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*Research Article*

# **Chronic Bronchitis and Associated Factors in Workers at A South African Welding Company**

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## **ABSTRACT**

Chronic bronchitis affects individuals in both developed and developing countries resulting in a poor quality of life. Emphysema and chronic bronchitis constitute chronic obstructive pulmonary disease (COPD) which is among the diseases that result in a high mortality rate. This study was conducted to find out about the prevalence of chronic bronchitis and the associated factors in workers of a South African welding company. A retrospective cross-sectional design was used whereby a self-administered questionnaire was used to gather the information from the participants who gave an informed consent. Thirty-eight participants (43.2%) reported suffering from chronic bronchitis. More welders (62.2%) had chronic bronchitis than office workers (30%) and fitters (28.6%). Chronic bronchitis was significantly associated with asthma as well as respiratory symptoms such as shortness of breath, chest pain, chest, and irritation to the nasal cavity ( $p < 0.05$ ). Chronic bronchitis was highly prevalent among workers in this welding company. Occupational health and safety measures that include avoiding exposure to pollutants and proper use of respiratory protective devices are essential to prevent chronic bronchitis..

**Keywords:** *chronic bronchitis, welding fumes, respiratory symptoms, occupational health and safety measures*

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## **INTRODUCTION**

Chronic bronchitis is a respiratory disease characterized by a cough which is accompanied by sputum production for a period of 3 months of a year for two consecutive years (ALA, 2012; Holm *et al.*, 2012). It is a lung disease which together with emphysema constitute chronic obstructive pulmonary disease (COPD) (ALA, 2012). An estimated number of about 3 million deaths were caused by COPD worldwide in the year 2015 (WHO, 2017). Research has shown a high prevalence of CB among patients with chronic obstructive pulmonary disease (COPD) with prevalence rates ranging from 14 to 74% (Burgel *et al.* 2009; Kim *et al.*, 2011; Agusti *et al.*, 2010; de Oca *et al.*, 2012).

Welding involves the melting of the work pieces and joining of metal components using heat or pressure or both (Stern, 1986; Meo and Al-Khlaiwi, 2003). During the welding process toxic fumes are produced when the metals such as nickel, chrome, iron, copper, magnesium and zinc are heated (Al-Otaib, 2014). Workers who perform welding tasks are also exposed to gases and particulates that are generated. The workers are affected by exposure to welding fumes and this depends on the composition and concentration of the airborne

particles (Balkhyour and Goknil, 2010; Dasch and D'Arcy, 2008).

Previous studies (Blanc and Torén 2007; Pelkonen *et al.*, 2006) have investigated the prevalence and incidence of chronic bronchitis in occupational settings. In a review of literature conducted by Blanc and Torén (2007), it was concluded that COPD is associated with work-related exposures to pollutants. The study investigating welding exposure at work and the prevalence of respiratory symptoms found an association between the incidence of chronic bronchitis symptoms and occupational exposure to welding fumes (Lillienberg, 2008). In the said study, 62% of participants performed welding tasks for less than an hour per day while 23% spent between one hour and three hours per day performing welding tasks. Furthermore, 15% of the participants reported welding for less than four hours per day. It was also found that the symptoms of chronic bronchitis were higher among participants who performed welding tasks on iron or galvanized steel.

In the Respiratory Health in North Europe (RHINE) study conducted among participants born between the years 1945 and 1971, the prevalence rate of chronic bronchitis was 5.4% (Holm *et al.*, 2012). Halbert *et al.* (2006) reported similar

findings in a systematic review of the previous prevalence data. Furthermore, Holm *et al.* (2012) found that the prevalence rate for chronic bronchitis was high among participants who were current smokers than those who never smoked. Participants who were exposed to welding fumes at work had a high prevalence of chronic bronchitis than those who were not exposed to welding fumes (Holm *et al.*, 2012; Lillienberg, 2008).

In South Africa, the study conducted to determine the prevalence of chronic bronchitis and risk factors among adults showed that the prevalence among men and women were 2.3% and 2.8% respectively (Ehrlich, 2004). Some of the risk factors identified in the said study were a history of tuberculosis, smoking and occupational exposure to environmental pollutants. In China, a study investigating the association between the occupation and CB found an increased prevalence of CB among Chinese women employed as welders (Krstev *et al.*, 2008). In a study investigating the respiratory symptoms and respiratory function of welders, 26.8% of welders suffered from chronic bronchitis most days for a period of 3 months (Al-Otaib, 2014).

