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Original Article

Prevalence of Chronic Obstructive Pulmonary Disease in Kocaeli: An Industrialised City in Turkey

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is an important cause of mortality worldwide.

Aims: The aim of this study was to establish the prevalence of chronic obstructive pulmonary disease (COPD) in residents who were ≥40 years old and living in a heavily industrialised city of Turkey, Kocaeli, using the Burden of Obstructive Lung Disease Initiative questionnaire.

Study Design: Cross-sectional study.

Methods: 1035 residents ≥40 years old and living in Kocaeli were surveyed. Spirometry and the basic BOLD questionnaire was performed.

Results: 946 subjects entered into the analysis. The prevalence of stage I or higher COPD was 13.3% (8.7% for women and 16.5% for men), the prevalence of COPD at GOLD stage II or higher was 7.1% (4.1% for women and 9.2% for men). We also noted a high prevalence of COPD in never-smokers.

Conclusion: Besides cigarette smoking, occupational exposure to fumes, chemicals and dusts might have also contributed to the high prevalence of COPD noted in residents who were ≥40 years old and living in Kocaeli, Turkey.

Key Words: COPD, prevalence, questionnaires, cigarette smoking, age, epidemiology

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Introduction

Chronic obstructive pulmonary disease (COPD) is an important cause of mortality worldwide, with around 2.5 million people dying as a result of COPD every year. It is expected that this disease will be in the top five causes of death by 2020 (1). Depending on the distribution of risk factors, the prevalence of COPD and the morbidity and mortality rates change for each country, as well as for different groups of individuals in countries. Although the prevalence of COPD is mainly driven by the prevalence of cigarette smoking, indoor air pollution and occupational exposure to dusts and gases also make a substantial contribution to the prevalence of COPD. The prevalence, as well as the burden of COPD, is expected to elevate in the coming decades as exposure to risk factors continues, and the population ages (2).

Existing data on the prevalence of COPD show discrepancy due to methodological differences in studies such as differences in diagnostic criteria or survey methods (3, 4). The lowest estimates of prevalence are commonly obtained in surveys depending on a physician's self-report on the diagnosis of COPD or equivalent conditions. This may reflect the fact that the disease is often under-recognised and under-diagnosed, and that patients with stage I COPD may be asymptomatic, or have symptoms (e.g., chronic cough and sputum) which cannot be primarily recognised as a sign of early COPD by patients themselves or their physicians (5).

COPD was defined as "a preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in individual patients" by the Global Initiative for Obstructive Lung Disease (GOLD) in 2009 (2). Airflow limitation, which is not fully reversible, represents the pulmonary component of COPD. Spirometry performed before and after an inhaled bronchodilator is commonly used to measure reversibility.

Population-based surveys using spirometry have shown that the disease is often under-diagnosed in the US, Japan, Korea, Spain, Sweden, and South America (4, 6-10). There is a large difference among national COPD prevalence estimates depending on self-reported diagnoses (4).

The Burden of Obstructive Lung Disease (BOLD) Initiative was started to develop and use standardised methods for the measurement of worldwide COPD prevalence in adults ≥40 years of age and to assess variations in the prevalence of different countries (11). The Turkey arm of this study was conducted in Adana city (12). The present cross-sectional study conducted in Kocaeli, a heavily industrialised city of Turkey, aimed to determine the COPD prevalence in residents who were ≥40 years old.

Material and Methods

Study area

Kocaeli is one of the heavily industrialised cities in northwestern Anatolia. Kocaeli, which houses 17% of industrial

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firms, is one of the biggest industrial provinces of Turkey in terms of the heavy metal and chemical industry. Accordingly, most of the residents in Kocaeli are industry labourers and their dependents.

Study population and sampling

The study population included residents who were ≥40 years old and living in Kocaeli. Considering a power of 90%, an alpha value of 5%, and a reported prevalence of COPD of 10% among the population who were ≥40 years old in Turkey, we calculated that we would need 864 subjects. Allowing a 20% margin of safety for non-responders, we decided to include 1000 subjects (13).

