbidities are common in this population, typically of the respiratory system, sleep disorders and depressive symptoms.

Conflict of interest statements

JCV has the following to disclose:

- Lectured for and received honoraria from: AstraZeneca, Avontec, Bayer, Bencard, Bionorica, Boehringer Ingelheim, Chiesi, Essex/Schering-Plough, GSK, Janssen-Cilag, Leti, MEDA, Merck, MSD, Mundipharma, Novartis, Nycomed/Altana, Pfizer, Revotar, Sandoz-Hexal, Stallergens, Teva, UCB/Schwarz-Pharma, Zydus/Cadila and possibly others
- Participated in advisory boards for: Avontec, Boehringer Ingelheim, Chiesi, Essex/Schering-Plough, GSK, Janssen-Cilag, MEDA, MSD, Mundipharma, Novartis, Regeneron, Revotar, Roche, Sanofi-Aventis, Sandoz-Hexal, Teva, UCB/Schwarz-Pharma and possibly others
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CJ and HS are full-time employees of MSD Sharp & Dohme GmbH, Haar, Germany.

EF, JB, and JS are employees of Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Kenilworth, NJ, USA and shareholders in Merck & Co., Inc., Kenilworth, NJ, USA.

VWL and AM are employees of Kantar LLC.

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Figure 1. Prevalence estimates of chronic cough in the NHWS sample: lifetime, in past 12 months, diagnosed, drug treated (unweighted estimated)

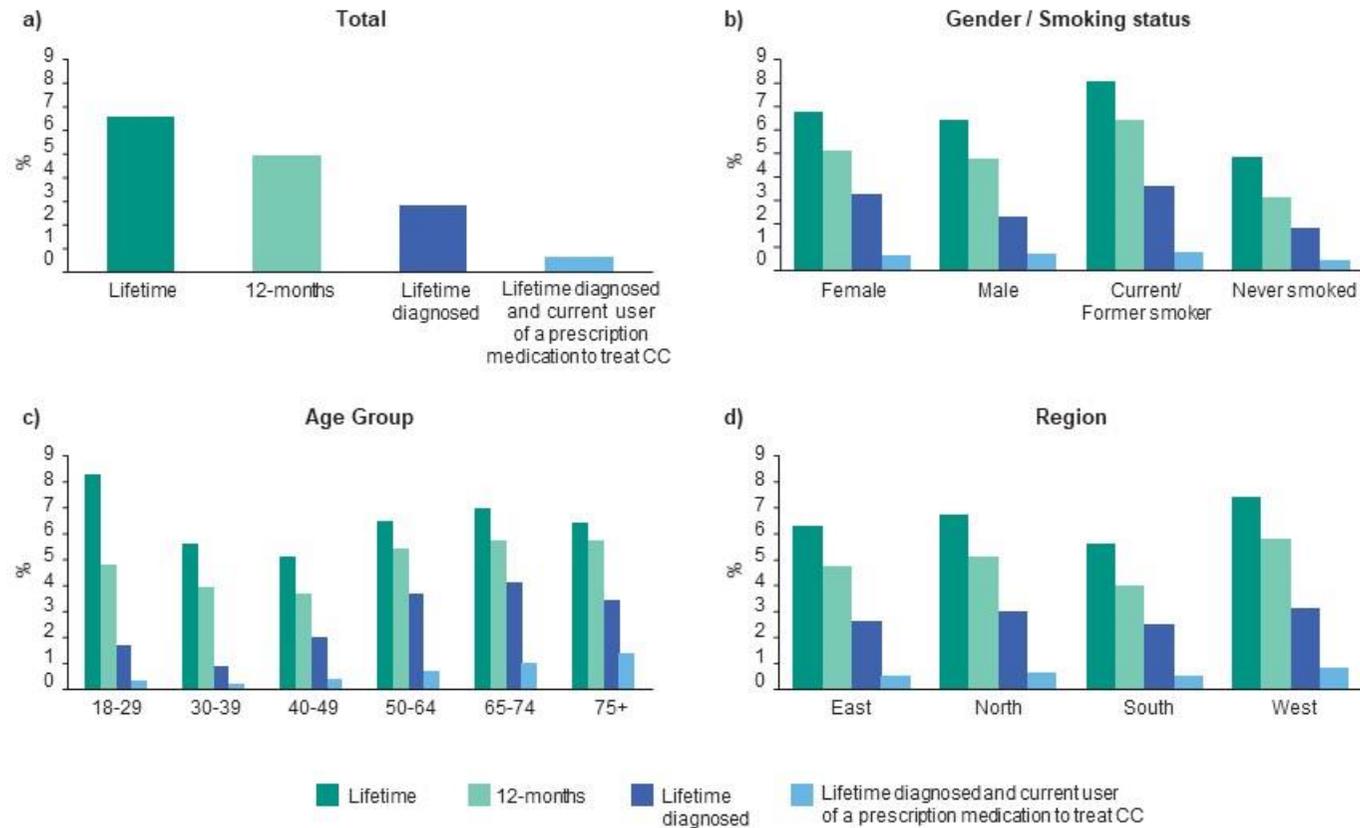


Table 1. Prevalence estimates of chronic cough in the NHWS sample: lifetime, in past 12 months, diagnosed, drug treated (unweighted estimated)