Few studies have been conducted to investigate the prevalence of chronic bronchitis in South Africa. The data about the prevalence of chronic bronchitis particularly in the South African welding industry is lacking and this is exacerbated by non-reporting of CB cases. CB impacts negatively on the health of the workers and economy of the country. It may lead to increased absenteeism at work due to ill health and early retirement. The productivity at the workplace is also affected. Individuals who are suffering from chronic bronchitis have an increased risk of morbidity and mortality than healthy individuals. The objective of this study was to investigate the prevalence of CB and associated factors among workers in a South African welding company.

## MATERIALS AND METHODS

**The setting:** This study utilized the cross-section study design. The study was conducted in a South African welding company located in Bloemfontein, Free State province. The welding company consists of two large welding workshops and a block of offices. Welders and fitters were assigned to work in two welding workshops and performed the same tasks under the supervision of their supervisors.

**Participants:** An invitation was sent to all workers to participate in the study. From a total number of 124 workers, 88 volunteered and gave informed consent to participate in the study. Thus the participants were welders (n=37), fitters (n=21) and office workers (n=30). Both male and female participants of different races and educational background participated in the study. The majority of participants were married (47.7%) and there were more males (n=75) than females (n=13).

**Data collection:** A questionnaire consisting of open-and close-ended questions was administered to the participants by the researcher. Biographical, work and health-related information was collected from the participants. The biographical information included the age, gender, marital status, smoking status and level of education. The information

was also gathered in relation to the job titles, hours of work per day, hours spent welding, work experience. The health-related information was collected about the type of respiratory symptoms they have experienced and other diseases. Participants who reported a cough with sputum production for three months in a year for at least two consecutive years were regarded as suffering from CB. Participants were asked if they have experienced respiratory symptoms such as cough with sputum production, wheeze, shortness of breath, chest tightness and chest pain. A screening question was used to identify participants who suffered from chronic bronchitis.

All workers who were performing welding tasks were asked to describe their welding experience. Workers who perform welding tasks were assigned to two similar welding workshops and used metal inert gas welding method while office workers worked in offices. Participants were divided into two groups based on whether they have suffered CB (with CB) or not (without CB).

**Validity and Reliability:** A pilot study was conducted among five welders and four office workers before the study commence to test a questionnaire. The participants of the pilot study were not included in the main study.

**Ethical issues:** The participants participated in this study voluntarily and were informed about the aim of the study. An informed consent form was completed and signed by the participants before completion of a questionnaire. They were informed about their rights as participants and that confidentiality will be maintained. Ethical approval was obtained from the ethics committee of the University of the Free State.

**Data analysis:** Microsoft excel 2010 was used to capture the data obtained from the participants. The statistical analysis software (SAS) version 9.2 was used to perform the analysis of the data. The Chi square tests were performed to evaluate the association of CB with personal or work-related factors. The statistically significant level was kept at the level of 5% ( $p < 0.05$ ).

## RESULTS

**Biographical information:** The study included 88 participants of which 37 (42%) worked as welders. Thirty-four percent and 24% were office workers and fitters respectively. A total of 73 (83%) participants were males. Regarding the level of education, 50 (56.8%) participants had secondary education and almost 39% had tertiary education. Forty-seven percent of the participants were married.

**Socio-demographic and work-related factors and chronic bronchitis:** From Table 2, it is clear that the total number of 38 participants was experiencing chronic bronchitis and 18 of them were aged between 25 and 34 years. Furthermore, the results in Table 2 show that there were more participants who were non-smokers (70.5%) than smokers (29.5%). In terms of the smoking status, chronic bronchitis was more prevalent among non-smokers (46.8%) than smokers (34.6%). The

workstations for majority of participants (65.9%) were in the welding workshops and 34% participants worked in the offices. Regarding the job titles, it is evident from Table 2 that a high proportion of welders (62.2%) were suffering from chronic bronchitis than office workers (30.0%) and fitters (28.6%). The risk of developing chronic bronchitis was associated with an occupation as a welder. The working experience for majority of participants was from 1 to 10 years. From a total number of 58 participants who were assigned to welding workshops, 55.6% reported welding or fitting for 6 to 8 hours a day. These hours of welding and fitting were associated with the prevalence of chronic bronchitis (p=0.017).

**Chronic bronchitis and other disorders/respiratory symptoms:** Health-related disorders such as dizziness, stress, fatigue, headaches, asthma, heart palpitations, concentration and sleeping difficulties were associated with CB (P<0.05) as illustrated in Table 3. The occurrence of other respiratory symptoms in participants with chronic bronchitis is shown in

Table 4. It is clear that a significant association was found between chronic bronchitis and shortness of breath, chest pain, chest tightness, wheezing and irritation to the nasal cavity (p<0.05).