A stratified sampling method was used; the sample was distributed according to the population density of each district of Kocaeli. Then, primary health care units that have medical information of all household members living in that particular region were randomly selected. Houses were selected from the registries of these primary health care units using a cluster sampling method, and then household members ≥ 40 years of age were invited to the primary health care units. Home visits were performed for those who did not attend for reasons, such as physical limitation. As all residents consented to participate, the study population exceeded our goal of 1000. A total of 1035 residents (605 men and 430 women) were included in the study.

Data collection

We were able to contact all 1035 individuals in the sample, 17 of whom did not agree to answer the minimum data questionnaire, which provides information on history of cigarette smoking, respiratory symptoms, and co-morbidities. Of the remaining 1018 participants, 72 were excluded because of a lack of usable spirometry data; thus, 946 subjects completed the full protocol.

Approval was obtained from the Kocaeli University Local Ethics Committee (2008/86 IAEK 12/7), and all individuals provided written informed consent. In addition, the Kocaeli Health Directorate granted the study permission.

Study measures

On the basis of the American Thoracic Society (ATS) criteria (14), spirometry was performed by trained and certified technicians, while the participants were in the sitting position. A metered-dose inhaler with a spacer (Volumatic; GlaxoSmithKline; Research Triangle Park, NC, USA) was used for the measurements performed prior to and minimum 15 min after four puffs of salbutamol (100 mcg). Spirometry data were examined, and each spirogram was revised and classified by one of the investigators. Only spirograms fulfilling the acceptability and reproducibility criteria of the ATS were used for analysis (14). The 1996 version of the ATS guideline was used, since the 2006 version was not available when the study was planned. The study was conducted in accordance with the BOLD criteria.

Questionnaire

The basic BOLD questionnaire, which assesses the respiratory symptoms, health status, COPD risk factors, diagnosis, and activity limitation of the patients, was used in the present study (11). Translation of the questionnaire from English into Turkish and its back-translation were performed using standardised methods (11). The questionnaire was applied by trained and certified staff. The minimum data questionnaire was used to collect data on cigarette smoking history, comorbidities and respiratory symptoms for the participants not completing the full spirometry protocol.

Table 1. Demographic and clinical characteristics of the study sample

		Men	Women	Overall
Age, years				
40-49	N	156	139	295
	%	28.1	35.6	31.3
50-59	N	200	137	337
	%	36.0	35.1	35.5
60-69	N	131	82	213
	%	23.6	21.0	22.6
70+	N	69	32	101
	%	12.4	8.2	10.6
Smoking status				
Current smoker	N	135	25	160
	%	24.3	6.4	16.9
Former smoker	N	189	46	235
	%	34.0	11.8	24.8
Never smoker	N	232	319	551
	%	41.7	81.8	58.8
Pulmonary function				
FEV_1, L	mean±SD	3.12±0.77	2.24±0.51	2.77±0.80
% predicted	mean±SD	77.20±10.09	79.70±7.39	78.23±9.16
FVC, L	mean±SD	4.01±0.84	2.84±0.61	3.52±0.94
FEV_1/FVC	mean±SD	0.78±0.10	0.80±0.07	0.78±0.09
Exposure to dust at work				
Never	N	379	356	735
	%	68.2	91.3	77.7
≤10 years	N	60	21	81
	%	10.8	5.4	8.6
>10 years	N	117	13	130
		21.0	3.3	13.7
Education, years				
≤5 years	N	332	319	651
	%	60.4	82.6	69.6
>5 years	N	218	67	285
	%	39.6	17.4	30.4

FEV_1: forced expiratory volume in one second; FVC: forced vital capacity

Definitions

The GOLD guidelines (2) define irreversible airflow obstruction as "a post-bronchodilator forced expiratory volume in one second/forced vital capacity (FEV1/FVC) ratio of <0.70". This refers to GOLD stage I or higher COPD.

