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Attitudes toward tobacco cessation and lung cancer screening in two South African communities

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ABSTRACT

Among men in South Africa, the prevalence of tobacco smoking is as high as 33%. Although smoking is responsible for most lung cancer in South Africa, occupational and environmental exposures contribute greatly to risk. We conducted a tobacco and lung cancer screening needs assessment and administered surveys to adults who smoked >100 cigarettes in their lifetime in Johannesburg (urban) and Kimberley (rural). We compared tobacco use, risk exposure, attitudes toward and knowledge of, and receptivity to cessation and screening, by site. Of 324 smokers, nearly 85% of current smokers had a <30 pack-year history of smoking; 58.7% had tried to stop smoking ≥1 time, and 78.9% wanted to quit. Kimberley smokers more often reported being advised by a healthcare provider to stop smoking (56.5% vs. 37.3%, p=0.001) than smokers in Johannesburg but smokers in Johannesburg were more willing to stop smoking if advised by their doctor (72.9% vs. 41.7%, p<0.001). Findings indicate that tobacco smokers in two geographic areas of South Africa are motivated to stop smoking but receive no healthcare support to do so. Developing high risk criteria for lung cancer screening and creating tobacco cessation infrastructure may reduce tobacco use and decrease lung cancer mortality in South Africa.

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Tobacco smoking; Tobacco cessation; Lung cancer; Lung cancer screening; South Africa

Introduction

Lung cancer is the leading cause of cancer death worldwide (Bray et al., 2018). In South Africa (SA), lung cancer is the number one cause of cancer mortality among men and the third most common cause of cancer mortality among women (Cancer Association of South Africa (CANSA), 2014). About 60% of South African lung cancer deaths are attributable to smoking tobacco (Sitas et al., 2004). The prevalence of smoking in South Africa among all adults is 17.6% with rates as high as 33% among males and 33% in the Western Cape (Reddy et al., 2015; World Bank Group, 2019).

Although smoking is responsible for most lung cancer cases, occupational exposure to uranium, ionising radiation, asbestos, silica, arsenic, beryllium, chloromethyl, and nickel chromates associated with mining and indoor emissions, and polycyclic aromatic hydrocarbons (PAHs) from burning fuels to cook, are also known to cause lung cancer (Bello et al., 2011; Driscoll et al., 2005; Siemiatycki

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et al., 2004). Nearly 500,000 people are employed in SA mines (Chamber of Mines of South Africa, 2020), and about 18% of the population uses biomass energy for cooking (Statistics South Africa).

Infection with tuberculosis (TB) or human immunodeficiency virus (HIV) further contributes to lung cancer incidence in South Africa, which has one of the highest burdens of TB and HIV in the world (van Zyl-Smit et al., 2013). Approximately 19% of adults aged 15–49 years in South Africa are infected with HIV (Statistics South Africa, 2016) and 80% of the population is believed to be infected with TB, most of which are latent infections among adults 30–39 years (TBFacts.org, 2019). Lung cancer is the leading non-AIDS defining cancer and is the most common cause of cancer related death among HIV infected individuals (Moltó et al., 2015; Morlat et al., 2014; Shiels et al., 2011; Winstone et al., 2013). While higher smoking rates among those infected with HIV increase their lung cancer risk, HIV positivity, independent of smoking status, also is associated with lung cancer risk (Sigel et al., 2012; Sigel et al., 2017). The relationship between Infection with tuberculosis and lung cancer has long been debated but there is evidence to support that latent or previous history of TB increases risk for lung cancer (Brenner et al., 2011; Keikha & Esfahani, 2018). Patients with TB were found to be 10.9 times more likely than others to develop lung cancer (Yu et al., 2011), and smoking exacerbates the risk.

The most effective way for smokers to reduce their risk of lung cancer is tobacco cessation. A study conducted in the United States among more than 200,000 individuals reported that tobacco cessation by the age of 40 years reduced mortality associated with continued smoking by nearly 90%, and that cessation before age 65 reduced the excess risk of death by two-thirds (Jha et al., 2013). Daily smoking prevalence is highest among Coloured (i.e. individuals of mixed African and European or Asian ancestry) and Indian/Asian men and prevalence among Coloured women is much higher (12-fold higher) than among other women (Alcohol Tobacco and Other Drug Research Unit and South African Medical Research Council, 2016). Despite ratification of Article 14 of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) (World Health Organization (WHO), 2010) mandating that local healthcare systems in South Africa identify tobacco users and refer them to treatment (Alcohol Tobacco and Other Drug Research Unit and South African Medical Research Council, 2016; Omole et al., 2010), no systems have yet implemented that mandate. Few counsellors/specialists had been trained to treat tobacco addiction in South Africa and they are available primarily in mental health facilities (Alcohol Tobacco and Other Drug Research Unit and South African Medical Research Council, 2016). A single dedicated smoking cessation clinic in Cape Town is the only clinical service and training centre for tobacco treatment in the country (Tadzimirwa et al., 2019).

