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Comparative Study on the Respiratory Outcomes among Underground Gold Miners and Non Miners in Orkney, South Africa

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Abstract

There is scarce knowledge about respiratory outcomes among underground gold miners in Orkney, South Africa. Due to the occupational exposure to poor ventilation, dust and others underground gold mine workers are vulnerable to respiratory or pulmonary disorders and diseases. There has not been a documented literature in the past to compare the respiratory outcome of gold miners and non-miners in Orkney area of South Africa. This was a cross sectional study designed to investigate and compare respiratory outcomes among gold miners and non-miners.

A comparative cross sectional survey of gold miners and non-miners living in the same geographical location of Orkney, South Africa was carried out using a modified health assessment questionnaire to determine the prevalence of such respiratory disorders among these underground gold miners and comparing the same with the non-miners.

*A total of 222 gold miners and 222 non gold miners were surveyed using the questionnaire while trying to match the two groups as closely as possible. Data analysis was done using the Statistical Package for Social Science (SPSS) version 20. Paired sample t-test was used to compare the mean differences between the gold miners and the non-gold miners. Statistical level of significance was set at P-value <0.05. Result shows a higher prevalence of respiratory diseases (**2.71** times higher) among the underground gold mine workers when compared to the non-miners. With a standard deviation of +-11.46 and +-9.79 respectively.*

It was concluded that occupational exposures to respirable dust mainly silicon must have contributed significantly to the observed difference in these two groups. More protective and preventive measures become imperative in controlling this outcome. Employers of gold miners should therefore take more appropriate health preventive measures aimed at reducing significantly the exposure rate and amount to respirable dust among the miners.

Keywords: *Respiratory, disorders, exposure, underground.*

Introduction

In a country like South Africa, where gold mining is the mainstay of the economy according to the country's chamber of mines report (Cmsa, 2014) due attention, contribution and constructive criticism from all stakeholders in the economy become imperative. Health care practitioners are also expected to contribute their quota to this sector. It is a common knowledge that arguably the most disturbing health hazard facing the underground gold miners remains respiratory diseases; with increased frequency of pulmonary tuberculosis and silicosis (Eisler, 2003). Health conditions associated with gold miners who worked underground has been found to include; cancer of the trachea, bronchus, lung, stomach, and liver; increased incidences of pulmonary tuberculosis (PTB), silicosis, and pleural diseases. (Eisler, 2003). A similar study identified silica related lung disease as a common disorder among gold miners (Labuschagne, 2006). While there have been many challenges in the gold mining industry particularly on safety and health issues as regards occupational exposure underground there has not been adequate study or research into the effects of dust on the respiratory outcome of these miners (MOSH, 2014; NIOSH, 2000). Silica or dust exposure has been documented to adversely affect respiratory outcome in gold miners generally (Hertzberg et al, 2002). Public health practitioners should wade in to study and propose an adequate solution to this menace.

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In an economy where the mainstay remains on gold mining, the health and wellness of the workers becomes a necessary measure to increase productivity and ensure safety in the mining industry. With annual mortality and morbidity challenges facing the industry, for example, I was reported that annually 1% of gold miners die in South Africa (SAMJ,2014); studies aimed at describing and evaluating the courses and measures to adequately prevent occurrences should be a concern of all stake holders. Respiratory diseases are the major occupational health hazard that plagues this industry for centuries with little desirable attention at reducing the problem. The main purpose of this research is to evaluate and compare the respiratory outcome of gold miners working in Orkney gold mine fields in South Africa with that of Orkney residents who are non-gold miners.

Hypothesis

1. H0: There will be no significant differences in the respiratory outcome among underground gold miners.

H1: There will be a significant difference in the respiratory outcome among underground gold miners.

Literature review

Poor ventilation

With some underground depth of between 2 to 3 kilometres poor ventilation is one of the major health hazards confronting these underground gold miners. This is coupled with heat exhaustion which could always remain a problem in underground mines, (Donoghue, 2004), having a cooling system becomes imperative. In terms of equipment and capacity, the design of such cooling systems must meet requirements for high demand peaks. Therefore, constructing a good ventilation system for modern mines is an integral aspect of a mine's technical layout or design (Biffi et al, 2007). The objective of any ventilation system is the provision of healthy and safe tunnel conditions. The gold mining sector pioneered cooling strategies which will serve as the basis of future ventilation planning and need. However, healthy and safe working environment still remains a challenge in the industry. (Biffi et al, 2007).

