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Clinical Symptoms, Gender Variation and the Effect of Occupational Inhalation of Gasoline Vapour Among Petrol Station Attendants in Lagos, South West Nigeria

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ABSTRACT

Introduction: To describe the clinical symptoms of male and female staff occupationally exposed to gasoline vapor (GV) in metropolitan Lagos Nigeria.

Method: A face-to-face interview, using semi-structured questionnaire, was conducted among 275 (males=190 females=85) respondents to collect socio-demographic reproductive nutritional and occupational data as well as sleep pattern from individuals working at gasoline (gasoline) stations as pump attendants. NCSS 20 statistical software was used for data analysis.

Results: The mean (±) age of all respondents was 31.2 (7.4) years and that of males, recorded as 32.1 (7.8) years was significantly different (P-value=0.0005) from that of females noted as 29.1 (5.9) years. Mean duration of exposure to GV (3.70±3.56 years) was significantly longer (t-test=2.28, P-value=0.02) in males. Mean duration of sleep among females exposed to GV for 1-2 years was significantly lower (t-test=2.6, P-value=0.01) than that of females exposed for <1 year. The most prevalent symptoms in all respondents were headache (72.4%) followed by cough and catarrh (34.5%) chest pain (21.1%) and eye irritation (20.7%) Among married male respondents 4 (3.5%) reported wife had difficulty in getting pregnant, mostly (3, 75.0%) among those exposed to GV for 4.1-6 years. Miscarriage, dyspareunia, use of contraceptive devices and irregular menstruation were respectively reported by 36.8%, 41.7%, 46.2% and 40.9% females who had been occupationally exposed to GV for 2.1-4 years and 36.4% of these women used more than 3 menstrual hygiene pads monthly.

Conclusion: Headache was the most prevalent symptom of ill health among those occupationally exposed to GV. Perceived gynecological outcome as reported by women occupationally exposed to GV for over 2 years were miscarriage, dyspareunia, irregular menstruation and heavy menstrual bleeding. This study recommends phased change to a better fuel dispensing system and possible capture of gasoline vapor during refueling gasoline storage tanks.

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Introduction

Gasoline (also known as petrol, petroleum or oleum) was first discovered in Olivieri, currently in Bayelsa State of Nigeria in 1956. Since then, a large number of males and females have been employed either in the direct exploration, drilling, mixing, transport and selling of the gasolineeum and its by-products. Because of the economic importance of gasolineeum and its products, the Federal Government established a parastatal - Nigerian National Gasolineeum Corporation (NNPC) - to oversee the operations of the gasolineeum industry in the country. To this effect, many fuel stations were set up in various parts of the country to cater for needs of vehicular transportation such as cars, airplanes, ships, motorized boats and electricity generators. Over the years, the gasolineeum industry has employed a large number of people as fuel pump attendants. However, it seems that the authority has paid little attention to the health hazard of occupational exposure to the benzene, toluene, ethylbenzene, and the isomers of xylene (BTEX), the naturally occurring hazardous compounds found in the gasolineeum [1,2] that are collectively known as Polycyclic Aromatic Hydrocarbons (PAH) Studies have shown that occupational exposure at fuel stations raises vulnerability of gasoline pump attendants to highly toxic compounds [3,4]. The need for gasoline in various sectors of the economy such as the automobile, aviation, military and other industries consequent upon a rise in global population raised the demand for gasoline

and thus an upsurge in occupational exposure [1]. The International Agency for Research on Cancer (IARC) has documented the harmful effects of the exposure to gasoline and has acknowledged gasoline and gasoline engines as possibly human carcinogen factors affecting the health of exposed individuals [6]. A study has documented that the primary source of exposure to benzene the principal component of gasoline is refueling of vehicles especially by gasoline pump attendants, where the degree of exposure "is dependent on the liquid temperature and composition along with the dispensed fuel volume" [7]. Coupled with the duration of stay. Studies have also documented severe harmful consequences of BTEX on neurological development and chronic health conditions [8-11]. An earlier study reports significant degree of anemia, neutropenia and thrombocytopenia among roadside gasoline vendors, auto mechanics and fuel pump attendants in Nigeria the authors also reported that gasoline products were used by some workers as solvents and skin cleansers and also siphoned by mouth [12]. Gasoline pump attendants who are occupationally exposed to gasoline and its fumes, which consist of several mutagenic chemicals, have been documented to demonstrate reductions in spirometry indices, adverse effect on the kidney and liver function and reduction in hematological indices which worsens with prolonged exposure [13-18]. It has been ascertained that exposure to air pollution may have a negative impact on health [19]. The World Health Organization estimated that all-cause daily mortality due to air pollution was estimated to increase by 0.2-0.6% per 10 μg/m^3 of PM_{10} while other studies have shown that long-term exposure to $PM_{2.5}$ is associated with an increase in the long-term risk of cardiopulmonary mortality by 6-13% per 10 μg/m^3 of $PM_{2.5}$ [20-23]. Most of these studies conducted in Nigeria were laboratory based, focusing on lung kidney and liver function tests as well as hematological parameters. Few has focused on subjective illness entities or sleep pattern as reported by individual pump-gasoline attendant in the country relative to sex. The aim of this study was to document clinical symptoms and gender variation in the health profile of gasoline pump attendants in metropolitan Lagos Nigeria.

Method

This survey was conducted in Lagos City in Southwest Nigeria, a predominantly Yoruba geo-political area with a heterogenous population. The city shares the same name with the state - Lagos State, and though it is the smallest of the 36 States that make up the country, it is nevertheless the economic capital and the most populated with about 16.5 million people, making it the largest city in the country and one of the most populous urban areas in Africa [24]. The state is divided into three Senatorial districts - Lagos East, Lagos Central and Lagos West - and 20 Local Government Administrations (LGAs) A minimum of 3 LGAs were selected from each of the 3 Senatorial districts using simple random sampling.

Study Design

This was a questionnaire-based expository survey in the sense that it informs readers with facts and evidence supporting the topic of study that has multiple points of view. The study was also descriptive in that it gave a complete explanation of the topic with evidence examples, and background history.

Sample Size

The minimum sample size was calculated using Epi-Info Statically software for population survey. With expected frequency of 50%, confidence interval of 90% acceptable margin of error taken to be 5% and design effect of 1.0, the calculated sample size was 270. Finally, 3% of the sample size was added to cover for attrition or incomplete data: (3% of 270) + 384 = 278. Thus, the final sample size of 278 was rounded up to 280. Five (1.8%) of the questionnaires were discarded because of incomplete or missing information and 275 that were complete were eventually analyzed.

Inclusion/Exclusion Criteria

To be included into the study, a responder must be a Nigerian of either gender, employed at a gasoline station and must have been resident in Lagos State for a minimum of 24 months and not just visiting. The minimum age of a respondent must be 18 years who must also be apparently physically and mentally healthy with acceptable sensorium and awareness of his/her immediate environment. People living near a gasoline station, those who came to fill their vehicles with gasoline, and managers or supervisors who were not directly involved or in close contact with gasoline pumps were excluded from the study.

Ethical Clearance

The approval to conduct this study was given by the Institutional Review Board of the Nigerian Institute of Medical Research (IRB-23-054) and received on September 26, 2023. The objectives of the study were explained to the respondents. Verbal informed consent was requested by the researchers and given by the respondents.

