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Effect of the working environment on oculo-visual health of some sand and stone miners in Ghana

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Abstract

The health of the working population is an important prerequisite for productivity. The study therefore aimed at investigating the effect of the working environment on the oculo-visual health of some sand and stone mine workers in Ghana. A cross-sectional survey involving 247 sand and stone mine workers and 250 non-mine workers was conducted between February 2010 and May 2011. Structured interview was used to obtain information on demographics, ocular protective wear use, and ocular symptoms. External ocular assessments and distance visual acuity measurements were performed. While 45.7% of mine workers used either sunglasses or safety goggles, none of non-mine workers wore safety goggles; a few (8.8%) occasionally wore sunglasses. A significant proportion ($P \leq 0.0001$) of non-mine workers (59.2%) did not show ocular symptoms relative to the sand and stone miners. The vast majority ($P \leq 0.0001$) of non-mine workers (75.2%) had no visible ocular findings compare to the sand and stone miners (32.4%). Among quarry workers, pterygium (24.3%), pingueculae (5.7%), inflamed eyes (18.2%), and scleral pigmentation 13.8% were significant ($P \leq 0.0001$) findings which was not the case with non-mine workers. Visual acuity was however not significantly different ($P > 0.05$) with only approximately 5% from both categories recording moderate to very low (6/18 - 6/60) acuities. Although the working environment in the sand and stone mines seems to have no effect on visual acuity, it has detrimental effect on ocular structure which eventually could affect vision. Using appropriate ocular protectives and regular ocular examinations would be beneficial.

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INTRODUCTION

Mining of natural aggregates, including both sand and gravel and crushed rock, represents the main source of construction aggregates used throughout the world, including Australia [1], France [2], Italy [3], the USA [4], Belgium [5] and Britain [6]. Sand and stone mining in Ghana consists mostly of smaller-scale operations that produce sand, gravel, cement, limestone, and granite [7]. This mining practice has for long been an important vocation for many rural dwellers and especially for communities that are closer to urban or metropolitan centres. The escalation of this mining activity in recent times has been the result of the high

demand for shelter, an important component of life for the ever-increasing population [8].

Four Districts; namely Offinso, Ejisu, Efiduase Sekyere, and Berekese; in the Ashanti Region of Ghana which has sand and stone mining industries were selected randomly for the study. The Ashanti Region is centrally located in the middle belt of Ghana (lying between longitudes 0.15W and 2.25W, and latitudes 5.50N and 7.46N). It is the third largest of ten administrative Regions in Ghana, occupying a total land surface of 24389 square kilometers or 10.2 per cent of the total land area of Ghana. The Region has seen very rapid growth in recent times due to increased

activities especially in the fields of engineering, estate development, roads, bridge construction and other infrastructure development. This has made sand and stone mining activity very prominent in the Region.

It is documented that the working power of the workforce sustains the economic and material base of society [9] therefore the health of the working population is an important pre-requisite for productivity and is of essential consequential impact on all socioeconomic parameters and sustainable development [10]. The International Labour Organization (ILO) estimated that the total costs of occupational accidents and work-related diseases are 4% of the gross national product [11]. In the sand and stone mines the common chemical and physical substances that cause hazards include fumes, gases, dust, debris and ultraviolet radiation (UVR) mainly from the sun, all of which are associated with ocular adverse effects [12, 13]. Repeated exposure to natural UVR sources such as sunlight is thought to be associated with slowly degenerative changes of the conjunctival epithelium such as pterygium and pingueculae [14] seen in some outdoor workers [15]. The sand and stone mining environment therefore, is potentially hazardous to the eye. This suggests the need for adequate ocular protection during quarrying activities and appropriate occupational health measures to ensure optimum oculo-visual health and well-being required for productivity.

In view of the absence of previous ocular health-related studies among sand and stone miners in most Districts in Ashanti Region of Ghana where this activity is predominant, the oculo-visual health status of the sand and stone miners and non-mine workers in four selected districts was investigated.

MATERIALS AND METHODS

Sampling Technique

A map of the Ashanti Region was obtained from the Geological Survey Department, Kumasi, Ghana and four Districts namely Offinso, Ejisu, Efiduase Sekyere, and Barekese, in the Ashanti Region were selected at random. One major sand and stone mining site in each of the randomly selected Districts was selected and used in the study between February 2010 and May 2011.