Exposure to dust

Dust exposure is another common occupational hazard facing gold miners (Donoghue, 2004). According to a systematic review study, a statistically significant association was found between loss of pulmonary function and cumulative respirable dust exposure. There was found a significant increase in the effect of total cumulative dust exposure on breathlessness according to a study in Ghana. (Sadhra et al, 2007). Estimates put it that 80 (95% CI, 34 to 137) of 1,000 non-smoking coal miners with a cumulative respirable exposure of 122.5 Gh/m3 to dust(considered equivalent to 35 years of work with a mean respirable dust level of 2 mg/m3) could be expected to develop a clinically important (> 20%) loss of FEV1, due to exposure to dust. Among 1,000 smoking miners, the comparable estimate was 66 (95% CI, 49 to 84). The risk of a clinically important loss of lung function due to dust among non-smoking gold miners was found to be three times as large as for coal miners at less than one-fifth of the cumulative respirable dust exposure (21.3 Gh/m3), the maximal exposure observed among the cohort of gold miners. (William, 2007) It was thus concluded in the study that occupational dust is an important cause of COPD, and the risk appears to be greater for gold miners when compared to coal miners. One possible explanation of the greater risk among gold miners is the higher silica content in gold mine dust. (William, 2007).

Morbidity and mortality

According to Gavin Churchyard of the Aurum Institute, silicosis prevalence "jumped dramatically" among gold miners after 15 - 20 years of underground work, and around 41% of gold mine workers are found to have active TB upon autopsy in South Africa (SAMJ, 2014).

The South African Medical Journal also reported that one in every 100 gold miners in the country has been dying annually for at least the past 10 years - and the mortality rate, fed by the HIV/TB epidemic, shows no sign of changing anytime soon.(SAMJ,2014;Churchyard&Fielding,2014).

Additional 4% of gold miners are repatriated home (medically boarded) every year due to ill health (mainly due to respiratory disease) - roughly 5 times the national workforce average.(SAMJ,2014). Silica or dust associated occupational disease are high among gold miners and in recent years, the incidence of tuberculosis (TB) has increased tremendously as a result of the combined effects of the HIV epidemic and the exposure to silica dust. (Corbet et al, 2002).

Methodology

Research design

A cross sectional study design was used. Participants were selected with a simple random sampling technique. These two groups were matched as close as possible in terms of age, gender, height, and race to limit the influence of these confounders on their respiratory indices. 12 different respiratory conditions and 1 heart condition were assessed with the questionnaire. The entire participant signed a consent form before being given the health assessment questionnaire, which is a 57-item questionnaire that extracts information on their demographic variables, past medical history, occurrence of respiratory symptoms, smoking habit, and the use of respiratory protective equipment.

Sampling technique

In order to have a good sample representation for this cross sectional study, the Slovin's formula for calculating sample size was utilized while simple random sampling method was used to pick the participants in a particular small suburb of Orkney.

The minimum sample size (n) using Slovin's formula: n = N/1+Ne2

- Where n is the minimum sample size needed
- e is the level of error that can be tolerated (0.05 chance of error)
- N is the target population = (500)

n= 500/1+ (500*0.052)
= 500/1+ (500*0.0025)
= 500/1+1.25= 500/2.25
=222.22

A total of 222 miners were selected to make up the study participant. For non-miners, also resident of Orkney, with approximately the same target population of 500, a total of 222 were also selected to make up the study participant. Questionnaire Description: A Standardized respiratory health questionnaire was modified and adapted appropriately for this study (BMRC, 1960). The modified 57 item questionnaire seeks information on demographic indices, past medical records, smoking habit, respiratory symptoms, and respiratory protective wear/equipment.

Participants, both miners, and non-miners were adequately matched on gender, height and age to limit extraneous influence on measurement (confounding factor). This is because of gender, age, and height influences respiratory function (Ostrowski & Barud, 2006).

Subject selection

Inclusion criteria

The following characteristic or features were used for inclusion in this study:

1. Gold mine workers who reside in Orkney, South Africa.
2. Age between 20 and 55(To minimise the effect of ageing on respiratory function). (Pruthi & Multani, 2012).
3. Males and Females.
4. Non-miners must be residing in Orkney, South Africa.
5. Participant must have been a miner for at least 2 years (to allow for adequate occupational exposure to dust and poor ventilation, and must be working underground.