		NHWS Sample Size	Lifetime			12 months			Lifetime diagnosed			Lifetime diagnosed and current user of a prescription medication to treat CC		
			n	%	P value	n	%	P value	n	%	P value	n	%	P value
Total		15020	981	6.5		739	4.9		418	2.8		95	0.6	
Gender	Female	7741	518	6.7	0.412	397	5.1	0.223	248	3.2	0.001	45	0.6	0.415
	Male	7279	463	6.4		342	4.7		170	2.3		50	0.7	
Age Group	18-29	2357	195	8.3	<0.001	113	4.8	<0.001	40	1.7	<0.001	8	0.3	<0.001
	30-39	2187	122	5.6		85	3.9		20	0.9		4	0.2	
	40-49	2288	116	5.1		84	3.7		46	2.0		9	0.4	
	50-64	4214	273	6.5		229	5.4		154	3.7		31	0.7	
	65-74	3330	234	7.0		191	5.7		136	4.1		34	1.0	
	75+	644	41	6.4		37	5.7		22	3.4		9	1.4	
Smoking status	Current/Former smoker	8187	655	8.0	<0.001	526	6.4	<0.001	293	3.6	<0.001	68	0.8	<0.001
	Never smoked	6833	326	4.8		213	3.1		125	1.8		27	0.4	
Region*	East	4960	310	6.3	0.008	232	4.7	0.004	130	2.6	0.327	27	0.5	0.424
	North	1155	77	6.7		59	5.1		35	3.0		7	0.6	
	South	3665	205	5.6		147	4.0		90	2.5		19	0.5	
	West	5230	389	7.4		301	5.8		163	3.1		42	0.8	

Lifetime = prevalence estimates for ever being diagnosed with chronic cough.

12 Month = Prevalence estimates for experienced chronic cough in past 12 months

Lifetime diagnosis = Prevalence estimates for ever being diagnosed with chronic cough.

Currently using prescription medicine = Prevalence estimates for ever being diagnosed and for currently using a prescription medication to treat their chronic cough
p-value: comparison of subsample with Total sample

* South: Baden-Wuerttemberg, Bavaria; East: Berlin, Brandenburg, Lower Saxony, Mecklenburg-Western Pomerania, Saxonia, Saxonia-Anhalt, Thuringia; North: Bremen, Hamburg, Schleswig-Holstein; West: Hestia, North Rhine-Westphalia, Rhineland-Palatinate, Saarland; Not specified: 10 respondents chose not to answer that question but also did not report chronic cough.

Table 2. Characteristics in the subsample of respondents with CC in the past 12 months versus the German adult general population subsample without CC

		Unmatched						Matched*							
		Total NHWS Respondants		Respondents with CC in past 12 months		Respondents without CC in past 12 months		p value	Total		Respondents with CC in past 12 months		Respondents without CC in past 12 months		P value**
N		15020		739		14281			2930		736		2194		
Age	Mean, SD	50.1±16.8		52.0±17.0		50.0±16.7		0.001**	51.8±16.7		52.1±17.0		51.8±17.7		0.62
Age groups, years		n	%	n	%	n	%	0.001**	n	%	n	%	n	%	0.443
	18-24	1276	8.5	66	8.9	1210	8.5		232	7.9	65	8.8	167	7.6	
	25-39	3268	21.8	132	17.9	3136	22		556	19	130	17.7	426	19.4	
	40-49	2288	15.2	84	11.4	2204	15.4		380	13	84	11.4	296	13.5	
	50-64	4214	28.1	229	31	3985	27.9		863	29.5	229	31.1	634	28.9	
	65-74	3330	22.2	191	25.8	3139	22		758	25.9	191	26.0	567	25.8	
	75+	644	4.3	37	5	607	4.3		141	4.8	37	5.0	104	4.7	
Gender	Male	7279	48.5	342	46.3	6937	48.6	0.223	1299	44.3	340	46.2	959	43.7	0.24
	Female	7741	51.5	397	53.7	7344	51.4		1631	55.7	396	53.8	1235	56.3	
Employment status	Employed full time/Part time/Self-employed	8365	55.7	332	44.9	8033	56.2	.000**	1384	47.2	329	44.7	1055	48.1	0.049**
	Homemaker/Student/Long-Term Disability/Not employed and not looking for work	1737	11.6	88	11.9	1649	11.5		374	12.8	88	12.0	286	13.0	
	Retired	4390	29.2	280	37.9	4110	28.8		1058	36.1	280	38.0	778	35.5	
	Not employed, but looking for work/Short-Term Disability	528	3.5	39	5.3	489	3.4		114	3.9	39	5.3	75	3.4	
Marital status	Married or Living with partner	8329	55.5	390	52.8	7939	55.6	0.323	1556	53.1	389	52.9	1167	53.2	0.888
	Single/Never married or Divorced or Separated or Widowed	6614	44	345	46.7	6269	43.9		1361	46.5	343	46.6	1018	46.4	