Data Collection

Data collectors were students participating in Industrial Training Course at the Nigerian Institute of Medical Research during their internship on Research Methodology, a course that lasted from June to August 2023, approximately 3 months. They were trained on questionnaire preparation, entry into community, correct attitude and mannerism during data collection, appropriate dressing and line of communication. Data collection was conducted from September 30 to October 3, 2023 from gasoline stations in 10 randomly selected LGAs in the state. The trained data collectors were instructed to select gasoline stations along main streets.

Data Entry and Statistical Analyses

Data was initially coded and entered into WPS Spreadsheet 2019 and cleaned before being exported into NCSS 21 (Kaysville, Utah, USA) statistical software for analysis. Descriptive statistics, comprising frequencies, percentages, mean, and standard deviation, were used in analyzing the data. Chi-square with P-values, odds ratio and 95% confidence interval were used to determine the relationship between two categorical variables. Density plot was used to visualize the distribution of exposure to gasoline fume by male and female respondents over time. Prevalence was defined as number of people with sample characteristics divided by total number of people in the sample multiplied by 100. A p-value of less than 0.05 was considered statistically significant. Data were presented as Tables and Figures.

Results

The mean (±Sd) age of all and of male and female respondents were 31.2 (7 4), 32.1 (7.8) and 29.1 (5.9) years respectively, ranging from18-60 years (Figure 1). Males were significantly older (P-value=0.005) than females. In all, 81 (29.4%) respondents were within the age range of 25-29 years while 17 (6.2%) were 45 years or older; 148 (53.8%) were single, 110 (40.0%) were married and 7 (2.6%), 7 (2.6%) and 3 (1.0%) were divorced, separated or widow/widower (Figure 2). Also, 144 (52.4%) of the respondents had secondary education, and 196 (71.3%) had monthly income of 20-50,000 Naira (equivalent to US$36.4 - US$90.9 at the time of study). Concerning their previous occupations, only 20 (7.3%) of the respondents previously worked as gasoline pump attendants 2 (0.7%) worked in Oil and Gas Industry, and 52 (18.9%) had

no former occupation. and 164 (59.6%) conducted any form of physical exercise. (Table 1). The mean duration of daily hours of sleep among males (6.2±1.8) was not significantly different from that among females (6.4±2.1). Only 10 (3.6%) were vegetarians while 79 (28.7%) and 186 (67.6%) were either non-vegetarians or both vegetarians and non-vegetarians. Majority (n=190, 69.3%) of the respondents consumed alcoholic beverages, especially men (n=139, 73.5%), though alcohol consumption was also fairly high (n=51, 60.0%) among women. However, the proportion of males that consumed alcohol was significantly higher (χ^2=5.06, P-value=0.02) than that of females and the proportion of males that take alcohol regularly was also significantly higher (χ^2=7.85, P-value=0.005) than that of females that take alcohol regularly. Cigarette smoking was significantly more common (χ^2=10.08, P-value=0.002) among men (n=50, 26.3%) than women (n=8, 9.4%) (Table 2). Table 3 and Figures 3 respectively illustrate frequency distribution of duration of exposure to gasoline fumes at current workplace and density plot of such exposure by gender of respondents. As duration of exposure increased, the number of persons exposed decreased such that 56 (20.4%) respondents were exposed continuously to GV for 2 years and only 12 (4.4%) were exposed for 10-26 years (Table 3, Figures 3 and 4). Overall, the duration of exposure to gasoline fumes was significantly longer (t-test=2.28, P-value=0.02) in men (n=190, 3.70±3.56 years) compared to women (n=85, 2.76±2.97 years). After about 8 years, the proportion of occupational exposure to gasoline fumes drops (Figure 3) to only one person each being exposed for 14, 16, 17, 19, 23 and 26 years, mostly males. The mean duration of sleep among females exposed to gasoline fumes for 6.1-8 years was significantly lower (t-test=3.27, P-value=0.005) than that of females exposed for <1 year. Even the mean duration of sleep among females exposed to GV for 1-2 years was significantly lower (t-test=2.68, P-value=0.01) than that of females exposed for <1 year. Thus, exposure to gasoline fumes may cause insomnia among females. Further studies are needed to confirm this finding (Table 4). Symptoms of illness of the respondents are as shown in Table 5 and graphically illustrated in Figures 5a and b. The most prevalent clinical complaint was headache (72.4%) which was reported more among women than men (76.5% vs 70.5%), followed by cough and catarrh (36.5% vs 33.7%), chest pain (24.7% vs 19.5%), eye irritation (24.7% vs 19.0%), skin irritation (14.1% vs 6.8%) and arthritis (11.8% vs 9.0%). However, the prevalence of insomnia (26.8% vs 24.7%), hypertension (4.7% vs 1.2%), diabetes mellitus (1.6% vs 1.2%), kidney problems (1.6% vs 0.0%), problem with passing urine (4.2% vs 2.3%) and asthma (1.6% vs 0%) were higher in men than among women exposed to gasoline fumes. Women exposed to GV were about 9 times more likely to develop headache compared to men (OR=9.17, 95% CI=0.86, 97.70). The prevalence of headache (100.0%), insomnia (50.0%), eye irritation (62.5%) skin irritation (37.5%), diabetes (12.5%), urinating problem (25.0%) and chest pain (50.0%) were highest among female respondents who both consumed alcohol and also smoked cigarettes (Figure 5b). Figures 6a-d are graphical illustrations comparing duration of exposure to gasoline fumes and systemic health outcomes among male and female respondents. A high percentage (91.7%) of females who were occupationally exposed for less than one year reported headaches, though no consistency was observed in this proportion. The Figures also illustrate the comparative analysis of health issues reported relative to various other systems such as the respiratory system, renal and dermatological system, cardiovascular, endocrine and Musculo-skeletal system among others. Lines of best fit (trendlines) indicate overall direction and both pattern and relationships of each variable (health issues) among male and female respondents as shown in the figures. In all, 16 (8.4%) of the male respondents ever had a sperm count done, especially those occupationally exposed for less than 1 year (5, 31.2%). Among the married men (n=114, 60.0) only 4 (3.5%) reported wife had difficulty in getting pregnant mostly (3, 75.0%) among those who have been occupationally exposed for 4.1-6 years, while 16 (14.0%) reported that their wived had miscarriage during their present occupation, mainly among those exposed for 2.1-6 years. A total of 48 (25.3%) male respondents, reported using sex-enhancing drugs, mainly among those who have been working for less than 1 year (18, 37.5%). In this current occupation, miscarriage, dyspareunia, use of contraceptive devices and irregular menstruation were reported by 19 (22.1%), 12 (14.1%), 13 (15.3% and 22 (25.9%) of female respondents, mainly among those who have been exposed for 2.1-4 years (7, 36.8%; 5, 41.7%; 6 (46.2% and 9 (40.9%) respectively). Of the 22 occupationally exposed women, 11(50.0%) used more than 3 menstrual hygiene pads due to heavy monthly menstrual bleeding among who 4 (36.4%) had been working at gasoline stations for 2.1-4 years (Table 6).