Population-based lung cancer screening using low-dose computed tomography (LDCT) also can reduce lung cancer mortality based on the landmark National Lung Screening Trial (NLST), which demonstrated a 20% reduction in lung cancer mortality among high-risk individuals (National Lung Screening Trial Research et al., 2011). In 2015, the European Society of Radiology and the European Respiratory Society issued a white paper with lung cancer screening recommendations like that issued by the United States Preventive Services Task Force, recommending LDCT among high-risk individuals, defined as current or former (quit within the past 15 years) smokers aged 55–80 years with a 30 pack-year history of tobacco use (Kauczor et al., 2015). South Africa has recently issued a similar statement on lung cancer screening (Koegelenberg et al., 2019). Uptake of LDCT in high-income countries with the resources to implement population-based lung cancer screening is low (Li et al., 2018; Rai et al., 2019). In low and middle income countries challenged with establishing the necessary infrastructure to support LDCT lung cancer screening, training healthcare personnel, and developing referral algorithms, LDCT screening is practically non-existent (Pinsky, 2018; Raez et al., 2018; Shankar et al., 2019). Instead, tobacco control and prevention strategies used in smoking cessation programmes will likely be the most important interventions for decreasing lung cancer morbidity and mortality in developing countries at this time (Raez et al., 2018; Shankar et al., 2019).

The Bristol Myers Squibb Foundation–funded Wits Health Consortium Centre of Respiratory Excellence Gauteng (CORE) linked to the University of Witwatersrand (Wits) in Johannesburg, South Africa, is a member of a multi-national research programme in sub-Saharan Africa with overarching goals to improve the early detection, management, and outcomes of lung cancer for the region. In line with these goals, our research team at the Herbert Irving Comprehensive Cancer Center (HICCC) of Columbia University in New York, U.S.A., partnered with CORE researchers to examine patterns of tobacco use, exposure to lung cancer risk factors, attitudes and knowledge about lung cancer, tobacco cessation, and lung cancer screening among adult current and former smokers. Findings generated from this preliminary study will inform future community-based interventions that can be tested in both urban and rural South African settings to decrease lung cancer mortality by reducing tobacco use and increasing rates of lung cancer screening with low-dose computed tomography.

Materials and methods

Setting

This pilot study was conducted in two CORE sites: Johannesburg, the largest city in South Africa, and Kimberley, a rural diamond mining community in the Northern Cape province of SA. In Johannesburg, recruitment was conducted in primary level clinics within the referral networks of the three Wits-associated tertiary hospitals: Charlotte Maxeke Johannesburg Academic Hospital, Helen Joseph Hospital, and Chris Hani Baragwanath Academic Hospital in Soweto and western suburbs of Johannesburg. In Kimberley, participants were recruited at clinics at the Kimberley Hospital and Dr. Harry Surtie Hospital in Upington, and Kuruman Hospital, affiliated with the Kimberley Hospital Complex (KHC) in the Northern Cape Province.

Participants

Adults aged 20–80 years who had never been diagnosed with lung cancer and who reported having smoked at least 100 cigarettes in their lifetime were invited to participate in this study. With the permission of the medical director at each recruitment clinic, multilingual study team nurses trained in the conduct of human subject research identified study-eligible individuals, obtained written informed consent, and conducted face-to-face interviews that were approximately 15 min in duration.

Survey

Sociodemographic, health-related, and tobacco smoking characteristics, exposure to occupational and residential environmental risk factors, and knowledge of and attitudes toward tobacco cessation and lung cancer screening were evaluated. Participant demographics included age (based on actual or estimated date of birth), sex, and racial group (White, Black, Coloured, or Asian). Literacy level was assessed by asking 'Can you read?' ('Yes', 'No', or 'A little bit'.) Also assessed were educational attainment, medical insurance coverage, and employment status. Participants were further asked about their health status (excellent, good, fair, poor, or bad) and existing comorbidities (heart disease, hypertension, chronic bronchitis, asthma, TB, HIV/AIDS, and cancer).

Tobacco use history was obtained by asking participants about their current smoking status (current or former cigarette smoker). Additional questions assessed use of e-cigarettes or vaping, oka (hookah) pipe, tobacco chew or snuff, and tobacco pipe or cigars. For both current and former smokers, age when started smoking, the number of years smoking, and the number of cigarettes smoked per day were determined. Pack history was calculated using the number of cigarettes smoked per day, divided by 20, and multiplied by the number of years smoking for current smokers. Current and

former smokers were also asked whether or not a healthcare provider had ever spoken to them or recommended that they quit smoking; had ever given them a prescription for medication (Champix) to quit smoking, suggested nicotine replacement therapy (nicotine patch or gum), or referred them to a smoking cessation 'quitline' for help to stop smoking. Among current smokers, to assess level of nicotine addiction, we asked how soon after waking they had their first cigarette, the number of previous quit attempts, and whether or not they wanted to stop smoking.

Environmental exposures were grouped as residential and occupational. Residential exposures included whether or not wood, coal, or animal dung was burned indoors for cooking, heating, or lighting; the type of cooking facility available in the home (gas stove, paraffin/gel stove, coal/wood stove, electric stove/hot plate, or open fire), and where cooking is done (mainly inside, mainly outside, inside and outside). Environmental exposures to asbestos, radon and radioactive gas and heavy dust in the air, heavy air pollution from diesel engines or generators or car exhaust fumes, and second-hand smoke exposure in the home or at work were determined with Yes/No responses. Questions about occupational exposures included ever working in the mining (arsenic/gold, asbestos, diamond, gold, platinum, copper, coal, rare metals), building and construction, and scrap yard, or metal recycling industries.