	Decline to answer	77	0.5	4	0.5	73	0.5		13	0.4	4	0.5	9	0.4	
Household income (categorical)	Low (< €20,000)	3201	21.3	203	27.5	2998	21	<0.001**	824	28.1	202	27.4	622	28.4	0.53
	Medium (€20,000 - €49,999)	6350	42.3	315	42.6	6035	42.3		1285	43.9	315	42.8	970	44.2	
	High (≥ €50,000)	4133	27.5	168	22.7	3965	27.8		639	21.8	166	22.6	473	21.6	
	Decline to answer	1336	8.9	53	7.2	1283	9		182	6.2	53	7.2	129	5.9	
Level of education	Did not attend school or declined to answer	489	3.3	22	3	467	3.3	0.076	83	2.8	22	3.0	61	2.8	0.611
	Less than 4-year university degree	10456	69.6	542	73.3	9914	69.4		2115	72.2	540	73.4	1575	71.8	
	4-year university degree or higher	4075	27.1	175	23.7	3900	27.3		732	25	174	23.6	558	25.4	
Smoking Status (cigarettes and other tobacco products)	Current smoker	4566	30.4	374	50.6	4192	29.4	<0.001**	1010	34.5	371	50.4	639	29.1	<0.001**
	Former smoker	3621	24.1	152	20.6	3469	24.3		737	25.2	152	20.7	585	26.7	
	Never smoked	6833	45.5	213	28.8	6620	46.4		1183	40.4	213	28.9	970	44.2	
Region	South	3665	24.4	147	19.9	3518	24.6	0.004** ,***	675	23	147	20.0	528	24.1	0.032** ,***
	East	4960	33	232	31.4	4728	33.1		961	32.8	231	31.4	730	33.3	
	West	5230	34.8	301	40.7	4929	34.5		1057	36.1	299	40.6	758	34.5	
	North	1155	7.7	59	8	1096	7.7		236	8.1	59	8.0	177	8.1	
	Not specified	10	0.1	0	0	10	0.1		1	0	-	0.01	1	0.0	
Health insurance type	Public, without additional private insurance	10246	68.2	489	66.2	9757	68.3	0.06	2054	70.1	487	66.2	1567	71.4	.001**
	Public, along with additional private insurance	2393	15.9	120	16.2	2273	15.9		465	15.9	119	16.2	346	15.8	
	Private insurance	1199	8	70	9.5	1129	7.9		202	6.9	70	9.5	132	6.0	
	Aid entitlement and additional private insurance	688	4.6	42	5.7	646	4.5		127	4.3	42	5.7	85	3.9	

Other	151	1	10	1.4	141	1	30	1	10	1.4	20	0.9
None of the above	343	2.3	8	1.1	335	2.3	52	1.8	8	1.1	44	2.0

Data are based on respondents who completed the 2020 Germany NHWS (National Health and Wellness Survey). CC = chronic cough.

* Propensity score matched on age, gender, CCI modified to exclude COPD, marital status, household income, interaction term of marital status x household income; using 1:3 nearest neighbour on the logit, caliper = 0.25