Exclusion criteria

The following were the exclusion criteria in the study:

1. Gold miners who have not been up to 2 years on the job.
2. Non-Orkney residents.

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Data analysis

Data analysis was done using the Statistical Package for Social Science (SPSS) version 20. Paired sample t-test was used to compare the mean differences between the gold miners and the non-gold miners. A bar chart was used to represent measured variables. Statistical level of significance was set at P-value <0.05.

Results

The result shows a significant difference in the prevalence of the respiratory diseases. It was 2.71 times higher among the miners. With a mean of 55 against 35; variance of 131.41 against 96.01; and standard deviation of +-11.46 against +-9.79 among the gold miners and non-miners respectively.

The null hypothesis, "there will be no significance difference in respiratory outcome among gold miners and non-miners" was rejected.

Table 1. Age range and percentage of gold miners

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	18 - 24 Years	40	18.0	18.0	18.0
	25 - 31 Years	77	34.7	34.7	52.7
	32 - 38 Years	49	22.1	22.1	74.8
	39 - 45 Years	40	18.0	18.0	92.8
	46 & Above	16	7.2	7.2	100.0
	Total	222	100.0	100.0	

Table 2. Age range and percentage of non-miners

	Frequency	Percent	Valid percent	Cum.percent
18-24 Years	41	18.5	18.5	18.5
25-31 Years	54	24.3	24.3	42.8
Valid 32-38 Years	41	18.5	18.5	61.3
39-45 Years	43	19.4	19.4	80.6
46 &Above	43	19.4	19.4	100.0
Total	222	100.0	100.0	18.5

Prevalence of respiratory diseases

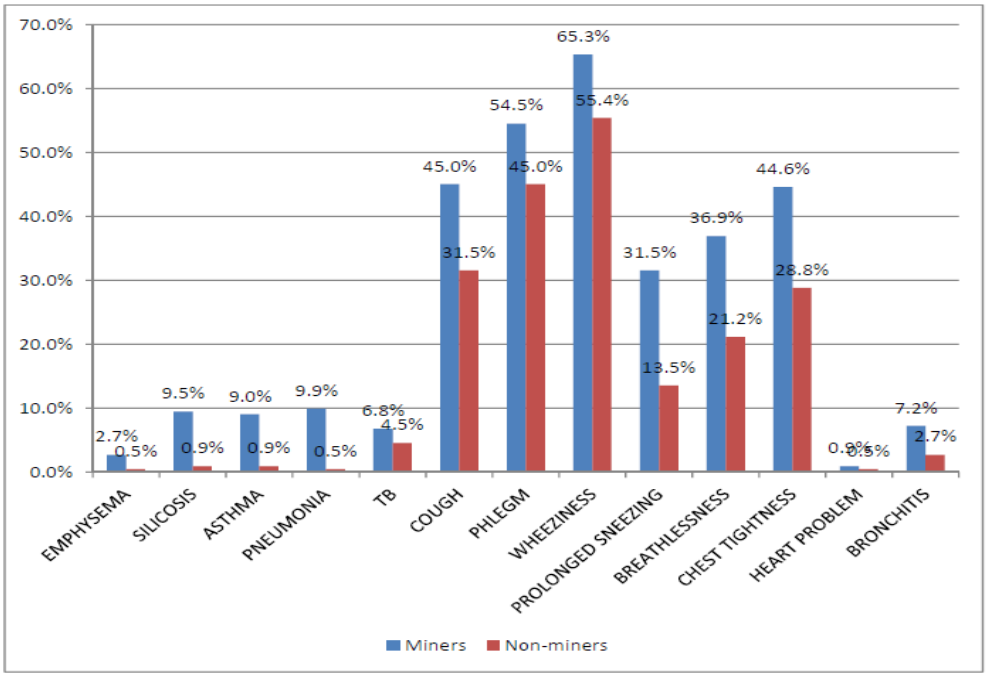

Figure 1. Bar chart showing the prevalence of respiratory disease among miners and non-miners.

Table 3. Prevalence rate of conditions among miners and non-miners

Miners	Non-Miners
2.7	0.5
9.5	0.9
9	0.9
9.9	0.5
6.8	4.5
45	31.5
54.5	45
65.3	55.4
31.5	13.5
36.9	21.2
44.6	28.8
0.9	0.5
7.2	2.7
TOTAL=558%	TOTAL=205.9%

558%/205.9% = 2.71

Therefore, overall the Prevalence rate, PR of all the respiratory conditions is **2.71** times higher among gold miners.

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Table 4. Prevalence rates.