Knowledge of lung cancer risk factors was assessed by asking participants if they agreed or disagreed that lung cancer risks were associated with: cigarette smoking; second-hand cigarette smoke exposure; exposure to radon gas or other chemicals like asbestos and silica; air pollution; lung disease such as COPD, being HIV positive; or having TB. To assess lung cancer risk perceptions, participants were asked 'How common do you think lung cancer is?', 'How serious do you think lung cancer is?', 'Do you worry about getting lung cancer?' and 'What do you think your chances of getting lung cancer are?' (Park et al., 2014).

Receptivity to tobacco cessation and treatment and lung cancer screening with low-dose computed tomography (LDCT) were examined. Participants were presented with a series of scenarios in which one might consider tobacco cessation. These included: if your doctor recommended it, if Champix (nicotinic agonist medication) was free, if you had symptoms of lung cancer, if your family wanted you to, and if cessation support was available. Responses included 'Yes, definitely', 'Maybe', and 'Definitely not'. To evaluate attitudes and beliefs toward LDCT screening for lung cancer, the interviewer first read a brief description of LDCT that included how the test is performed, the use of low-dose radiation, the need to find tumours when they are small, the possibility of incidental findings, and the current criteria for LDCT lung cancer screening. Following this description, current smokers were asked if they would have LDCT to screen for lung cancer if the doctor recommended it, or if they thought they had symptoms of lung cancer. They were also asked if they feared that LDCT would find lung cancer, if the test would cause them worry, and if they would want to find lung cancer early if it was present.

Data analysis

Responses were recorded in a RedCap database (Harris et al., 2009; Harris et al., 2019) by the study coordinator at each site. De-identified survey data were transmitted to the Columbia researchers for analysis. All procedures were reviewed and approved by the Columbia University Institutional Review Board and the University of Witwatersrand Ethics Committee. We conducted descriptive analyses including frequency distributions, means, and univariable analyses using chi-square tests to evaluate differences in demographics, health-related and smoking use characteristics, environmental risk factors, and knowledge of and attitudes toward tobacco cessation and lung cancer screening. Normal distribution of continuous variables was assessed with the Shapiro Wilk test. The difference in the means of normally distributed continuous variables was calculated using Student's t test and, for non-parametrically distributed continuous variables, using the Mann–Whitney *U* test. *P*-values less than 0.05 were considered statistically significant, and all analyses were conducted using IBM SPSS, version 26 (IBM Corp., 2019).

Results

In total, 324 current and former smokers (who had smoked more than 100 cigarettes in their lifetime) completed the survey; 182 (56.2%) at the Johannesburg sites and 142 (43.8%) at the sites in Kimberley (Table 1). The mean age of all participants was 44.7 [SD 15.2] years; 70.4% were male, and 71.9% were Black. A majority were at least high school educated (81.8%), but nearly half (48.5%) were unemployed. The most commonly reported comorbidities were hypertension (25.6%) and HIV/AIDS (15.4%). Nearly 87% of the participants were current smokers and slightly more than half reported using e-cigarettes or vaping (52.2%). Participants from urban Johannesburg, more often reported having HIV/AIDS (24.2% vs. 4.2%, p <0.001) and using e-cigarettes and vaping (65.4% vs. 35.2%, p <0.001) than did participants in the rural Kimberley area.

Among current smokers, the mean age at initiation of smoking was 18.0 years [SD 5.9] and the mean number of years smoking was 25.4 [SD 13.8] (Table 1). The mean number of pack years (number of cigarettes smoked per day multiplied by the number of years smoking) was 15.5 [SD15.4]. The majority of current smokers reported wanting to quit (78.9%) but less than half (45.2%) had ever had a conversation with their doctor about quitting. Compared to current smokers in Johannesburg, current smokers in Kimberley more often reported ≥30 pack-years history of smoking (19.1% vs. 9.6%, p = 0.03) and twice as frequently reported more than 4 quit attempts (24.3% vs. 12.7%, p = 0.04). Current smokers in Kimberley also more often reported that a doctor spoke with them about quitting (56.5% vs. 37.3%, p = 0.001) and offered nicotine replacement therapy (15.7% vs. 3.6%, p <0.001) or referred them to a quitline for help quitting smoking (14.8% vs. 3.6%, p = 0.001). Current smokers in Johannesburg however, reported more often smoking their first cigarette within 5 min of waking, demonstrating a higher level of nicotine addiction (47.0% vs. 30.4%, p = 0.008) and more often reported wanting to quit (83.7% vs. 71.9%, p = 0.02).

Although current and former smokers in Kimberley more often reported working in the mines (11.3% vs. 4.4%, p = 0.019), Johannesburg participants claimed greater environmental exposures to lung cancer risk factors at home and at work (Table 2). Residential exposures to chemicals and pollutants were high in both communities but, in Johannesburg, significantly more smokers lived in a home where wood, coal, or animal dung was used for heat or light; worked in the cement or building industry, were exposed to asbestos or radon gas, or lived or worked in an area with heavy air pollution from diesel generators or engines and second-hand smoke.