Table 1: Socio-Demographic Characteristics of Study Participants

Variable	Sub-variable	All (n=275, 100.0%)	Male (n=190, 69.1%)	Female (n=85, 30.9%)
	Mean (±sd)	31.2 (7.4)	32.1 (7.8)*	29.1 (5.9)*
	<20	4 (1.5)	3 (1.6)	1 (1.2)
	20-24	44 (16.0)	27 (14.2)	17 (20.0)
	25-29	81 (29.4)	49 (25.8)	32 (37.6)
	30-34	64 (23.3)	45 (23.7)	19 (22.4)
	35-39	36 (13.1)	26 8(13.7)	10 (11.8)
	40-44	29 (10.5)	25 (13.2)	4 (4.7)
	≥45	17 (6.2)	15 (7.9)	2 (2.4)
	None	2 (0.7)	2 (1.1)	0 (0.0)
	Primary	10 (3.6)	9 (4.7)	1 (1.2)
	Secondary	144 (52.4)	97 (51.1)	47 (55.3)
	Tertiary	106 (38.6)	71 (37.4)	35 (41.2)

	Others		13 (4.7)	11 (5.8)	2 (2.4)
	<20,000		47 (17.1)	29 (15.3)	18 (21.2)
	20-50,000		196 (71.3)	132 (60.5)	64 (75.3)
	51-100,000		25 (9.1)	22 (11.6)	3 (3.5)
	>100,000		7 (2.5)	7 (3.7)	0 (0.0)
	Yes		164 (59.6)	122 (64.2)	42 (49.4)
Conduct physical exercise	No		111 (40.4)	68 (35.8)	43 (50.6)
Former employment	Salaried	Oil and Gas Industry	2 (0.7)	2 (1.1)	0 (0.0)
		Pump attendant	20 (7.3)	15 (7.9)	5 (5.9)
		Others	79 (28.7)	50 (26.3)	28 (32.9)
	Self employed		45 (16.4)	27 (14.2)	18 (21.2)
	Housewife		1 (0.4)	0 (0.0)	1 (1.2)
	Casual laborer		53 (19.3)	42 (22.1)	12 (14.1)
	Student		23 (8.4)	16 (8.4)	7 (8.2)
	Unemployed		52 (18.9)	38 (20.0)	14 (16.5)

**t-test (P-value) = 3.51 (0.0005)*

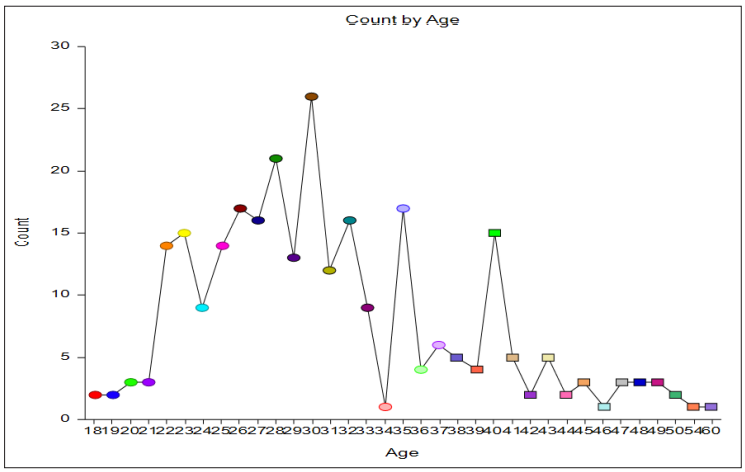


Figure 1: Frequency Distribution of age (18-60 years) of all Gasoline Pump Attendants in the study

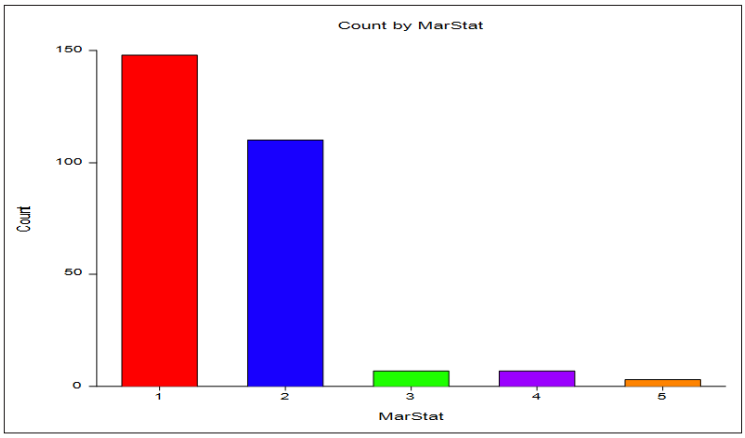


Figure 2: Frequency Distribution of marital status of all Gasoline Pump Attendants in the study (1=Single, 2=Married, 3=Divorced, 4=Separated, 5=Widow/er)

Table 2: Hours of sleep, Type of Diet, Smoking Habit and Alcohol Consumption among Male and Female Study Participants

Variable	Items	All	Males	Females	χ^2	P-value
		Freq. (%)				
Daily hours of sleep	≤5	104 (37.8)	72 (37.9)	32 (37.6)	2.60	0.27
	5.1-8	141 (51.3)	101 (53.2)	40 (47.1)		
	>8	30 (10.9)	17 (8.9)	13 (15.3)		
		Mean (±sd)			t-test	P-value
		6.3 (1.9)	6.2 (1.8)	6.4 (2.1)	0.76	0.45
Diet type	Vegetarian	10 (3.6)	6 (3.1)	4 (4.7)	0.51	0.77
	Non-vegetarian	79 (28.7)	56 (29.5)	23 (27.1)		
	Both	186 (67.6)	128 (97.4)	58 (68.2)		
Take alcohol	Yes	190 (69.3)	139 (73.5)	51 (60.0)	5.06	0.02
	No	85 (30.7)	50 (26.5)	34 (40.0)		
If Yes, is it regularly	Yes	55 (28.9)	48 (34.5)	7 (13.7)	7.85	0.005
	No	135 (71.1)	91 (65.5)	44 (86.3)		
Smoke cigarettes	Yes	58 (21.1)	50 (26.3)	8 (9.4)	10.08	0.002
	No	217 (78.9)	140 (73.7)	77 (90.6)		

Mean (±sd) Daily hours of sleep for all=6.3 (1.9), for males=6.2 (1.8), for females=6.4 (2.1). There was no significant difference (t-test=0.76, P-value=0.45) in the mean (±sd) daily hours of sleep among males and females.