	Miners	Non-Miners	PR-Miners	PR-Non Miners
EMPHYSEMA	6	1	2.70E+00	4.50E-02
SILICOSIS	21	2	9.46E+00	9.01E-01
ASTHMA	20	2	9.01E+00	9.01E-01
PNEUMONIA	22	1	9.91E+00	4.50E-02
TB	15	10	6.76E+00	4.50E+08
COUGH	100	70	4.50E+01	3.15E+69
PHLEGM	121	100	5.45E+01	4.50E+99
WHEEZINESS	145	123	6.53E+01	5.54E+122
PROLONGED SNEEZING	70	30	3.15E+01	1.35E+29
BREATHLESSNESS	82	47	3.69E+01	2.12E+46
CHEST TIGHTNESS	99	64	4.46E+01	2.88E+63
HEART PROBLEM	2	1	9.01E-01	4.50E-02
BRONCHITIS	16	6	7.21E+00	2.70E+04
Mean	55	35		
Variance	131.4054	96.01802		
SD	11.46322	9.798878		

As shown in Figure 1 above, gold miners are more prone to respiratory diseases. Wheeziness was the most (65.3 percent of miners) cited respiratory disease among the other types of diseases the respondents are prone to, compare with non-gold miners (55.4 percent). This is followed by Phlegm (54.5 percent), cough (45.0 percent), chest tightness (44.6 percent), and breathlessness (36.9 percent) and prolonged sneezing (31.5 percent) for gold miners compared to non-gold miners Phlegm (45.0 percent), cough (31.5 percent), chest tightness (28.8 percent), breathlessness (21.2 percent) and prolonged sneezing (13.5 percent). Other respiratory diseases that gold miners are prone to include pneumonia (9.9 percent), silicosis (9.5 percent), and asthma (9 percent). As noted earlier in the study of Churchyard et al. (2004), an estimated 18.3-19.9 percent of gold miners in South Africa have silicosis.

Discussion

This study aimed to compare or evaluate the respiratory outcome among underground mine workers in the South African gold mining industry and non- miners living in the same geographical area. Occupational exposure to respirable crystalline silica (which cannot be seen with the naked eye) usually occurs in any workplace where airborne dust, containing a proportion of respirable crystalline silica, is generated. (DOL, 2015). From the bar chart depicted in figure 1, it was clear that the incidence of more respiratory diseases reported among these underground gold miners in Orkney as compared the non-miners was huge. Overall, prevalence rate was 2.71 higher among the miners. Dust exposure has been found to be a common occupational hazard facing gold miners according to Donoghue, 2014 which equally agrees with a systematic review done in 2007 that found a statistically significant association between loss of pulmonary function and cumulative respirable dust exposure (William, N.R, 2007),(DOL,2015). The result of this cross sectional study equally corroborated these early studies. The study rejected the null hypothesis as there was a significant differences in all the 13 respiratory outcomes or indices (except in heart problem) of underground gold miners compared to non-miners. This actually brings to the fore the essence of this study, which is to evaluate the respiratory outcome among the gold miners and non-miners that both reside in the same geographical area-Orkney. The only possible and reasonable explanation for these observed differences is

associated with the occupational exposures particularly to dust and poor ventilation in the underground gold mines which the non-miners are not subjected to. Other occupational exposures by the gold miners to noise and heat could not have adversely affected their respiratory function and respiratory disease outcome as indicated by the questionnaire. In view of these findings more protective and, adequate measures become imperative to curb the negative health effects of this exposure to dust in the underground gold mines of Orkney and South Africa at large.

Conclusion

There was a significant variation in the reported respiratory outcomes among the underground gold mine workers when compared to the non-miners as depicted in the Table 4 above with a standard deviation of 11.46 and 9.79 among the gold miners and non-miners respectively.

Gold miners from the given health assessment questionnaire are more prone to respiratory diseases such as wheeziness, phlegm, cough, chest tightness, breathlessness, silicosis and prolonged sneezing; and due to the reported variation in the given health assessment questionnaire there is need for proper medical attention to be given to gold miners in the areas in addition to the enforcement of proper safety measures to limit the exposure to materials that may increase the occurrence of respiratory related diseases among gold miners. Therefore as unguided occupational exposure to dust appears to remain one of the greatest threats to respiratory function or outcome among gold miners leading to morbidities like silicosis, asbestosis, pneumoconiosis, tuberculosis, dyspnoea, dehydration, tachycardia, hearing difficulties and even mortality. Adequate and well-structured occupational preventive measures (like adequate rehydration, fitting wears, air filter, etc.,) become imperative in curbing these unnecessary adverse health outcomes.

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