Overall, knowledge of lung cancer risk factors ranged from 85.2% for cigarette smoking to 46.9% for having HIV infection (Table 3). Participants from Johannesburg were far more aware of lung cancer risk factors than those in Kimberley. For example, 92.3% of smokers in Johannesburg but only 76.1% in Kimberley agreed that cigarette smoking was a lung cancer risk factor (p <0.001). Attitudes and beliefs about how common and serious lung cancer is also varied by site; more respondents in Johannesburg believed that lung cancer is 'very common' (61.0% vs. 49.3%, p = 0.01) worried about getting lung cancer 'all the time' (40.7% vs. 26.8%, p = 0.018), or believed they have a 50/50 chance of getting lung cancer (63.2% vs. 35.2%, p <0.001) than Kimberley participants. Johannesburg current smokers were also more receptive to the ideas of undergoing tobacco cessation and lung cancer screening than current smokers in Kimberley. More Johannesburg than Kimberley smokers responded 'Yes, definitely' to questions about willingness to quit if the healthcare provider told you to quit, if you could obtain free Champix, if you had symptoms, and if support was available. More current smokers in Johannesburg than in Kimberley also responded 'Yes, definitely' to having an LDCT to screen for lung cancer if the healthcare provider recommended it and if they had any symptom of cancer. Although more Johannesburg than Kimberley participants reported that the LDCT would cause them to worry, participants in Johannesburg reported being less afraid of the test finding lung cancer (77.7% vs. 64.3%, p = 0.042) and more of them wanted to know early if lung cancer was present (95.2% vs. 87.0%, p = 0.038).

Table 1. Demographic, health-related, and tobacco use characteristics of current and former tobacco smokers in urban Johannesburg and rural Kimberley in South Africa.

	Total (n = 324)	Johannesburg (n = 182)	Kimberley (n = 142)	P value
Demographics				
Age (years)				0.038
Mean [SD]	44.7 [15.2]	43.0 [14.4]	46.9 [15.8]	
Range	20–85	20–85	20–78	
Gender				<0.001
Male	228 (70.4)	145 (79.7)	83 (58.5)	
Female	96 (29.6)	37 (20.3)	59 (41.5)	
Race				<0.001
White	16 (4.9)	12 (6.6)	4 (2.8)	
Black	233 (71.9)	159 (87.4)	74 (52.1)	
Coloured	75 (23.1)	11 (6.0)	64 (45.1)	
Asian	0 (0.0)	0 (0.0)	0 (0.0)	
Ability to read				0.15
Yes	298 (92.3)	171 (94.0)	127 (89.4)	
No	13 (4.0)	4 (2.2)	9 (6.3)	
A little bit	12 (3.7)	6 (3.3)	6 (4.2)	
Education				0.70
No formal education	12 (3.7)	4 (2.2)	8 (5.6)	
Primary school	46 (14.2)	20 (11.0)	26 (18.3)	
High school/tech school	226 (69.8)	136 (74.7)	90 (63.4)	
University/college	39 (12.0)	21 (11.5)	18 (12.7)	
Pay for medical care				<0.001
Government	254 (78.6)	152 (83.5)	102 (71.8)	
Medical aid	24 (7.4)	6 (3.3)	18 (12.7)	
Self pay	41 (12.6)	23 (12.6)	18 (12.6)	
Other	4 (1.2)	0 (0.0)	4 (2.8)	
Employment				0.20
Full time	61 (18.8)	36 (19.8)	25 (17.6)	
Part time	46 (14.2)	29 (15.9)	17 (12.0)	
Unemployed	157 (48.5)	88 (48.4)	69 (48.6)	
Self employed	17 (5.2)	12 (6.6)	5 (3.5)	
Other	43 (13.3)	17 (9.3)	26 (18.3)	
Health related characteristics				
Health status				0.001
Excellent	58 (17.9)	28 (15.4)	30 (21.1)	
Good	123 (38.0)	58 (31.9)	65 (45.8)	
Fair	100 (30.9)	66 (36.3)	34 (23.9)	
Poor	37 (11.4)	24 (13.2)	13 (9.2)	
Bad	6 (1.9)	6 (3.3)	0 (0.0)	
Comorbidities				
Hypertension	83 (25.6)	50 (27.5)	33 (23.2)	0.37
Heart disease	13 (4.0)	3 (1.6)	10 (7.0)	0.015
Chronic bronchitis	16 (4.9)	10 (5.5)	6 (4.2)	0.59
Asthma	21 (6.5)	11 (6.0)	10 (7.0)	0.73
Tuberculosis				
Current infection	18 (5.6)	11 (6.0)	7 (4.9)	0.65
Past infection	32 (9.9)	20 (11.0)	12 (8.5)	
HIV/AIDS	50 (15.4)	44 (24.2)	6 (4.2)	<0.001
Cancer	13 (4.0)	2 (1.1)	11 (7.7)	0.003
Smoking history				
Smoking status				
Cigarettes				0.007
Former smoker	43 (13.3)	16 (8.8)	27 (19.0)	
Current smoker	281 (86.7)	166 (91.2)	115 (81.0)	
e-Cigarettes or vaping	169 (52.2)	119 (65.4)	50 (35.2)	<0.001
Oka (Hookah) pipe	46 (14.2)	21 (11.5)	25 (17.6)	0.21
Chew or snuff	5 (1.5)	3 (1.6)	2 (1.4)	0.86
Tobacco pipe or cigars	68 (21.0)	40 (22.0)	28 (19.7)	0.60
Current smoker				
Age at initiation of smoking (years)				0.79
Mean [SD]	18.0 [5.9]	17.6 [5.6]	17.8 [6.0]	

(*Continued*)

Table 1. Continued.