** T-test or Chi-square statistic is significant at the .05 level.

*** Given low sample size, 'undefined' region was not included in the statistical comparison.

Table 3. Matched respondent experienced and physician-diagnosed conditions

	Total NHWS Respondents		Respondents with CC		Matched* Respondents without CC		
N	15020		739		2194		
	n	%	n	%	n	%	p value**
Respondent-reported conditions experienced in prior 12 months							
Migraine	522	17.8	170	23.1	352	16.0	.000**
Sleep conditions combined (at least 1)	1412	48.2	520	70.7	892	40.7	.000**
Insomnia	768	26.2	287	39.0	481	21.9	.000**
Narcolepsy	52	1.8	39	5.3	13	0.6	.000**
Sleep apnoea	252	8.6	114	15.5	138	6.3	.000**
Other sleep difficulties	711	24.3	257	34.9	454	20.7	.000**
Respondent-reported being diagnosed with condition by a physician during lifetime							
Cancer (any tumour, leukaemia, lymphoma, metastatic solid tumour)	183	6.2	40	5.4	143	6.5	0.068
Chronic pain due to rheumatoid arthritis	159	54.0	45	6.1	114	5.2	0.047**
Digestive tract (gastroesophageal reflux, heartburn, irritable bowel syndrome, ulcerative colitis, ulcers)	628	21.4	248	33.7	380	17.3	.000**
Heart and blood (congestive heart failure, heart attack, mini-stroke/transient ischemia attack, peripheral vascular disease, stroke, diabetes Type I/II, latent autoimmune diabetes)	747	25.5	208	28.3	539	24.6	0.018**
Infectious diseases (AIDS, hepatitis B or C, HIV)	91	3.1	36	4.9	55	2.5	0.001**
Liver (chronic liver disease or cirrhosis)	63	2.2	28	3.8	35	1.6	.000**
Neurological (hemiplegia, multiple sclerosis, Parkinson's disease)	76	2.6	24	3.3	52	2.4	0.057
Respiratory (allergies, asthma, hay fever, chronic bronchitis, chronic cough, COPD, emphysema)	1178	40.2	522	70.9	656	29.9	.000**
Sleep (insomnia, narcolepsy, sleep apnoea, other sleep difficulties)	2828	18.8	278	37.6	2550	17.9	.000**
Moderate or severe renal/kidney disease	32	1.1	5	0.7	27	1.2	0.191
Other (connective tissue disease or community-acquired pneumonia)	86	2.9	50	6.8	36	1.6	.000**

NHWS = National Health and Wellness Survey. CC = chronic cough. COPD = chronic obstructive pulmonary disease.

* Propensity score matched on age, gender, CCI modified to exclude COPD, marital status, household income, interaction term of marital status x household income; using 1:3 nearest neighbour on the logit, caliper = 0.25

** Chi-square statistic is significant at the .05 level.

Table 4. Matched general health scores and measures and report of weight and exercise

	Total NHWS Respondants		Respondents with CC		Matched* Respondents without CC		P value**
	N=	15020	739	2194			
	Mean	SD	Mean	SD	Mean	SD	
Charlson comorbidity Index	0.87	1.31	1.16	1.39	0.77	1.27	.000**
Charlson Comorbidity Index - Modified (without COPD)	0.73	1.23	0.80	1.26	0.70	1.21	0.068
PHQ-9 score ¹	6.39	6.15	8.97	6.49	5.52	5.78	.000**
GAD-7 score ¹	4.73	4.72	6.75	5.15	4.06	4.36	.000**
SF-12 physical component score ²	46.33	10.11	42.75	9.52	47.53	10.02	.000**
SF-12 mental component score ²	46.27	10.77	42.75	10.45	47.53	10.59	.000**
BMI ³	27.29	6.51	27.93	7.03	27.08	6.31	0.004**
Numbers of days of vigorous exercise in the past month ⁴	5.51	7.53	4.98	7.27	5.69	7.61	0.023**

NHWS = National Health and Wellness Survey. CC = chronic cough. COPD = chronic obstructive pulmonary disease. BMI = body mass index. PHQ-9 = Patient Health Questionnaire, 9-item. GAD-7 = Generalized Anxiety Disorder questionnaire, 7-item.

* Propensity score matched on age, gender, CCI modified to exclude COPD, marital status, household income, interaction term of marital status x household income; using 1:3 nearest neighbour on the logit, caliper = 0.25

** T-test or Chi-square statistic is significant at the .05 level.

¹ PHQ-9 and GAD-7 are validated instruments to assess depressive symptoms over the prior 2 weeks (score range 0-27) and severity of generalized anxiety symptoms over the prior 2 weeks (score range 0-21), respectively.

² SF-12 = the Medical Outcomes Study 36-item Short Form Survey v2, a validated health-related quality of life. The physical and mental health component summary scores were calculated with a mean score set at 50 and a standard deviation at 10; higher scores represent better health.

³ BMI was collected for a subset of respondents who reported their height and weight, respectively N = 2824 out of 2930; 707 out of 736; and 2117 out of 2194. BMI between 25 and <30.0 kg/m² indicates overweight.

⁴ The question was "How many days in the past month did you exercise vigorously for at least 20 minutes for the purpose of improving or maintaining your health, with the purpose of losing weight, or for enjoyment?"

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