Table 3: Frequency Distribution of duration of exposure to Gasoline Fumes at current workplace

Duration of exposure (years)	All	Male	Female
	Freq. (%)		
<1	23 (8.4)	11 (5.8)	12 (14.1)
1	55 (20.0)	38 (20.0)	17 (20.0)
2	56 (20.4)	37 (19.5)	19 (22.4)
3	43 (15.6)	29 (15.3)	14 (16.5)
4	34 (12.4)	24 (12.6)	10 (11.8)
5	23 (8.4)	18 (9.5)	5 (5.9)
6	10 (3.6)	9 (4.7)	1 (1.2)
7	7 (2.6)	3 (1.6)	4 (4.7)
8	9 (3.3)	7 (3.7)	2 (2.4)
9	3 (1.1)	3 (1.6)	0 (0.0)
10	3 (1.1)	3 (1.6)	0 (0.0)
12	1 (0.4)	1 (0.5)	0 (0.0)
13	2 (0.7)	2 (1.1)	0 (0.0)
14	1 (0.4)	1 (0.5)	0 (0.0)
16	1 (0.4)	1 (0.5)	0 (0.0)
17	1 (0.4)	1 (0.5)	0 (0.0)
19	1 (0.4)	1 (0.5)	0 (0.0)
23	1 (0.4)	0 (0.0)	1 (1.2)
26	1 (0.4)	1 (0.5)	0 (0.0)
Mean (±sd)	3.41 (3.41)	3.70 (3.60)	2.76 (2.97)

Mean (±sd) duration of exposure: All=3.41 (3.41); Males (n=190,3.70 (3.60); Female=2.76 (2.97) years The duration of exposure was significantly longer (t-test=2.27, P-value=0.02) in men (3.70±3.60 years) compared to women (2.76±2.97 years).

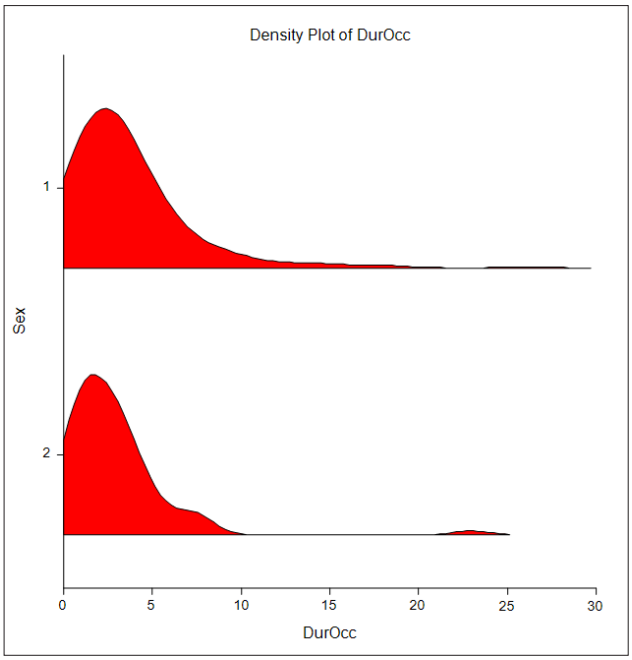
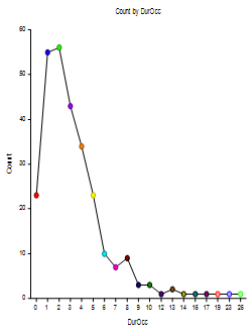
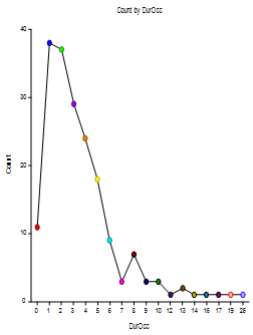
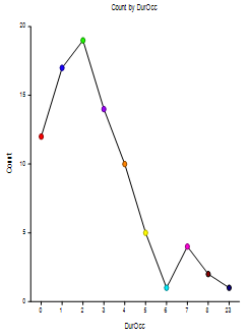


Figure 3: Density Plot of Duration of Occupational Exposure to Gasoline Fumes relative to sex (1=males, 2=females)

All	Males	Females
Mean (±sd) (excluding <1 year duration) n=252; 3.72 (3.40) yrs	Mean (±sd) (excluding <1 year duration) n=179; 3.93 (3.55) yrs	Mean (±sd) (excluding <1 year duration) n=73; 3.21 (2.97) yrs
Range: 1-26 years	Range: 1-26 years	Range: 1-23 years
Mean (±sd) (including <1 year duration) n=275; 3.41 (3.42) yrs	Mean (±sd) (including <1 year duration) n=190; 3.70 (3.56) yrs	Mean (±sd) (including <1 year duration) n=85; 2.76 (2.97) yrs
Range: <1-26 years	Range: <1-26 years	Range: <1-23 years

Figure 4: Duration of occupational exposure to gasoline fumes by gender (2023)

Table 4: Duration of Exposure to Gasoline Fumes and daily hours of sleep among male and female participants

Duration of exposure (yrs)	Freq. (%) (n=275)	Mean duration of sleep (hrs)					t-test	P-value
		All	Males		Females			
			n	Mean (±sd)	n	Mean (±sd)		
			190	6.2 (1.8)	85	6.4 (2.1)	0.76	0.45
<1	23 (8.4)	6.3 (2.5)	11 (5.8)	5.0 (1.8)!#	12 (14.1)	7.4 (2.5)*	-2.66	0.02
1-2		6.2 (1.9)	75 (39.5)	6.4 (2.0)	36 (42.4)	5.9 (1.6)	1.42	0.16
2.1-4	77 (28.0)	6.5 (2.0)	53 (27.9)	6.3 (1.8)	24 (28.2)	6.9 (2.4)	-1.09	0.28
4.1-6	33 (12.0)	6.3 (1.8)	27 (14.2)	6.1 (1.7)	6 (7.1)	7.2 (1.9)	-1.31	0.23
6.1-8	16 (5.8)	5.6 (1.6)	10 (5.3)	6.1 (1.1)	6 (7.1)	4.8 (2.0)*	1.46	0.19
>8	15 (5.3)	5.9 (1.5)	14 (7.4)	5.9 (1.5)	1 (1.2)	6.0 (0.0)	0.0	0.00
1 to >8	252 (91.6)	6.3 (1.9)	179 (94.2)	6.2 (1.8)!	73 (85.9)	6.3 (2.0)#	-0.37	0.71

**The mean duration of sleep among females exposed to gasoline fumes for 6.1-8 years was significantly lower (t-test=-2.39, P-value=0.03) than that of females exposed for <1 year. Thus, exposure to gasoline fumes may cause insomnia among females. Further studies are needed to confirm this finding.*

!The mean duration of sleep among males exposed to gasoline fumes for 1->8 years was marginally significantly longer (t-test=-2.15, P-value=0.05) than that of males exposed for <1 year Thus, exposure to gasoline fumes may cause insomnia among males. Further studies are needed to confirm this finding.

#The mean duration of sleep among males exposed to gasoline fumes for <1 year was significantly lower (t-test=-2.20, P-value=0.045) than that of females exposed for 1->8 years while no significant difference was observed in the mean duration of sleep among females exposed to gasoline fumes for <1 year compared to males exposed for 1->8 years. Thus, exposure to gasoline fumes may be sex dependent. Further studies are needed to confirm this finding.