In the present study, we also presented data for GOLD stage II or higher COPD (FEV1/FVC <0.70 and FEV1 <80% of predicted). For the primary analysis, the predicted values in percentages were evaluated using the National Health and Nutrition Examination Study (NHANES) III reference equations (15).

The term "doctor-diagnosed COPD" was referred to the physician's self-report on the diagnosis of COPD, emphysema or chronic bronchitis (11).

Statistical Analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 11.5. Pearson's chi-square and chi-square for trend tests were carried out. A p value less than 0.05 was considered significant.

Results

A total of 946 subjects (556 men and 390 women) completed the study and were entered into the analysis. While most of the participants were between 50-59 years of age, considering the overall study sample, the majority of women were in the 40-49-year age group. When considering all age groups, smoking status varied between men and women; among current and former smokers, the number of men was remarkably higher than women. Although the majority of men and women stated that they were never exposed to dust at work, we noted a higher number of men than women exposed to dust at work. While 60.4% of men had education ≤5 years, this rate increases up to 82.6% among women. Table 1 summarises the demographic and clinical features of the study sample.

The highest rate of current smokers was noted in the >70 years age group. The rate of former smokers was higher in the 40-49-year age group. We also observed the same trend for men and women alone. The distribution of smoking status with respect to age and gender is presented in Table 2.

Table 2. Smoking status by age and sex

			Smoking Status			
	Age		**Never†**	**Current†**	**Former†**	**Total‡**
Overall	40-49	N	154	34	107	295
		%	52.2	11.5	36.3	31.2
	50-59	N	198	52	87	337
		%	58.8	15.4	25.8	35.6
	60-69	N	137	44	32	213
		%	64.3	20.7	15.0	22.5
	70+	N	62	30	9	101
		%	61.4	29.7	8.9	10.7
	Total	N	551	160	235	946
		%	100.0	100.0	100.0	100.0
			Never	**Current**	**Former**	**Total**
Men	40-49	N	52	25	79	156
		%	33.3	16.0	50.6	28.1
	50-59	N	80	42	78	200
		%	40.0	21.0	39.0	36.0
	60-69	N	67	40	24	131
		%	51.1	30.5	18.3	23.6
	70+	N	33	28	8	69
		%	47.8	40.6	11.6	12.4
	Total	N	232	135	189	556
		%	100.0	100.0	100.0	100.0
			Never	**Current**	**Former**	**Total**
Women	40-49	N	102	9	28	139
		%	73.4	6.5	20.1	35.6
	50-59	N	118	10	9	137
		%	86.1	7.3	6.6	35.1
	60-69	N	70	4	8	82
		%	85.4	4.9	9.8	21.0
	70+	N	29	2	1	32
		%	90.6	6.3	3.1	8.2
	Total	N	319	25	46	390
		%	100.0	100.0	100.0	100.0

†Percent of the row
‡Percent of the column

When considering the overall study sample, the prevalence of COPD that was GOLD stage I or higher was 13.3%. The prevalence of COPD at stage I or higher was 8.7% for women and 16.5% for men (p=0.001). The overall prevalence of COPD at GOLD stage II or higher was 7.1%, 4.1% for women, and 9.2% for men (p=0.003). The rate of patients who were previously diagnosed with COPD was 8.9% overall, 13.8% for women, and 5.4% for men (p<0.001; Table 3).