Sample Size

The entire workers (247) of the selected sand and stone mines and 250 non-mine workers in the areas around the mines were used in this study. The survey grouped the sand and stone mine workers into office workers, manual workers (comprising of loading boys, mechanics, 'crusher' operators, cooks, electricians and

welders), casual workers (mainly in the sand weaning sector, who are just hired hands for the job), security men, blast men (drillers, explosive engineers) and drivers. The non-mine workers were made up of food stuff sellers and hawkers, cart pushers, laborers, head porters, and drivers randomly selected from open market places and lorry stations in the districts.

Data Collection Instrument

A structured interview guide was used to collect data on demography, level of education, years of work at the sand and stone mining sites or other work places, use and non-use of protective eye wear, frequency of eye examination and case history to establish visual symptoms among the workers.

Ophthalmic Assessment

Both distance and near visual acuity measurements (using Snellen Acuity Chart and M Chart respectively), pinhole, ophthalmoscopy and external assessment (using pen light) were used to assess their oculo-visual health status.

Data Analysis

Data obtained from the study was presented as number of individual (frequency) and/or percentage distribution. Data was compiled using the Statistical Packages for Social Sciences (SPSS) version 17 (SPSS Inc., Chicago, IL, 2008). Significant differences in measured parameters were assessed with Yates' correction of Pearson's chi-square test (X^2) using GraphPad Prism version 5.00 for Windows (San Diego California USA, www.graphpad.com), calculated as follows:

$$X_{Yates}^2 = \sum_{i=1}^N \frac{(|O_i - E_i| - 0.5)^2}{E_i}$$

where:

O_i = an observed frequency

E_i = an expected (theoretical) frequency, asserted by the null hypothesis

N = number of distinct events

$P \leq 0.05$ was considered significant. Graph was plotted using SigmaPlot 11 (Systat Software, Inc., San Jose, CA, 2008).

Ethical Consideration

The proposal for this study was approved by the Department of Optometry and Visual Science Research and Ethics Committee, KNUST, Kumasi, Ghana.

Permission was obtained from the managers of the quarrying and individual workers before the commencement of the study. A research consent form was given to each participant for completion and those who needed assistance were assisted by the researchers. The workers were alerted that participation in the study was voluntary and that they were free to withdraw from participation at any stage.

RESULTS

Socio Demographics Characteristics

A total of 247 mine workers were interviewed comprising 37 (15%) females and 210 (75%) males. The modal age was 36-45 years (30%). Those over 55 years were in the minority (8.9%). The study identified 3 (1.2%) of the workers as having worked in the sites for over 25 years while 108 (43.7%) had worked between 1-5 years (Table 1). One hundred and twenty four (50.2%) were manual workers. The educational levels of the various workers are as shown in Table 2

with those with intermediate level education (Junior and Senior High/Technical School) being in the majority (64.05%). Of the total mine workers interviewed, 74 (30%) had visited an eye care facility once, 19 (7.7%) twice and 9 (3.6%) three times (Table 2).

The non-mine workers interviewed were 250 comprising of 46.8% females and 53.2% males. The modal age was 36-45 years (48.8%), with those over 55 years being in the minority (9.2%). The study identified that 93 (37.2%) had been working for 1-5 years, 81 (32.4%) 6-10 years, and the remaining, more than 10 years (Table 1). Of the participants, 88 (35.2%) were laborers, 67 (26.8%) were foodstuff sellers, and 58 (23.2 %) were vehicle drivers. Cart- pushers, hawkers and head porters made up 14.8%. The educational level was mainly basic school (46.0%) and Junior High School levels (40.4%) (Table 2). Non-mine workers were less likely to visit eye clinics with 67.2% having no previous visits to the eye clinic and Fifty five (22%) visiting an eye care facility just once (Table 2).