Table 5: Frequency Distribution of Illnesses among male and female Gasoline Pump Attendants in Lagos State relative to duration of exposure at current place of work

Symptom	Response	Duration of Occupational Exposure (Years)														
		<1		1-2		2.1-4		4.1-6		6.1-8		>8		All Male	All Female	All
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female			
		(n=11)	(n=12)	(n=75)	(n=36)	(n=53)	(n=24)	(n=27)	(n=6)	(n=10)	(n=6)	(n=14)	(n=1)	(n=190)	(n=85)	(n=275)
Headache	Yes	6 (54.5)	11 (91.7)	55 (73.3)	23 (63.9)	38 (71.7)	21 (87.5)	20 (74.1)	5 (83.3)	7 (70.0)	4 (66.7)	8 (57.1)	1 (100.0)	134 (70.5)	65 (76.4)	199 (72.4)
	No	5 (45.5)	1 (8.3)	20 (26.7)	13 (36.1)	15 (28.3)	3 (12.5)	7 (25.9)	1 (16.7)	3 (30.0)	2 (33.3)	6 (42.9)	0 (0.0)	56 (29.5)	20 (23.6)	76 (27.6)
χ^2 (P-value) OR (95%CI)		2.40 (0.12) 0.11 (0.01, 1.16)*		1.03 (0.31) 1.55 (0.66, 3.64)		1.51 (0.22)* 0.36 (0.09, 1.40)		0.00 (1.00) 0.57 (0.06, 5.78)		0.00 (1.00)* 1.17 (0.13, 10.22)		0.00 (1.00) undefined		1.03 (0.31) 0.74 (0.41, 1.33)		--
Insomnia	Yes	3 (27.3)	2 (16.7)	16 (21.3)	8 (22.2)	15 (28.3)	8 (33.3)	11 (40.7)	1 (16.7)	1 (10.0)	2 (33.3)	5 (35.7)	0 (0.0)	51 (26.8)	21 (24.7)	72 (26.2)
	No	8 (72.7)	10 (83.3)	59 (78.7)	28 (77.8)	38 (71.7)	16 (66.7)	16 (59.3)	5 (83.3)	9 (90.0)	4 (66.7)	9 (64.3)	1 (100.0)	139 (73.2)	64 (75.3)	203 (73.8)
χ^2 (P-value) OR (95%CI)		0.01 (0.91)* 1.87 (0.25, 14.08)		0.01 (0.92) 0.95 (0.36, 2.48)		0.20 (0.66) (0.79 (0.28, 2.23)		0.41 (0.52)* 3.44 (0.35, 33.61)		0.25 (0.62)* 0.22 (0.02, 3.22)		0.00 (1.00) undefined		0.14 (0.71) 1.12 (0.62, 2.01)		-
Cough	Yes	1 (9.1)	6 (50.0)	25 (33.3)	7 (19.4)	20 (37.4)	6 (25.0)	4 (14.8)	0 (0.0)	2 (20.0)	0 (0.0)	0 (0.0)	1 (100.0)	52 (27.4)	20 (23.5)	72 (26.2)
	No	10 (90.9)	6 (50.0)	50 (66.7)	29 (80.6)	33 (62.3)	18 (75.0)	23 (85.2)	6 (100.0)	8 (80.0)	6 (100.0)	14 (100.0)	0 (0.0)	138 (72.6)	65 (76.5)	203 (73.8)
χ^2 (P-value) OR (95%CI)		2.81 (0.09)* 0.10 (0.01, 1.04)		2.27 (0.13) 2.07 (0.80, 5.38)		1.18 (0.28) 1.82 (0.62, 5.34)		0.10 (0.75)* undefined		0.15 (0.70)* undefined		3.23 (0.07)* undefined		0.45 (0.50) 1.22 (0.68, 2.22)		-
Cough and catarrh (mucus)	Yes	3 (27.3)	4 (33.3)	29 (38.7)	16 (44.4)	19 (36.9)	8 (33.3)	5 (18.5)	3 (50.0)	4 (40.0)	0 (.0)	4 (28.6)	0 (0.0)	64 (33.7)	31 (36.5)	95 (34.5)
	No	8 (72.7)	8 (66.7)	46 (61.3)	20 (55.6)	34 (64.1)	16 (66.7)	22 (81.5)	3 (50.0)	6 (60.0)	6 (100.0)	10 (71.4)	1 (100.0)	126 (66.3)	54 (63.5)	180 (65.5)
χ^2 (P-value) OR (95%CI)		0.0 (1.00)* 0.75 (0.13, 4.49)		0.33 (0.56) 0.79 (0.35, 1.76)		2.45 (0.12) 0.50 (0.21, 1.19)		1.21 (0.27)* 0.23 (0.03, 1.48)		1.42 (0.23)* undefined		0.00 (1.00)* undefined		0.20 (0.65) 0.88 (0.52, 1.51)		-
Eye irritation	Yes	1 (9.1)	3 (25.0)	19 (25.3)	11 (30.6)	12 (22.6)	6 (25.0)	1 (3.7)	0 (0.0)	1 (10.0)	1 (16.7)	2 (14.3)	1 (100.0)	36 (18.9)	22 (25.9)	58 (21.1)
	No	10 (90.9)	9 (75.0)	56 (74.7)	25 (69.4)	41 (77.4)	18 (75.0)	26 (96.3)	6 (100.0)	9 (90.0)	5 (83.3)	12 (85.7)	0 (0.0)	154 (81.1)	63 (74.1)	217 (78.9)
χ^2 (P-value) OR (95%CI)		0.21 (0.65)* 030 (0.03, 3.43)		0.33 (0.56) 0.77 (0.32, 1.86)		0.05 (0.82) 0.88 (0.28, 2.71)		0.00 (1.00)* undefined		0.00 (1.00)* 0.56 (0.03, 10.93)		0.60 (0.44)* undefined		1.69 (0.19) 0.67 (0.37, 1.23)		-
Skin irritation	Yes	1 (9.1)	3 (25.0)	5 (6.7)	5 (13.9)	4 (7.6)	3 (12.5)	1 (3.7)	1 (16.7)	1 (10.0)	0 (0.0)	1 (7.1)	0 (0.0)	13 (6.8)	12 (14.1)	25 (9.1)
	No	10 (90.9)	9 (75.0)	70 (93.3)	31 (86.1)	49 (92.4)	21 (87.5)	26 (96.3)	5 (83.3)	9 (90.0)	6 (100.0)	13 (92.9)	1 (100.0)	177 (93.2)	73 (85.9)	250 (90.9)
χ^2 (P-value) OR (95%CI)		0.00 (1.00)* undefined		0.75 (0.39)* Undefined		0.17 (0.68)* undefined		0.00 (1.00)* undefined		0.00 (1.00) undefined		0.00 (1.00)* undefined		1.23 (0.27)* 4.18 (0.52, 33.51)		-
Diabetes Mellitus	Yes	0 (0.0)	0 (0.0)	2 (2.7)	1 (2.8)	0 (0.0)	0 (0.0)	1 (3.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.6)	1 (1.2)	4 (1.5)
	No	11 (100.0)	12 (100.0)	73 (97.3)	35 (97.2)	53 (100.0)	24 (100.0)	26 (96.3)	6 (100.0)	10 (100.0)	6 (100.0)	14 (100.0)	1 (100.0)	187 (98.4)	84 (98.8)	271 (98.5)
χ^2 (P-value) OR (95%CI)		0.00 (1.00)* undefined		0.00 (1.00)* 0.96 (0.08, 10.94)		0.17 (0.68)* undefined		0.00 (1.00)* undefined		0.01 (0.94)* undefined		0.18 (0.28)* undefined		0.00 (1.00)* 1.35 (0.14, 13.15)		-