The prevalence of stage I or higher COPD was observed to be increased by age for men and women. While the prevalence of COPD at GOLD stage I or higher was 5.8%, 13.5% and 24.4% for men in the age groups of 40-49 years, 50-59 years, and 60-69 years, it was 7.9%, 8.0% and 8.5% for women in the age groups of 40-49 years, 50-59 years, and 60-69 years, respectively. For those who were ≥70 years of age, the prevalence of stage I or higher COPD was 34.8% for men and 15.6% for women (p=0.048; Table 4a). Although the same increasing trend was observed for the prevalence of stage II or higher COPD in men, the prevalence of COPD varied between age groups when considering women with stage II or higher COPD. The highest COPD prevalence was noted in the 40-49 year age group, in women (Table 4b). Of note, the prevalence of stage II or higher COPD was significantly higher in men than in women (p=0.003). On the other hand, the prevalence of doctor-diagnosed COPD varied between men and women, and across age groups. Considering all age groups, the prevalence of doctor-diagnosed COPD was noted to be significantly higher in women as compared to men (p<0.001). The difference between the two genders may be attributed to the fact that women in our country are more likely to visit health care centres when they have symptoms. The prevalence of doctor-diagnosed COPD was 3.5%-10.1% for men, while it was 12.4%-15.9% for women (Table 4c).

The prevalence of stage I or higher COPD was significantly lower in subjects who were never smokers compared to those who were former/current smokers (10.5% vs. 17.2%, p=0.003).

Table 3. Prevalence of chronic obstructive pulmonary disease by sex

		Men (556)	Women (390)	Overall (946)	p
Stage I or higher					0.001
Yes	N	92	34	126	
	%	16.5	8.7	13.3	
No	N	464	356	820	
	%	83.5	91.3	86.7	
Stage II or higher					0.003
Yes	N	51	16	67	
	%	9.2	4.1	7.1	
No	N	505	374	879	
	%	90.8	95.9	92.9	
Doctor-diagnosed					<0.001
Yes	N	30	54	84	
	%	5.4	13.8	8.9	
No	N	526	336	862	
	%	94.6	86.2	91.1	

Similarly, the lowest prevalence of COPD at GOLD stage II or higher was noted in the never smoker group as compared to the former/current smoker group (5.3% vs. 9.6%, p=0.010; Table 5).

Discussion

COPD is a major public health issue associated with high morbidity and mortality rates in Turkey. Despite the magnitude of the problem, few prevalence studies of COPD have been conducted in Turkey, with a great discrepancy between the results. From this aspect, the current study provides one of the first broad-based data sets, contributing to the understanding of the magnitude of the prevalence of COPD in Turkey.

Aging and increasing exposure to inhaled particles and gases enhances the COPD risk (2, 16). Recently, the estimated rise in the worldwide COPD prevalence has been determined

Table 4a. Prevalence of stage I or higher chronic obstructive pulmonary disease by sex and age

Stage I or higher			Men	Women	Overall	p
40-49	Yes	N	9	11	20	0.465
		%	5.8	7.9	6.8	
	No	N	147	128	275	
		%	94.2	92.1	93.2	
	Total	N	156	139	295	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
50-59	Yes	N	27	11	38	0.119
		%	13.5	8.0	11.3	
	No	N	173	126	299	
		%	86.5	92.0	88.7	
	Total	N	200	137	337	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
60-69	Yes	N	32	7	39	0.004
		%	24.4	8.5	18.3	
	No	N	99	75	174	
		%	75.6	91.5	81.7	
	Total	N	131	82	213	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
70+	Yes	N	24	5	29	0.048
		%	34.8	15.6	28.7	
	No	N	45	27	72	
		%	65.2	84.4	71.3	
	Total	N	69	32	101	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
Overall	Yes	N	92	34	126	<0.001
		%	16.5	8.7	13.3	
	No	N	464	356	820	
		%	83.5	91.3	86.7	
	Total	N	556	390	946	
		%	100.0	100.0	100.0	

Table 4b. Prevalence of stage II or higher chronic obstructive pulmonary disease by sex and age