Table 1. The category of workers, their educational levels and their visits to eye clinics for sand and stone mine and non-mine workers

	Category of Workers				Educational Level		Eye Clinic Visits			
	SSMW		NMW		Levels	SSMW	NMW	Visits	SSMW	NMW
Office	17 (6.9)		Foodstuff sellers	67 (26.8)	No formal	9 (3.6)	11 (4.4)	None	145 (58.7)	168 (67.2)
Manual	124 (50.2)		Hawkers	18 (7.2)	Basic	59 (23.9)	115 (46.0)	Once	74 (30.0)	55 (22.0)
Casual	31 (12.6)		Cart Pushers	6 (2.4)	JHS	118 (47.85)	101 (40.4)	Twice	19 (7.7)	22 (8.8)
Security	9 (3.6)		Labourers	88 (35.2)	SHS/Tech	40 (16.2)	19 (7.6)	Thrice	9 (3.6)	5 (2.0)
Blastmen	43 (17.4)		Headporters	13 (5.2)	Tertiary	21 (8.5)	4 (1.6)			
Drivers	23 (9.3)		Drivers	58 (23.2)						

Data is presented as number of individual with percentage distribution in parenthesis. Sand and Stone Mine Workers (SSMW), Non-Mine Workers (NMW). JHS- Junior High School Level; SHS/Tech- Senior high school/Technical School level

Table 2. Socio-demographic characteristics of sand and stone mine workers and non-mine workers in four selected Districts of the Ashanti Region of Ghana

Sex	Gender Distribution		Age range	Age Distribution		Year range	Years of Work	
	SSMW	NMW		SSMW	NMW		SSMW	NMW
Males	210 (75)	133 (53.2)	15-25	27 (10.9)	33 (13.2)	1-5	108 (43.7)	93 (37.2)
Females	37 (15)	117 (46.8)	26-35	57 (23.1)	42 (16.8)	6-10	69 (27.9)	81 (32.4)
			36-45	74 (30.0)	122 (48.8)	11-15	25 (10.1)	29 (15.6)
			46-55	67 (27.1)	29 (12.0)	16-20	23 (9.3)	21 (8.4)
			> 56	22 (8.9)	23 (9.2)	21-25	19 (7.7)	11 (4.4)
						> 25	3 (1.2)	5 (2.0)

Data is presented as number of individual with percentage distribution in parenthesis. Sand and Stone Mine Workers (SSMW), Non-Mine Workers (NMW)

Foreign bodies and Ocular injury

In totality 89.3% of the population interviewed had ever suffered foreign bodies in their eyes during work at their work places. Two hundred and thirty nine (96.8%) of the sand and stone miners and 205 (82%) of non-mine workers reported that sand was the most frequent foreign body on their eyes. The study identified however that the prevalence of foreign body was highest (51.2%) among manual workers in the sand and stone mines and laborers (61.9%) in the non-mining area. The prevalence of ocular injury was 59.2% and 43.7% respectively.

Ocular Symptoms, Ocular Findings, and Visual Acuity

The significant ($P \leq 0.0001$) ocular symptoms established from frequent complains among the 247 workers relative to non-mine workers were gritty and foreign body sensations (30%), burning sensation and tearing (18.2%), or itchy eyes (8.5%). These symptoms occurred less frequently in non-mine workers as follows: Gritty and foreign body sensations (7.6%), burning sensation and tearing (5.9%), and itchy eyes (3.7%). Other ocular symptoms recorded were not significantly different ($P > 0.05$) between the two categories. A significant proportion of non-mine workers (59.2%) however, did not show ocular symptoms relative to the sand and stone miners (22.8%) (Table 3).

Pterygium was found in 60 (24.3%) sand and stones miners upon penlight examination while 45 (18.2%) had red/inflamed eyes, 14 (5.7%) pingueculae and 34 (13.8%) scleral pigmentation. These findings were very significant ($P \leq 0.0001$) compared to the non-mine workers. Of pterygia cases found 27 (43.5%) was unilateral and 35 (56.5%) bilateral and of the 14 pingueculae cases 11 (78.6%) were bilateral (Table 3).

The occurrences of these ocular findings among the non-mine workers were low with only 4.8 % having pterygium, 2.8% having inflamed eyes, with no pingueculae found. Infact, while only about a third (32.4%) of the sand and stone miners had no visible ocular findings, the vast majority ($P \leq 0.0001$) of non-mine workers (75.2%) had no visible ocular findings (Table 3).