	Total (n = 324)	Johannesburg (n = 182)	Kimberley (n = 142)	P value
Range	8–66	8–66	9–56	
Number of years smoking				0.94
Mean [SD]	25.4 [13.8]	24.4 [13.4]	27.1 [14.1]	
Range	2–65	2–65	2–63	
Number of cigarettes per day				0.10
Mean [SD]	11.2 [7.4]	10.9 [6.1]	11.6 [9.0]	
Range	0–60	2–35	0–60	
Pack years				
Mean [SD]	15.5 [15.4]	13.9 [12.5]	17.6 [18.5]	0.29
Range	0.3–105	0.3–74	0.3–105	
Heavy smoker pack years				0.03
<30	237 (84.3)	145 (87.3)	92 (80.0)	
≥30	38 (13.5)	16 (9.6)	22 (19.1)	
Missing	6 (2.1)	5 (3.0)	1 (0.9)	
First cigarette how soon after waking				0.008
Within 5 min	113 (40.2)	78 (47.0)	35 (30.4)	
6–30 min	74 (26.3)	43 (25.9)	31 (27.0)	
After 30 min	94 (33.5)	45 (27.1)	49 (42.6)	
How many times have you tried to quit				0.04
None	116 (41.3)	67 (40.6)	49 (42.4)	
1–2 times	89 (1.8)	59 (35.8)	30 (26.1)	
3–4 times	26 (9.3)	18 (10.9)	8 (7.0)	
More than 4 times	49 (17.5)	21 (12.7)	28 (24.3)	
Want to quit				0.02
Yes	221 (78.9)	139 (83.7)	82 (71.9)	
No	59 (21.1)	27 (16.3)	32 (29.1)	
Doctor ever talked to you or recommended you quit smoking				0.001
Yes	127 (45.2)	62 (37.3)	65 (56.5)	
No	154 (54.8)	104 (62.7)	50 (43.5)	
Doctor ever prescribed medicine (Champix) to help you quit				0.25
Yes	23 (8.2)	11 (6.6)	12 (10.4)	
No	258 (91.8)	155 (93.4)	103 (89.6)	
Doctor ever recommended nicotine patch or gum				<0.001
Yes	24 (8.5)	6 (3.6)	18 (15.7)	
No	257 (91.5)	160 (96.4)	97 (84.3)	
Doctor ever recommended calling a quitline for help quitting				0.001
Yes	23 (8.2)	6 (3.6)	17 (14.8)	
No	258 (91.8)	160 (96.4)	98 (85.2)	

Discussion

This study is the first to evaluate attitudes, knowledge, and behaviours surrounding tobacco use among individuals in two different geographic locations in South Africa who have smoked more than 100 cigarettes in their lifetime and to assess differences by urban vs. rural locale. We found that smokers in both the urban and rural areas had a strong desire to stop smoking and had attempted to quit tobacco in the past but lacked support from the medical community in the form of screening for tobacco use or advice to stop cigarette smoking. The missed screening and counselling opportunities found in our study confirm the findings of Omole *et al.* that, in exit interviews following a primary healthcare provider visit among 500 South African adults, only 12.9% were screened for tobacco use and, of current smokers, 11.9% were advised against tobacco use (Omole et al., 2010).

We also found that smokers at both sites were favourably disposed toward tobacco cessation counselling, nicotine replacement therapy, nicotinic receptor agonist medication (e.g. Champix), and even lung cancer screening with LDCT. These attitudes may reflect knowledge regarding the lung cancer risk factors in the environment (both residential and occupational), overestimation of lung cancer risk, or excessive worry about developing lung cancer in the future. Other findings of interest include relatively little knowledge of the role HIV infection plays in the development of

Table 2. Environmental risk exposures among current and former smokers urban Johannesburg and rural Kimberley in South Africa by site.