Stage II or higher			Men	Women	Overall	p
40-49	Yes	N	4	8	12	0.166
		%	2.6	5.8	4.1	
	No	N	152	131	283	
		%	97.4	94.2	95.9	
	Overall	N	156	139	295	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
50-59	Yes	N	14	3	17	0.048
		%	7.0	2.2	5.0	
	No	N	186	134	320	
		%	93.0	97.8	95.0	
	Total	N	200	137	337	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
60-69	Yes	N	20	4	24	0.020
		%	15.3	4.9	11.3	
	No	N	111	78	189	
		%	84.7	95.1	88.7	
	Total	N	131	82	213	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
70+	Yes	N	13	1	14	0.034
		%	18.8	3.1	13.9	
	No	N	56	31	87	
		%	81.2	96.9	86.1	
	Total	N	69	32	101	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
Overall	Yes	N	51	16	67	0.003
		%	9.2	4.1	7.1	
	No	N	505	374	879	
		%	90.8	95.9	92.9	
	Total	N	556	390	946	
		%	100.0	100.0	100.0	

Table 4c. Prevalence of doctor-diagnosed chronic obstructive pulmonary disease by sex and age

Doctor diagnosed			Men	Women	Overall	p
40-49	Yes	N	8	19	27	0.011
		%	5.1	13.7	9.2	
	No	N	148	120	268	
		%	94.9	86.3	90.8	
	Total	N	156	139	295	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
50-59	Yes	N	7	17	24	0.002
		%	3.5	12.4	7.1	
	No	N	193	120	313	
		%	96.5	87.6	92.9	
	Total	N	200	137	337	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
60-69	Yes	N	8	13	21	0.020
		%	6.1	15.9	9.9	
	No	N	123	69	192	
		%	93.9	84.1	90.1	
	Total	N	131	82	213	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
70+	Yes	N	7	5	12	0.512
		%	10.1	15.6	11.9	
	No	N	62	27	89	
		%	89.9	84.4	88.1	
	Total	N	69	32	101	
		%	100.0	100.0	100.0	
			Men	**Women**	**Overall**	**p**
Overall	Yes	N	30	54	84	<0.001
		%	5.4	13.8	8.9	
	No	N	526	336	862	
		%	94.6	86.2	91.1	
	Total	N	556	390	946	
		%	100.0	100.0	100.0	

rather by the proposed world population aging than by the proposed variations on the smoking prevalence (17). Accordingly, our data showed that the prevalence of COPD that was stage I or higher increased with age. The BOLD study (12) reported an increasing trend with age in women, who were living in Adana city in Turkey, with the highest prevalence of GOLD stage II or higher COPD in women >70 years of age. Moreover, the projected population prevalence of GOLD stage II or higher COPD for women >70 years of age in Adana (12) was remarkably higher than that noted in the current study (14.3% vs. 3.1%). Although the BOLD study did not show an increasing trend with age in men, the prevalence of GOLD stage II or higher COPD for men >70 years of age in Adana (12) was quite close to the prevalence noted in Kocaeli (18.9% vs. 18.8%).

The findings of the current study also support the current evidence that cigarette smoking is a predominant risk factor for COPD (2, 16). We noted a higher prevalence of COPD that was GOLD stage I or higher in the former/current smoker group compared to the never smoker group (17.2% vs. 10.5%, respectively). In a study performed to determine the effect of passive smoking on the development of COPD disease in southeastern Turkey, COPD was found in 18.1 of the smokers >40 years of age (18). In a study in Italy, it was shown that the relative risk of developing lung cancer was 23.7 times higher in male smokers than non-smokers. On the other hand, the relative risk of developing lung cancer was 5.1 times higher in female smokers than female non-smokers (19). Consistently, the majority of patients who had stage II or higher COPD was in the former/current smoker group (9.6% vs. 5.3%). Similarly, the BOLD study reported the prevalence of COPD that was stage II or higher in Adana to be 5.3% and 5.9% for men and women who had never smoked.