The visual acuities (VA) of the population were taken monocularly. Among the two categories of workers VAs were not significantly different ($P > 0.05$). One hundred and forty nine (60.3%) of the sand and stone miners had VAs between 6/5 - 6/6 in the right eye and 138 (55.9%) for the left eye. The poorest visual acuity (6/36 - 6/60) was 3.2% for the right eye and 0.4% for the left eyes (Table 4). Pinhole improved the visual acuity up to 2% in the right eye of the category with reduced visual acuity and 0.23% in the left eye respectively. A fogging lens of +1.00DS was used among those with distance visual acuities of 6/5 - 6/6 to rule out latent hyperopia. This revealed that 10% of the workers were hyperopic in the right eye and 12% in the left eye respectively. An assessment of the crystalline done to determine the presence of lens opacity showed that 15% of the workers had lens opacity of varying degrees. Similarly, 170 (68%) of non-mine workers had VAs between 6/5 and 6/6 in the right eye and 151 (60.4%) for the left eye. Five (2%) had VAs of category 6/36-6/60 in the right eye and 7 (2.8%) in the left eye. Pin hole improved the VA up to 1.8% in the right eye and 1.34% in the left eye respectively. Upon fogging, 11% were hyperopic in the eye and 10% in the left eye. An assessment of the crystalline lens showed 10 % of lens opacity.

Table 3. Ocular symptoms and ocular findings of Sand and stone miners and non-miners interviewed

Symptoms	Ocular Symptoms				Findings	Ocular Findings			
	NMW	SSMW	P value	Chi-square value, df		NMW	SSMW	P value	Chi-square value, df
None	154 (59.2)	56 (22.8) ***	< 0.0001	77.16, 1	Pterygium	12 (4.8)	60 (24.3) ***	< 0.0001	36.55, 1
Blur at near	22 (8.8)	23 (9.3) ns	0.9661	0.002, 1	Pinguecula	0 (0.0)	14 (5.7) ***	0.0001	12.58, 1
Blur at far	15 (6.0)	12 (4.9) ns	0.7162	0.132, 1	Scleral pigmentation	26 (10.4)	34 (13.8) ns	0.3108	1.027, 1
Photophobia	7 (2.8)	9 (3.6) ns	0.7805	0.078, 1	Red/inflamed eyes	7 (2.8)	45 (18.2) ***	< 0.0001	29.91, 1
Headache	13 (5.2)	7 (2.8) ns	0.2654	1.240, 1	Other findings	17 (6.8)	14 (5.6) ns	0.7367	0.1131, 1
Burning Sensation with tearing	17 (6.8)	45 (18.2) ***	0.0002	13.81, 1	No visible findings	188 (75.2)	80 (32.4) ***	< 0.0001	79.41, 1
Gritty/Foreign body sensation	19 (7.6)	74 (30) ***	< 0.0001	39.38, 1					
Itchy sensation	9 (3.6)	21 (8.5) *	0.0352	4.435, 1					

Data is presented as number of individual with percentage distribution in parenthesis. Sand and Stone Mine Workers (SSMW); Non-Mine Workers (NMW). Significant differences in ocular symptoms and ocular findings between NMW and SSMW were established using chi-square with Yates' correction. ns implies $P > 0.05$; * implies $P \leq 0.5$; *** implies $P \leq 0.0001$.

Table 4. Visual Acuity (VA) of the right and left eyes of Sand and stone miners and non-miners interviewed

VA	NMW		SSMW		P Value	Chi-Square Value, df
	R	L	R	L		
6/5 – 6/6	170 (68.0)	151 (60.4)	149 (60.3) ns	138 (55.9) ns	0.1926	1.698, 1
6/9 – 6/12	69 (27.6)	86 (34.4)	86 (34.8) ns	102 (41.3) ns	0.1305	2.287, 1
6/18 – 6/24	6 (2.4)	6 (2.4)	4 (1.7) ns	6 (2.4) ns	0.8500	0.036, 1
6/36 – 6/60	5 (2.0)	7 (2.8)	8 (3.2) ns	1 (0.4) ns	0.6762	0.1745, 1

Data is presented as number of individual with percentage distribution in parenthesis. Sand and Stone Mine Workers (SSMW); Non-Mine Workers (NMW). R-Right eye; L-Left eye. Significant differences in VA between NMW and SSMW were established using chi-square with Yates' correction. ns implies P > 0.05.