Citation: Bamgboye Afolabi, Susan Holdbrooke, Victor Inem, Kyle Kuusisto (2025) Clinical Symptoms, Gender Variation and the Effect of Occupational Inhalation of Gasoline Vapour Among Petrol Station Attendants in Lagos, South West Nigeria. Japan Journal of Clinical & Medical Research. SRC/JJCMR-233.
DOI: doi.org/10.47363/JJCMR/2025(5)192

Kidney problem	Yes	0 (0.0)	0 (0.0)	1 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.7)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.1)	0 (0.0)	3 (1.6)	0 (0.0)	3 (1.1)
	No	11 (100.0)	12 (100.0)	74 (98.7)	36 (100.0)	53 (100.0)	24 (100.0)	26 (96.3)	6 (100.0)	10 (100.0)	6 (100.0)	13 (92.9)	1 (100.0)	187 (98.4)	85 (100.0)	272 (98.9)
χ^2 (P-value) OR (95%CI)		0.00 (1.00)* undefined		0.00 (1.00)* undefined		0.17 (0.68)* undefined		0.00 (1.00)* undefined		0.01 (0.94)* undefined		0.00 (1.00)* undefined		0.29 (0.59)* undefined		-
Micturition problem	Yes	0 (0.0)	0 (0.0)	6 (8.0)	0 (0.0)	2 (3.8)	2 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (4.2)	2 (2.4)	10 (3.7)
	No	11 (100.0)	12 (100.0)	69 (92.0)	36 (100.0)	51 (96.2)	22 (91.7)	27 (100.0)	6 (100.0)	10 (100.0)	6 (100.0)	14 (100.0)	1 (100.0)	182 (95.8)	83 (97.6)	265 (96.3)
χ^2 (P-value) OR (95%CI)		0.00 (1.00)* undefined		1.68 (0.19)* undefined		0.08 (0.78)* 0.43 (0.06, 3.26)		0.00 (1.00)* undefined		0.01 (0.94)* undefined		0.00 (1.00)* undefined		0.17 (0.68) 1.82 (0.38, 8.78)		-
Asthma	Yes	0 (0.0)	0 (0.0)	3 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.6)	0 (0.0)	3 (1.1)
	No	11 (100.0)	12 (100.0)	72 (96.0)	36 (100.0)	53 (100.0)	24 (100.0)	27 (100.0)	6 (100.0)	10 (100.0)	6 (100.0)	14 (100.0)	1 (100.0)	187 (98.4)	85 (100.0)	272 (98.9)
χ^2 (P-value) OR (95%CI)		0.00 (1.00)* undefined		0.35 (0.55)* undefined		0.17 (0.68)* undefined		0.00 (1.00)* undefined		0.01 (0.94)* undefined		0.00 (1.00)* undefined		0.29 (0.59)* undefined		-
Chest pain	Yes	3 (27.3)	9 (75.0)	13 (17.3)	1 (2.8)	13 (24.5)	9 (37.5)	6 (22.2)	1 (16.7)	2 (20.0)	1 (16.7)	0 (0.0)	0 (0.0)	37 (19.5)	21 (27.1)	58 (21.1)
	No	8 (72.7)	3 (25.0)	62 (82.7)	35 (97.2)	40 (75.5)	15 (62.5)	21 (77.8)	5 (83.3)	8 (80.0)	5 (83.3)	14 (100.0)	1 (100.0)	153 (80.5)	64 (72.9)	217 (78.9)
χ^2 (P-value) OR (95%CI)		3.50 (0.06)* 0.12 (0.02, 0.80)		3.45 (0.06)* 7.34 (0.92, 58.49)		1.34 (0.25) 0.54 (0.19, 1.53)		0.00 (1.00)* 1.43 (0.14, 14.70)		0.00 (1.00)* 1.5 (0.09, 17.65)		0.00 (1.00)* undefined		0.96 (0.33) 0.74 (0.40, 1.37)		-
Arthritis	Yes	1 (9.1)	2 (16.7)	7 (9.3)	2 (5.6)	5 (9.4)	4 (16.7)	3 (11.1)	0 (0.0)	1 (10.0)	2 (33.3)	0 (0.0)	0 (0.0)	17 (8.9)	10 (11.8)	27 (9.8)
	No	10 (90.9)	10 (83.3)	68 (90.7)	34 (94.4)	48 (90.6)	20 (83.3)	24 (89.9)	6 (100.0)	9 (90.0)	4 (66.7)	14 (100.0)	1 (100.0)	173 (91.1)	75 (88.2)	248 (90.2)
χ^2 (P-value) OR (95%CI)		0.00 (1.00)* 0.50 (0.04, 6.44)		0.10 (.76)* 1.75 (0.34, 8.88)		0.28 (0.59)* 0.52 (0.13, 2.14)		0.01 (0.94)* undefined		0.25 (0.62)* 0.22 (0.02, 3.22)		0.00 (1.00)* undefined		0.52 (0.47) 0.74 (0.32, 1.68)		-

** Fisher's exact test; !Females OR (95% CI)=9.17 (0.86,97.70)*

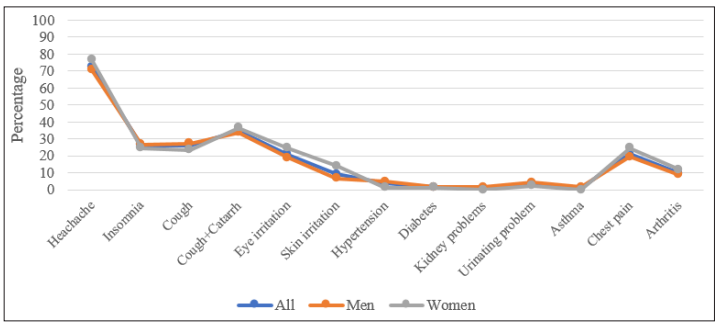


Figure 5a: Prevalence of clinical complaints among gasoline pump attendants in metropolitan Lagos, Nigeria (2023)

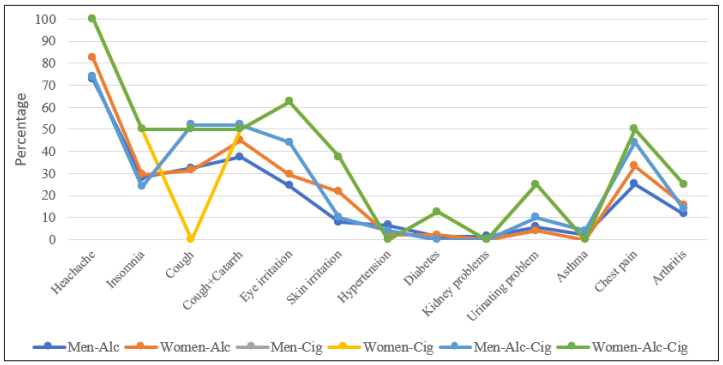
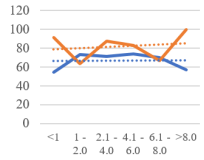
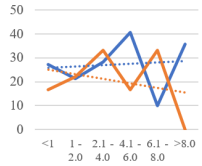
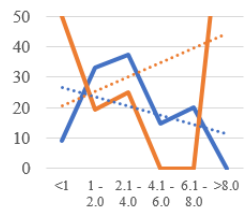
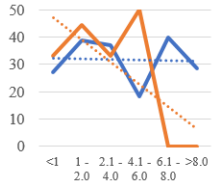
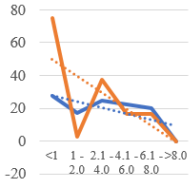
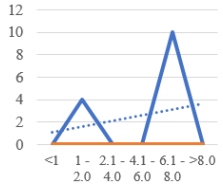