	Total (n = 324)	Johannesburg (n = 182)	Kimberley (n = 142)	P value
Residential				
Ever lived where wood, coal, or animal dung was burned indoors for cooking, heating, or lighting				0.004
Yes	174 (53.7)	110 (60.4)	64 (45.1)	
No	144 (44.4)	68 (37.4)	76 (53.5)	
Missing	6 (1.9)	4 (2.2)	2 (1.4)	
Type of cooking facility				0.27
Gas stove	7 (2.2)	4 (2.2)	3 (2.1)	
Paraffin/gel stove	8 (2.5)	4 (2.2)	4 (2.4)	
Coal/wood stove	9 (2.8)	2 (1.1)	7 (4.9)	
Electric stove	297 (91.7)	171 (94.0)	126 (88.7)	
Open fire	3 (0.9)	1 (0.5)	2 (1.4)	
Where cooking is done				0.06
Mainly inside	304 (93.8)	174 (95.6)	130 (91.5)	
Mainly outside	2 (0.6)	0 (0.0)	2 (1.4)	
Inside and outside	16 (4.9)	6 (3.3)	10 (7.0)	
Exposed to asbestos				<0.001
Yes	90 (27.8)	79 (43.4)	11 (7.7)	
No	234 (72.2)	103 (56.6)	131 (92.3)	
Exposed to radon/radioactive gas				<0.001
Yes	61 (18.8)	52 (28.6)	9 (6.3)	
No	263 (81.2)	130 (71.4)	133 (93.7)	
Lived or worked with dust in the air				<0.001
Yes	159 (49.1)	117 (64.3)	42 (29.6)	
No	165 (50.9)	65 (35.7)	100 (70.4)	
Lived or worked with heavy air pollution from diesel engines/ generators				<0.001
Yes	104 (32.1)	76 (41.8)	28 (19.7)	
No	220 (67.9)	106 (58.2)	114 (80.3)	
Second-hand smoke				<0.001
Yes	255 (78.7)	156 (85.7)	99 (69.7)	
No	69 (21.3)	26 (14.3)	43 (30.3)	
Occupational				
Worked in the mining industry				0.019
Yes	24 (7.4)	8 (4.4)	16 (11.3)	
No	300 (92.6)	174 (95.6)	126 (88.7)	
Arsenic/gold	1 (0.3)	1 (0.5)	0 (0.0)	0.28
Asbestos	1 (0.3)	0 (0.0)	1 (0.7)	0.20
Coal	2 (0.6)	2 (1.1)	0 (0.0)	0.13
Copper	4 (1.2)	0 (0.0)	4 (2.8)	0.01
Diamond	13 (4.0)	3 (1.6)	10 (7.0)	0.014
Gold	1 (0.3)	1 (0.5)	0 (0.0)	0.28
Platinum	4 (1.2)	3 (1.6)	1 (0.7)	0.43
Rare metals	0 (0.0)	0 (0.0)	0 (0.0)	1.00
Worked in cement, building industry				0.002
Yes	102 (31.5)	70 (38.5)	32 (22.5)	
No	222 (68.5)	112 (61.5)	110 (75.5)	
Worked in scrap yard/metal recycling				0.36
Yes	23 (7.1)	15 (8.2)	8 (5.6)	
No	301 (92.9)	167 (91.8)	134 (94.4)	

lung cancer, unexpectedly high reported use of vaping with e-cigarettes, and low pack-year history of cigarette smoking.

The urban Johannesburg respondents reported poorer health status overall; 24.2% stated that they were HIV-positive, compared to 4.2% of rural Kimberley respondents. Knowledge of lung cancer risk factors was consistently greater among the Johannesburg participants but neither group had a good grasp of the associations of HIV and TB with the development of lung cancer. Greater knowledge of lung cancer risk in the urban Johannesburg area may reflect more frequent contact with the

Table 3. Lung cancer risk knowledge, attitudes, and beliefs among current and former smokers urban Johannesburg and rural Kimberley in South Africa.