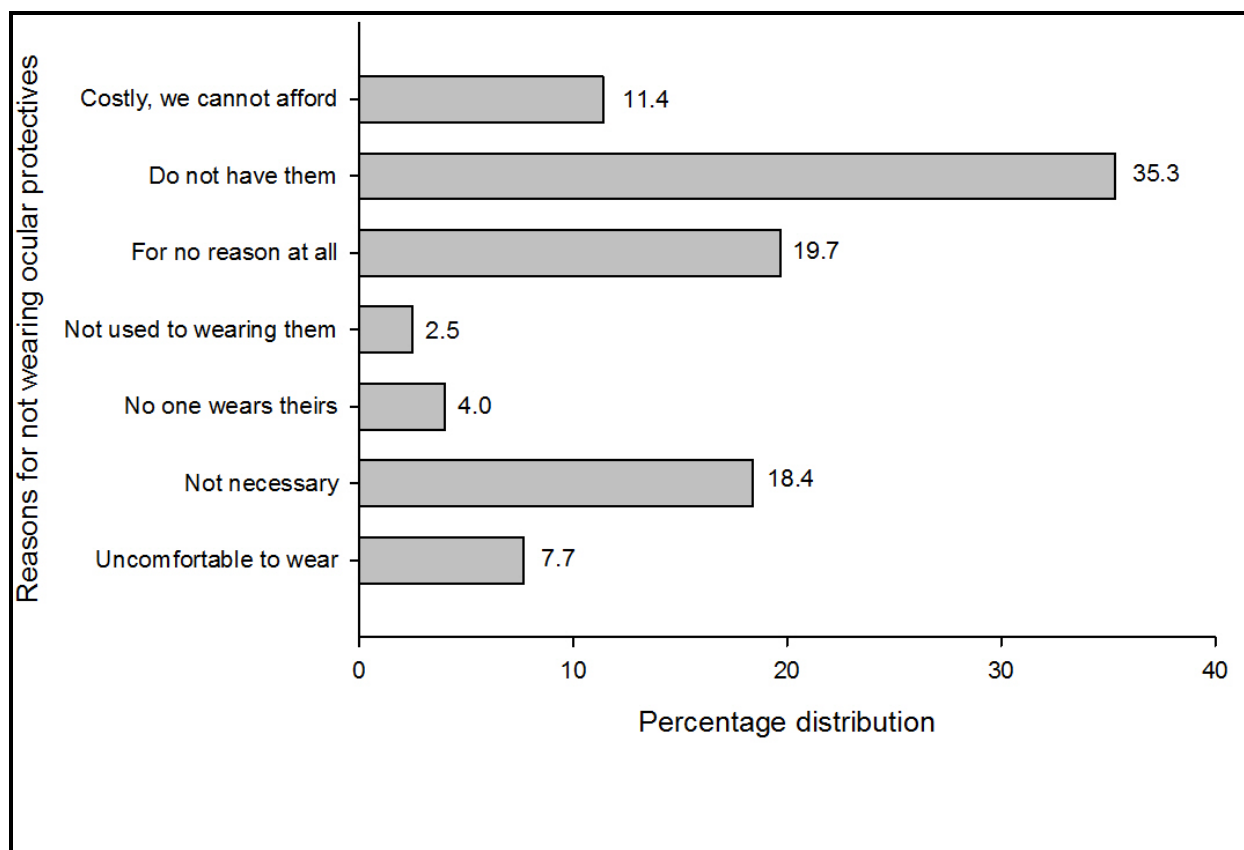


Figure 1. Reasons given by sand and stone miners for not wearing protective eyewear

Safety Wear

Among the sand and stone mine workers, only 113 (45.7%) used some form of protective eyewear. Of these 18 (15.9%) uses sunglasses, 95 (84.1%) safety goggles. Those who did not wear any form of protective were 134 (54.3%) with reasons shown in Figure 1. With the non-mine workers, none wore safety

goggles, while occasionally, 22 (8.8%) wore sunglasses. The reasons given for not wearing any form protective eyewear was that it was not necessary of their job, or was not affordable considering their income.