Figure 5b: Prevalence of various symptoms among gasoline pump attendants relative to their social history (2023)
Men-Alc=male respondents who consumed alcohol; Women-Alc=Female respondents who consumed alcohol; Men-Cig=male respondents who smoked cigarettes; Women-Cig=female respondents who smoked cigarettes; Men-Alc-Cig=male respondents who both consumed alcohol and smoked cigarettes; Men-Alc-Cig=male respondents who both consumed alcohol and smoked cigarettes; Men-Alc-Cig=male respondents who both consumed alcohol and smoked cigarettes; Women-Alc-Cig=female respondents who both consumed alcohol and smoked cigarettes.

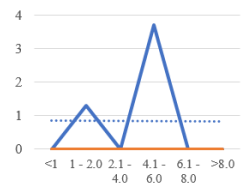
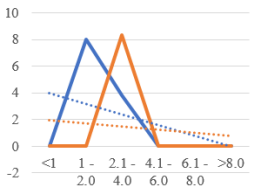
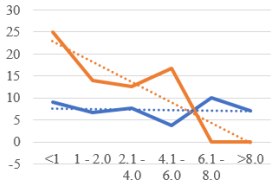
Citation: Bamgboye Afolabi, Susan Holdbrooke, Victor Inem, Kyle Kuusisto (2025) Clinical Symptoms, Gender Variation and the Effect of Occupational Inhalation of Gasoline Vapour Among Petrol Station Attendants in Lagos, South West Nigeria. Japan Journal of Clinical & Medical Research. SRC/JJCMR-233.
DOI: doi.org/10.47363/JJCMR/2025(5)192

	Neurological Symptoms	
	Headache	**Insomnia**
Percentage of respondents		
	X-axis: Duration of occupation at gas station (yrs)	
	Blue line (dotted) Male (Linear); Brown line (dotted) Females (Linear)	

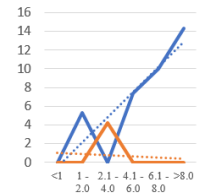
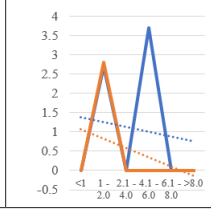
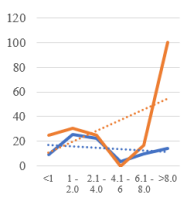
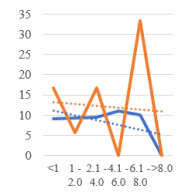
(a)

	Respiratory Symptoms			
	Cough	**Cough and catarrh**	**Chest pain**	**Asthma**
Percentage of respondents				
	X-axis: Duration of occupation at gas station (yrs)			
	Blue line (dotted) Male (Linear); Brown line (dotted) Females (Linear)			

(b)

	Renal and Dermatological symptoms		
Y-axis	**Kidney problems**	**Micturition problems**	**Skin irritation**
Percentage of respondents			

(c)

	Cardiovascular Symptom	**Endocrinological Symptom**	**Ocular Symptom**	**Musculo-skeletal Symptom**
Y-axis	**Hypertension**	**Diabetes mellitus**	**Eye irritation**	**Arthritis**
Percentage of respondents				
	X-axis: Duration of occupation at gas station (yrs)			
	Blue line (dotted) Male (Linear); Brown line (dotted) Females (Linear)			

(d)

Figures 6a-d: Comparative analysis of duration of exposure to gasoline fumes relative to gender of respondents

Table 6: Reproductive Responses of Male and Female respondents relative to duration of Exposure to Gasoline

Duration of exposure (yrs.)	Males										
	n (%)	Sperm count done.		Wife has difficulty in getting pregnant			Wife had miscarriage			Use sex-enhancing drug	
				Married (n=114, 60.0%)		Not married	Married (n=114, 60.0%)		Not married		
		Yes	No	Yes	No		Yes	No		Yes	No
	190 (100.0)	16 (8.4)	174 (91.6)	4 (3.5)	110 (96.5)	76 (40.0)	16 (14.0)	98 (51.6)	76 (40.0)	48 (25.3)	142 (74.7)
<1	57 (30.0)	5 (31.2)	52 (29.9)	1 (25.0)	22 (20.0)	34 (44.7)	2 (12.5)	21 (21.4)	34 (44.7)	18 (37.5)	39 (27.5)
1-2	44 (23.2)	3 (18.8)	41 (23.6)	0 (0.0)	22 (20.0)	22 (28.9)	1 (6.2)	21 (21.4)	22 (28.9)	10 (20.8)	34 (23.9)
2.1-4	49 (25.8)	3 (18.8)	46 (26.4)	0 (0.0)	33 (30.0)	16 (21.1)	5 (31.3)	28 (28.6)	16 (21.1)	10 (20.8)	39 (27.5)
4.1-6	22 (11.6)	2 (12.5)	20 (11.5)	3 (75.0)	16 (14.5)	3 (3.9)	5 (31.3)	14 (14.3)	3 (3.9)	6 (12.5)	16 (11.3)
6.1-8	10 (5.3)	3 (18.8)	7 (4.0)	0 (0.0)	10 (9.1)	0 (0.0)	1 (6.2)	9 (9.2)	0 (0.0)	3 (6.2)	7 (4.9)
>8	8 (4.2)	0 (0.0)	8 (6.0)	0 (0.0)	7 (6.4)	1 (1.3)	2 (12.5)	5 (5.1)	1 (1.3)	1 (2.1)	7 (4.9)
Duration of exposure (yrs.)	Females										
	n (%)	Miscarriage during current occupation		Dyspareunia during current occupation		Use of contraceptive		Regular menstruation		Number of pads used during monthly menstruation (among those with irregular menstruation, n=22)	
		Yes	No	Yes	No	Yes	No	Yes	No	1-2	2-3	>3
	85 (100.0)	19 (22.3)	66 (77.7)	12 (14.1)	73 (85.9)	13 (15.3)	72 (84.5)	63 (74.1)	22 (25.9)	6 (27.3)	5 (22.7)	11 (50.0)
<1	12 (14.1)	1 (5.3)	11 (16.7)	2 (16.7)	10 (13.7)	2 (15.4)	10 (13.9)	10 (15.9)	2 (9.1)	1 (14.3)	1 (20.0)	0 (0.0)
1-2	36 (42.4)	6 (31.6)	30 (45.5)	4 (33.3)	32 (43.8)	3 (23.1)	33 (45.8)	28 (44.4)	8 (36.4)	1 (14.3)	3 (60.0)	4 (36.4)
2.1-4	2.1-4	7 (36.8)	17 (25.8)	5 (41.7)	19 (26.0)	6 (46.2)	18 (25.0)	15 (23.8)	9 (40.9)	4 (66.7)	1 (20.0)	4 (36.4)
4.1-6	6 (7.1)	1 (5.3)	5 (7.6)	0 (0.0)	6 (8.2)	2 (15.4)	4 (5.6)	5 (7.9)	1 (4.5)	0 (0.0)	0 (0.0)	1 (9.1)
6.1-8	6 (7.1)	3 (15.8)	3 (4.5)	1 (8.3)	5 (6.8)	0 (0.0)	6 (8.3)	5 (7.9)	1 (4.5)	0 (0.0)	0 (0.0)	1 (9.1)
>8	1 (1.2)	1 (5.3)	0 (0.0)	0 (0.0)	1 (1.4)	0 (0.0)	1 (1.4)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	1 (9.1)