	Total (n = 324)	Johannesburg (n = 182)	Kimberley (n = 142)	P value
Lung cancer risk knowledge				
Cigarette smoking	276 (85.2)	168 (92.3)	108 (76.1)	<0.001
Second-hand cigarette smoke	269 (83.0)	160 (87.9)	109 (76.8)	0.008
Exposure to radon	196 (60.5)	131 (72.0)	65 (45.8)	<0.001
Exposure to chemicals	243 (75.0)	153 (84.1)	90 (63.4)	<0.001
Air pollution	249 (76.9)	147 (80.8)	102 (71.8)	0.06
Lung disease	192 (59.4)	133 (73.1)	59 (41.5)	<0.001
HIV positive	152 (46.9)	104 (57.1)	48 (33.8)	<0.001
Tuberculosis	212 (65.8)	139 (76.4)	73 (51.4)	<0.001
Lung cancer beliefs and attitudes				
How common is lung cancer				0.01
Not very common	19 (5.9)	7 (3.8)	12 (8.5)	
Somewhat common	75 (23.1)	45 (24.7)	30 (21.1)	
Very common	181 (55.9)	111 (61.0)	70 (49.3)	
Don't know	49 (15.1)	19 (10.4)	30 (21.1)	
How serious is lung cancer				0.25
Not very serious	10 (3.1)	4 (2.2)	6 (4.2)	
Somewhat serious	33 (10.2)	15 (8.2)	18 (12.7)	
Very serious	256 (79.0)	151 (83.0)	105 (73.9)	
Don't know	25 (7.7)	12 (6.6)	13 (9.2)	
Worry about lung cancer				0.018
Never	56 (17.3)	25 (13.7)	31 (21.8)	
Sometimes	156 (48.1)	83 (45.6)	73 (51.4)	
All the time	112 (34.6)	74 (40.7)	38 (26.8)	
Your chances of getting lung cancer				<0.001
No chance	19 (5.9)	6 (3.3)	13 (9.2)	
Probably will NOT get	16 (4.9)	5 (2.7)	11 (7.7)	
50/50 chance	165 (50.9)	115 (63.2)	50 (35.2)	
Definitely will get	48 (14.8)	30 (16.5)	18 (12.7)	
Don't know	54 (16.7)	18 (9.9)	36 (25.4)	
Missing	22 (6.8)	8 (4.4)	14 (9.9)	
Receptiveness to tobacco cessation and treatment				
Quit if doctor told you to				<0.001
Yes, definitely	169 (60.1)	121 (72.9)	48 (41.7)	
Maybe	86 (30.6)	33 (19.9)	53 (46.1)	
Definitely not	26 (9.3)	12 (7.2)	14 (12.2)	
Quit with free Champix				<0.001
Yes, definitely	220 (78.3)	147 (88.6)	73 (63.5)	
Maybe	44 (15.7)	16 (9.6)	28 (24.3)	
Definitely not	17 (6.0)	3 (1.8)	14 (12.2)	
Quit if had symptoms of lung cancer				<0.001
Yes, definitely	217 (77.2)	146 (88.0)	71 (61.7)	
Maybe	52 (18.5)	17 (10.2)	35 (30.4)	
Definitely not	12 (4.3)	3 (1.8)	9 (7.8)	
Quit if family wanted you to				0.96
Yes, definitely	114 (40.6)	67 (40.4)	47 (40.9)	
Maybe	121 (43.1)	71 (42.8)	50 (43.5)	
Definitely not	46 (16.4)	28 (16.9)	18 (15.7)	
Quit if support available				<0.001
Yes, definitely	192 (68.3)	133 (80.1)	59 (51.3)	
Maybe	60 (21.4)	23 (13.9)	37 (32.2)	
Definitely not	29 (10.3)	10 (6.0)	19 (16.5)	
LDCT lung cancer screening attitudes				
LDCT if doctor recommended				0.001
Yes, definitely	246 (87.5)	155 (93.4)	91 (79.1)	
Maybe	27 (9.6)	10 (6.0)	17 (14.8)	
Definitely not	8 (2.8)	1 (0.6)	7 (6.1)	
LDCT if had a LC symptom				0.001
Yes, definitely	254 (90.4)	159 (95.8)	95 (82.6)	
Maybe	18 (6.4)	5 (3.0)	13 (11.3)	
Definitely not	9 (3.2)	2 (1.2)	7 (6.1)	
Afraid test will find lung cancer				0.042

(*Continued*)

Table 3. Continued.

	Total (n = 324)	Johannesburg (n = 182)	Kimberley (n = 142)	P value
Yes	70 (24.9)	34 (20.5)	36 (31.3)	
No	203 (72.2)	129 (77.7)	74 (64.3)	
Don't know	8 (2.8)	3 (1.8)	5 (4.3)	
Test will cause worry				0.009
Yes	150 (53.4)	93 (56.0)	57 (49.6)	
No	114 (40.6)	69 (41.6)	45 (39.1)	
Don't know	17 (6.0)	4 (2.4)	13 (11.3)	
Want to find lung cancer as early as possible if there				0.038
Yes	258 (91.8)	158 (95.2)	100 (87.0)	
No	11 (3.9)	3 (1.8)	8 (7.0)	
Don't know	12 (4.3)	5 (3.0)	7 (6.1)	

healthcare system due to poorer overall health and HIV status. Enthusiasm for tobacco cessation and treatment and lung cancer screening with LDCT was also greater in the urban Johannesburg area than in Kimberley; more participants were willing to quit smoking if told to do so by a physician or if medication and support to quit were available, and to have lung cancer screening if the doctor recommended it. The observed significant population differences in knowledge and attitudes suggest that a 'one size fits all' type of intervention may not be effective and point to the need for tailored approaches to outreach, engagement, and education for both patients and physicians to accompany treatment interventions to decrease tobacco use.

Another important difference between the two locales is reported e-cigarette and vaping use. Reported e-cigarette and vaping use in urban Johannesburg (65.4%) was double that in Kimberley (35.2%). The 2016 South African Demographic and Health Survey (SADHS) reported that 2% of women and 3% of men aged 15 years or older use e-cigarettes (National Department of Health (NDoH), Statistics South Africa (Stats SA), South African Medical Research, & Council (SAMRC), 2019). While SADHS was a population-based evaluation of e-cigarette use and ours was an observational study of a small sample of current and former smokers who may be more likely to use e-cigarettes, the difference in rates of e-cigarette use is staggering and supports alarms being sounded by public health experts that e-cigarette use is increasing dramatically. Recent estimates predict that the e-cigarette market in South Africa, now $21 million annually, will nearly triple to $62 million by 2024 (PR Newswire, 2019). The major driver of this increase is the targeted marketing of these products to youth in South Africa via on-line channels and social media in which e-cigarettes are framed as an environmentally friendly, cost-effective, safe, convenient, and healthy alternative to traditional tobacco smoking (PR Newswire, 2019). As the largest city in South Africa, Johannesburg is the especially vulnerable to this type of intense marketing strategy. Governmental efforts to control tobacco use have driven up the price of traditional cigarettes intentionally making them unaffordable to larger numbers of individuals but therefore increasing the appeal of e-cigarettes (van Zyl-Smit, 2013). Additionally, the number of individuals suffering from serious illnesses associated with traditional tobacco consumption is increasing. Little is known about the potential harms of e-cigarettes at this time (van Zyl-Smit, 2013). This lack of data allows e-cigarettes to be touted as a healthy substitute source of nicotine and means of treating nicotine addiction (van Zyl-Smit, 2013). Future efforts to reduce tobacco use must therefore include educating the public about the uncertain safety of e-cigarettes and the dangers of nicotine addiction associated with vaping.