**Table 1.**  
Biographical information of participants (n=88)

	Characteristic	n	%
<b>Gender</b>	Male	73	83.0
	Female	15	17.0
<b>Job titles</b>	Welders	37	42.0
	Fitters	21	24.0
	Office workers	30	34.0
<b>Highest education level</b>	Primary	4	4.6
	Secondary	50	56.8
	Tertiary	34	38.6
<b>Marital status</b>	Single	35	39.8
	Divorced	8	9.1
	Married	42	47.7
	Living together	3	3.4

**Table 2.**  
Prevalence of Chronic bronchitis by socio-demographic and work-related factors.

Variable	Total	With CB (n=38)		Without CB (n=50)		P value	
		n	%	n	%		
<b>Gender</b>	Male	73	30	41.1	43	58.9	0.383
	Female	15	8	53.3	7	46.7	
<b>Age (years)</b>	25 – 34	43	18	41.9	25	58.1	0.807
	35 – 44	27	12	44.4	15	55.6	0.873
	45 – 54	2	6	50.0	6	50.0	0.608
	55 – 65	6	2	33.3	4	66.7	0.614
<b>Smoking status</b>	Smokers	26	9	34.6	17	65.4	0.293
	Non-smokers	62	29	46.8	33	53.2	
<b>Working hours per week</b>	<40	2	2	100.0	0	-	0.133
	40	62	26	41.9	36	58.1	
	>40	24	10	41.7	14	28.0	
<b>Workstations</b>	Welding workshop	58	29	50.0	29	50.0	0.726
	Offices	30	9	30.0	21	70.0	
<b>Job category</b>	Welders	37	23	62.2	14	37.8	0.002
	Fitters	21	6	28.6	15	71.4	0.121
	Office workers	30	9	30.0	21	70.0	0.073
<b>Working experience (years)</b>	1 – 10	74	29	39.2	45	60.8	0.821
	>10	14	9	64.2	5	35.7	
<b>Hours spent welding /fitting per day</b>	1-5	3	0	0	3	100.0	0.017
	6 – 8	45	25	55.6	20	44.4	
	>8	10	3	30.0	7	70.0	

**Table 3.**  
Prevalence of CB in participants with other diseases and health-related disorders

Disease/Disorder	Reported CB		No (n=50)	%	P value
	Yes (n=38)	%			
High blood pressure	2	5.3	7	14.0	0.180
Stress	16	42.1	10	20.0	0.024*
Sleeping difficulty	17	44.7	9	18.0	0.006*
Headache	33	86.8	21	42.0	0.00002*
Asthma	16	42.1	1	2.0	<0.00001*
Dizziness	14	36.8	6	12.0	0.006*
Memory difficulty	6	15.8	3	6.0	0.133
Fatigue/tiredness	19	50.0	10	20.0	0.003*
Heart palpitation	6	15.8	1	0.2	0.017*
Concentration difficulty	11	28.9	6	12	0.046*

**Table 4.**  
Prevalence of CB in participants with other respiratory symptoms

Disease/Disorder	Reported CB				P value
	Yes (n=38)		No (n=50)		
	n	%	n	%	
Shortness of breath	11	28.9	1	2.0	0.003
Chest pain	20	52.6	3	6.0	<0.00001
Chest tightness	11	28.9	1	2.0	0.003
Irritation to nasal cavity	13	34.2	3	6.0	0.0007
Wheezing	12	31.6	1	2.0	0.0001

## DISCUSSION

Almost half (n=43; 48.9%) of the participants in this study were in the age category of 25-34 years. A total of 38 participants suffered from chronic bronchitis representing a prevalence rate of 43.2%. This is inconsistent with other studies that reported the prevalence rate of 5.4% (Holm *et al.*, 2012) and 26.8% (Al-Otaib *et al.*, 2014) for chronic bronchitis. The prevalence of chronic bronchitis was higher among welders and it is in line with the previous studies (Meldrum *et al.*, 2005; Viegi and Di Pede, 2002; Viegi, 2001) that have reported an increased risk of chronic bronchitis among welders. Bradshaw *et al.* (1998) in another study reported that the prevalence for chronic bronchitis symptoms was higher in welders than non-welders.

An increased risk of chronic bronchitis observed among welders is due to exposure to welding fumes in the welding workshops. Carpet dust exposure in offices may contribute to the chronic bronchitis reported by office workers. Welding fumes include a mixture of gases, particles and metal oxide fumes which when it is inhaled reduce the lung function and increase the risk of chronic bronchitis (Krstev, 2008). Previous studies have reported occupational exposure to pollutants, tobacco smoke, indoor and outdoor air pollution as risk factors for chronic bronchitis (Ehrlich, 2004; Cai *et al.*, 2014).