DISCUSSION

Most of the workers were males, although the percentage of males in the non-mine workers was less than that of sand and stone mine workers. This could be attributable to the physical nature of work the sand and stone industry. Generally females are not involved in the nature of work in Ghana. The age distribution indicates that most workers were young or middle aged. These findings are consistent with other studies of this nature [16, 17]. The vast majority of the population of sand and stone miners and non-mine workers as revealed by the study do not attend eye clinic for routine ocular checkups. This will suggest that any ocular findings will not be attributable to the fact that one group seeks and/or receives ocular health care as against the other.

The use of ocular protective wears such as sunglasses and safety goggles are known to reduce the risk of ocular injury [18]. Although more mine (45.7%) workers used some form of ocular protective wear as compared with the non-mine (8.8%) workers, the mine workers had more ocular injury which possibly could be due to their working environment. Sand and stone quarries are one of the most dangerous industries to work in [19, 20]. A study conducted by Vats et al., (2008) revealed that the persons who sustained ocular trauma at their workplace used no protective gear [21]. It is essential that protective equipment be used in all such instances for the prevention of ocular injuries. It has been reported that provision of appropriate protective eyewear reduced the incidence of eye injuries in stone-quarry workers in Tamil Nadu, India [22]. The mine workers come into direct contact with the injurious agents such as sand, debris and stone chippings as compared with the non-mine counterparts. This could have contributed to the high prevalence of ocular injury and foreign body sensation recorded in this study (especially among the manual mine workers). There is therefore they need to wear protective eye devices at all times. The workers should understand the need for safety as the majority has attained at least an intermediate level of education. The Safety, Health and Welfare at Work (Quarries) Regulations 2008 (S.I. No 28 of 2008) have been effective from 1st May 2008 [23, 24]. Management could ensure safety by enforcing the use of ocular protective based on these regulations. Education and providing or giving incentives to buy safety equipments could be a motivation to workers.

Significant external ocular findings among the sand and stone mine workers were pterygium (24.3 %), pingueculae (5.7%), and red or inflamed eyes (18.2%). Pterygium is a growth of tissue on the white of the eye that may extend onto the clear cornea where it can obstruct vision. Pinguecula is a common, non-cancerous growth of the clear, thin tissue (conjunctiva)

that lays over the sclera of the eye. Pterygium and pingueculae could be as a result of exposure to excessive UV radiation from sunlight, dust and the fumes in the environment [25, 26]. Most of the mine workers who had bilateral pterygia and pingueculae had worked in the mine environment for over 6 years. Available epidemiological data shows a strong positive association between outdoor work and the development of pterygium and pinguecula [27].

The high prevalence of pterygium has direct relationship with the prevalence of foreign body sensation and inflamed eye as it causes ocular irritation potentiated by the ever present dust and fumes from heavy trucks and equipment used in the mining activity [28]. Risk factors other than exposure to ambient ultraviolet radiation from the sun observed at the mine were the white sand and granite rocks (which are split into smaller chippings) known to be a good reflector of UVR and the duration of work which coincide with mid-day hours of 10 am to 3pm of tropical Africa [28]. The gritty sensation, tearing, foreign body sensation and blur vision at near which is as a direct result of the working environment and age are expected.

Majority of the workers (mine and non-mine) had essentially normal visual acuities indicating that the hazards of the working environment have had little impact on the visual status of the workers. However, future visual implications can be far reaching as disorders such as pterygium could potentially obstruct vision at a later stage. Foreign body sensation could result in needless cornea damage which can impair vision [29].

CONCLUSION

Even though the sand and stone mining work environment seems to have no effect on visual acuity, it has detrimental effect on ocular structure which sooner or later would affect vision. The economic implication of these oculo-visual disorders cannot be overemphasized therefore management of these mines should ensure, enforce and educate the mine workers on the use of basic ocular protective wears as well as oculo-visual health safety to enhance the oculo-visual health well-being of worker.

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