Overall, 84.3% of study participants reported <30 pack-year history of cigarette smoking (number of years smoked x cigarettes smoked per day). Current United States Preventive Services Task Force (USPSTF) guidelines (United States Preventive Services Task Force, 2016) based on the findings of the National Lung Screening Trial (NLST) (National Lung Screening Trial Research, et al., 2011) recommend annual LDCT lung cancer screening only for those at high risk for lung cancer on the basis of age and smoking history – adults aged 55–80 years who have a minimum 30 pack-year smoking history and currently smoke or have quit within the past 15 years (Jemal & Fedewa, 2017). This

targeted approach selects out 'high risk' individuals to maximise the benefits of screening while minimising potential harms from false positive findings. Using NLST criteria, however, excludes most of the individuals who participated in our study. This does not imply that South Africans are not at greater risk, only that the risks to which South Africans in our study and those of other developing countries (i.e. positive HIV status, co-infection with tuberculosis, and exposure to environmental pollutants and toxins) were not evaluated in NLST therefore, the actual risk of this population may not be reflected in NLST criteria. Clearly additional research is needed to define 'high risk' in this setting that accounts for the specific risks to which South Africans are exposed in order to develop LDCT criteria that is relevant to these exposures and populations.

Further, because infrastructure to support widespread use screening with LDCT is not likely to be developed in the near future in South Africa and other low-to-middle income and developing countries and the research needed to define 'high risk' based on exposures not assessed in NLST has not yet been conducted, resources and efforts in South Africa should be directed toward tobacco cessation. Educating healthcare providers and supplying them with other tools to identify individuals who smoke, creating infrastructure to support referrals to counselling, and making nicotine replacement therapy available at little or no cost should be prioritised. Attention must be paid to the needs of special segments of the population, including those who are HIV positive and those who have tuberculosis – two conditions that are highly prevalent in South Africa. Two separate observational studies conducted in Johannesburg at HIV clinics surveyed individuals with HIV infection (Shapiro et al., 2011; Waweru et al., 2013), Each found high rates of tobacco use and a strong desire among HIV-infected individuals to quit smoking. Both studies concluded that including tobacco treatment in HIV care would be effective in assisting HIV-infected persons to quit smoking. Building upon this work, a recent South African randomised trial compared intensive anti-smoking counselling with counselling and nicotine replacement therapy among HIV-infected individuals found low rates of cessation in both study arms (Krishnan et al., 2018). Post-hoc qualitative interviews of participants and a focus group of counsellors revealed that multiple adverse social conditions, including stress, discrimination, and low social support, contributed to tobacco addictive behaviour and undermined the intervention. These findings suggestion that interventions to reduce tobacco use must also be sensitive to the lived experience of the individual undergoing cessation counselling and should be integrated into larger social support systems within healthcare organisations. In other words, a multilevel, coordinated approach is needed to address not only tobacco use behaviour but also the underlying determinants of this behaviour.

Our study has limitations that should be noted. It was an observational study conducted at two geographic locations in South Africa. Both sites were part of a larger healthcare network and affiliated with a Bristol Meyers Squib Foundation-funded grant to support lung health with trained research staff. Thus, our findings may lack generalizability to other South African healthcare settings. Our study participants had a history of smoking more than 100 cigarettes in their lifetime and were seeking primary and lung disease care and may not be representative of all South African tobacco smokers. Since medical charts are not maintained in the South African healthcare system in the way they are in the United States (e.g. electronic medical records retained at the health facility), comorbidity and environmental exposure data were self-reported. Inaccuracies in self-report may have led to misclassification of existing chronic disease and toxic exposures.

The findings of our study demonstrate that smokers, both current and former, in two geographically distinct areas in South Africa are aware of the effects of tobacco smoking and other exposures as risk factors for lung cancer and that smokers are receptive to tobacco cessation and lung cancer screening efforts. That almost half of our study participants reported that they have never received any advice or information on tobacco cessation from healthcare providers, indicates the need for a concerted effort to train physicians and healthcare workers in tobacco addiction treatment. Furthermore, infrastructure to provide tobacco cessation should be sensitive to vulnerable patient populations, including those who are HIV-positive, and should include referral to care for the social and other determinants of smoking behaviour. Efforts should also be made to counter the intensive

marketing campaigns that promote e-cigarette use and vaping as safe, less expensive, and healthier alternative sources of nicotine. Lastly, additional research is needed to assess 'high risk' criteria for LDCT lung cancer screening in the context of the exposures common to developing countries, examine attitudes and knowledge of healthcare providers surrounding LDCT lung cancer screening, and evaluate the feasibility and affordability of population-based LDCT as a means of decreasing lung cancer mortality in South Africa.

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