In the present study, most participants were non-smokers and the results did not indicate a significant association of smoking with chronic bronchitis. The proportion of workers who smoked and reported suffering from chronic bronchitis (34.6%) was smaller than those without chronic bronchitis (65.4%). It has been reported that the prevalence of chronic bronchitis was associated with current smoking and exposure to welding fumes (Holm *et al.*, 2012). In a study conducted among Finnish men, Pelkonen *et al.* (2006) found that the cumulative risk of chronic bronchitis for ex-smokers and continuous smokers was 26% and 42% respectively. Furthermore, the cumulative risk for non-smokers was 22% in the said study.

In the United States, about 10 million people are affected by chronic bronchitis and majority of them are aged between 44 and 65 years of age (ALA, 2013). The risk of developing chronic bronchitis becomes high with an increase in age (Pelkonen *et al.*, 2006). In this study, the study population was a relatively young group with a median age of 34 years and the prevalence of chronic bronchitis was not influenced by age. In a previous study by Holm *et al.* (2012), a 2% increased

risk of chronic bronchitis was observed for each additional year of age among the participants.

Research shows that men are at a high risk of chronic bronchitis as compared to women (de Oca *et al.*, 2012; Kim *et al.*, 2011). In the present study majority of participants were males. Chronic bronchitis was more prevalent in females (53.3%) than males (41.1%). The study conducted among South African patients found that chronic bronchitis was highly prevalent in females (Ehrlich *et al.*, 2004).

The hours spent in welding influenced the prevalence of chronic bronchitis. A statistically significant number of workers who performed welding tasks for 6-8 hours in a day reported suffering from chronic bronchitis.

Participants with chronic bronchitis also reported other respiratory symptoms. The respiratory symptoms such as shortness of breath, chest pain, chest tightness, wheezing and irritation to the nasal cavity were associated with chronic bronchitis. Shortness of breath is a condition whereby it is difficult to inhale air into the lungs. It can result from inhalation of fumes and pollutants that damage the lung function resulting in narrowed airways in the lungs. Oxidative damage and inflammation of the respiratory tract may be caused by exposure to welding fume particles (Ithnin *et al.*, 2019). Twenty-nine percent of participants with chronic bronchitis also experienced shortness of breath. In a previous study by Al-Otaib (2014), the prevalence for shortness of breath was 9.8% and 4.9% for welders and non-exposed group respectively. A statistically significant number of participants suffering from chronic bronchitis also reported chest pains (52.6%), chest tightness (28.8%), irritation to the nasal cavity (34.2%) and wheezing (31.6%). Chest pains may be caused by continuous coughing that put more strain on the chest area. El-Zein *et al.* (2003) found that about 15% of welders reported wheezing and chest tightness, while in a study by Beach *et al.* (1996), wheezing and chest tightness were reported by 16% and 14% of shipyard welders respectively. It has been reported that office workers who were allergic to house mice dust (HDM) experienced more wheeze (Lim *et al.*, 2015).

In this study, the health-related disorders and other diseases were reported by participants with chronic bronchitis and there was an association. Headache (86.8%) was the most common reported health-related disorder, followed by fatigue (50%), sleeping difficulty (44.7%), stress (42.1%) and dizziness (36.8%). In the present study, over one-third of the participants with chronic bronchitis reported suffering from asthma and there was an association. In another study, it was found that about one-third of participants with chronic bronchitis also had asthma (Mejza *et al.*, 2017).

This study showed a high prevalence of chronic bronchitis among workers in the welding company. The prevalence was high among welders as compared to other workers. It also showed that chronic bronchitis is associated with other respiratory diseases such as asthma and that workers who perform welding tasks for a duration of 6-8 hours per day are at a high risk of chronic bronchitis. Implementation and monitoring of health and safety measures in the workplace and the residential environment is necessary to prevent chronic bronchitis. Further studies should be conducted to investigate the exposure levels of environmental pollutants at the

workplace and residential areas. The recommendations that should be implemented in the workplace are as follows:

- A survey should be conducted to identify the working conditions that may increase the risk of chronic bronchitis among the workers.
- Those who are smoking should be encouraged to quit smoking. Workers who are suffering from bronchitis should be given the treatment and adhere to it.
- Educational programmes should be designed in the workplace to educate the workers about the risk factors for chronic bronchitis as well as the preventative and management strategies.
- Workers should be encouraged to exercise regularly to improve the quality of life and avoid exposure to pollutants that may cause chronic bronchitis.
- The use of respiratory protective equipment such as respiratory mask equipped with filters is recommended for all workers who perform welding tasks to protect them from inhaling welding fumes, gases and particles.

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