Table 5. Prevalence of chronic obstructive pulmonary disease by smoking status

		Smoking Status			
		Never smoker (551)	Former/Current smoker (395)	Overall (946)	p
Stage I or higher					0.003
Yes	N	58	68	126	
	%	10.5	17.2	13.3	
No	N	493	327	820	
	%	89.5	82.8	86.7	
Stage II or higher					0.010
Yes	N	29	38	67	
	%	5.3	9.6	7.1	
No	N	522	357	879	
	%	94.7	90.4	92.9	

In another epidemiologic study conducted in Malatya city in Turkey, the prevalence of COPD in residents >40 years of age was 9.1%, while the prevalence was 18.1% in smoking subjects >40 years of age (20).

Of note, a high prevalence of COPD was also noted in never-smokers (10.5%). Since industrial workers comprise the majority of our study population, and occupational exposure is a well-established risk factor for COPD (21, 22), it is not surprising to note such a high prevalence of COPD even in never-smokers in a heavily industrialised region of Turkey. Nevertheless, it deserves further study to explore whether the high prevalence of COPD in never-smokers is related only to occupational exposure to fumes, chemicals and dusts, or other yet unknown risk factors.

Because women are less likely to smoke than men in most countries, the prevalence of COPD is usually higher in men than women (7, 8, 23, 24). In a study performed in Elazığ-Turkey, the prevalence of cigarette smoking was higher in men (58.7%) than in women (13.1%) (25). Our results were consistent with these findings. The overall prevalence of COPD (GOLD stage I or higher) was 13.3%. The overall prevalence of GOLD stage I or higher COPD for women and men was 8.7% and 16.5%, respectively. Menezes et al. (10) reported that prevalence estimates varied from 7.8% to 19.7% for irreversible airway obstruction in COPD at GOLD stage I or higher in five cities of Latin America. The equivalent estimates for South Africa (26) and Turkey (12) were 23.2% (30.3% in men and 19% in women) and 19.1% (28% in men and 10.3% in women), respectively. A recent study from Salzburg (27) reported a COPD prevalence of 26.1%, which was similar for men (26.6%) and women (25.7%).

In the present study, we found a great difference between the physicians' self-report on the diagnosis of COPD and the spirometrically determined airflow obstruction. Data collected regarding COPD diagnosis were based on individuals' self-reports. Although our results are in accordance with those of other studies, it is known that women have reported higher morbidity than males in self-reported studies (28). The prevalence of doctor-diagnosed COPD was 8.9% overall, 13.8% for women, and 5.4% for men. These findings were consistent with the findings of Gunen et al. (20) who reported that the level of participants with a doctor-diagnosed COPD was 7.9% in Malatya. This rate was 5.6% for both men and women in Salzburg, Austria (27).

In conclusion, our data indicated that COPD was very common in Kocaeli. The great majority of COPD patients in Kocaeli had not received an appropriate diagnosis. Despite the high rate of cigarette smoking, which is the critical risk factor for COPD, in Kocaeli, occupational exposure may have a significant role in COPD development because of the high COPD prevalence noted in the non-smoking population.

Ethics Committee Approval: *The study was approved by the Institutional Review Board of Kocaeli University (2008/86 IAEK 12/7). In addition, permission for the study was granted by the Kocaeli Health Directorate.*

Informed Consent: *Written informed consent was obtained from the participants of the study.*

Peer-review: *Externally peer-reviewed.*

Author contributions: *Concept – Z.A., A.I., N.E.; Design – Z.A., N.E., O.H.; Supervision – A.I., O.H.,N.E.; Resource – A.I., O.H., N.E.; Materials – Z.A., A.I., N.E.; Data Collection&/or Processing – Z.A., A.I., N.E.; Analysis&/or Interpretation –N.E., O.H., Z.A.; Literature Search – Z.A., N.E., A.I.; Writing – Z.A., N.E., A.I.; Critical Reviews – N.E., A.I., O.H.*

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