Discussion

Nigeria has not yet transitioned to the modern way of automated gasoline dispensation vehicular drivers use pre-paid card to purchase gasoline at a station without any attendant, spending a maximum of 2-3 minutes to fill up their vehicle with gasoline fuel. Organic lead is added to gasoline as an anti-knock agent to preserve vehicular engine. This questionnaire study had initial limitations in that no laboratory evaluation was conducted for the hematological parameters, lung function test, BTEX and air quality index, or phycological assessment of the respondents. The current study evaluated the reported symptoms of ill health among those who were occupationally exposed to gasoline fumes in metropolitan Lagos, Nigeria. The study found certain symptoms more prevalent in female than in male workers while other symptoms were more frequent in male than in female workers exposed to GV. There are certain key findings in this study. First, the proportion of those who were occupationally exposed to GV decreased with time. This was also observed in a study conducted in Sudan [25] Secondly, headache was the most reported symptom, especially by female workers who were occupationally exposed to GV. This finding is consistent with the results from earlier study that reported predominant neurological symptoms including headache and dizziness, mostly in females [26] The pathophysiology of headache among those occupationally exposed to GV has not been clearly explained but it may be related to gradual enhanced peroxidative processes and oxidative stress within brain cells [27]. Another possible explanation of headache among those exposed to GV is benzene-related primary hypertension and/or disturbance in basic electrophysiology of the brain [28]. In consonance with another report this study observes a sort of trend in headache among both male and female subjects, with long history of occupational exposure to GV, though more pronounced in the females [29]. On the other hand, BTEX probably trigger release of free radicals, through lipid peroxidation, causing damages to the tissue, and

possibly spasm of brain blood vessels [30]. The only plausible reason that can be given for the higher prevalence of headache among female workers is that female hormones may have higher affinity for BTEX for benzene and other constituents of BTEX to stay longer in the female body. The mean duration of sleep among females exposed to GV for 6.1-8 years was significantly lower than that of females exposed for <1 year. Contrary to the report of Kraut et al which stipulates increased sleep requirement among those occupationally exposed to BTEX, insomnia was reported more frequently among males than females in this study [31]. The study of Ulla et al concludes that high serum benzene among gasoline workers is related to insomnia [32]. In layman's terms, pulmonary response to GV were "cough" and "cough and catarrh". In this study, the prevalence of cough and catarrh was higher in female than male respondents. The 26.7% and 34.5% prevalence of cough reported in this study is lower than the 39.7% reported by Ameen and Abdulla in Iraq but the prevalence of cough and mucus secretion of 34.5% was higher than the 8.6% reported by the same authors [33]. The lungs are the first port-of-call with direct and easy access for inhaled gasoline vapor and where primary damages are expected. Usman et al proposed that GV easily diffuses along a wide surface area of the lungs and penetrate circulation and the inhaled GV probably breaks down the antioxidant defense system of the lungs to generate excess reactive oxygen species (ROS) that the antioxidant buffering capacity may be unable to handle, thus causing cell injury or cell death [34-37]. Studies have reported pulmonary fibrosis, airway obstruction, asthma and chronic obstructive pulmonary disease (COPD) and reduced pulmonary function [16,38-42]. Chest pain was reported by 21.1% of the respondents, mainly in the females (27.1%) Data are very limited on chest pain among petrochemical workers, especially in Nigeria. However, in an animal model, tumor necrosis factor-alpha - an inflammatory marker - and transforming growth factor-β1, collagen and hydroxyproline - as fibrotic markers - were significantly increased in rats exposed to GV [43] This may presuppose fibrosis of the lung tissues and probably of the diaphragm to elicit chest pain as a result of occupational exposure to GV. During current occupational exposure, 16 (14.0%) among 114 married men in the study reported their wives had miscarriage among whom 10 (62.5%) had been occupationally exposed to GV for 2.1-6.0 years. Another animal study illustrated significant alterations in all levels of reproductive hormones including sperm count, sperm motility, damage to various anatomical part of the sperm among rats with prolonged exposure to gasoline fumes [44] Thus, exposure to GV, found to interfere with spermatogenesis and to impair fertility, may be responsible for the miscarriages among wives of males as described above. Some gynecological aberrations were also reported among female respondents, including miscarriage during current occupation (22.3%), dyspareunia (14.1%), irregular menstruation (74.1%) and use of more than 3 menstrual hygiene pads (50.0%), indicative of menorrhagia. Our findings are consistent with what another Nigerian study reported, that the prevalence of menstrual disorders among the exposed women was 37.2%; that exposure to gasoline was notably linked with disorders in both menstrual cycle length and quantity of flow and that exposed women had a were at greater risk of abnormal cycle length and abnormal quantity of flow, especially among those with longer duration of exposure >1 year [45].

Conclusion

This study established headache as the most prevalent complaint among these workers. Most of married male respondents with long duration of exposure reported wife had difficulty in getting pregnant. Miscarriage, dyspareunia and irregular menstruation were reported by a fairly large number of female respondents who has been occupationally exposed for more than 2 years. Gasoline vapors, especially from service stations, significantly contribute to poor health of attendants at various gasoline stations across the country. Gasoline vapors contain Volatile Organic Compounds (VOCs) including benzene, toluene, ethylbenzene and isomers of xylene. Robust measures are needed to reduce PAH exposure and mitigate its neuro-metabolic and psychological impacts on the health of petrochemical workers. Petrol pump attendants in metropolitan Lagos are subjected to gasoline vapor that are emitted when filling up automobiles, trucks of various sizes, motorcycles or jerrycans.

Recommendation

Adequate safety precautions among this group of people, such as wearing of masks during work hours, should be made mandatory by policy makers. Environmental Protection Agency (EPA) in each state of the country should work closely with Oil and Gas Industry Stakeholders to implement vapor recovery (VR) requirements at gasoline stations in urban or rural parts of each state. Further, state EPA should ensure that these workers undergo regular training programs, focusing on the necessity of using safety equipment's. Also, Oil and Gas companies should be mandated to conduct medical checkups for their exposed employees and the state should establish a system to monitor and keep track of the health of those occupationally exposed to gasoline hazard.

Note: Vapor recovery control equipment aims to capture gasoline vapors before they enter the atmosphere. They are designed in two stages - VR1 and VR2. VR1 captures displaced vapors from storage tanks when a tanker delivers gasoline to a service station, while VR2 captures displaced vapors at the bowser while a motorist refuels.

VR1 technology has been required in the Sydney Metropolitan Area since 1986. In 2010 the Protection of the Environment Operations (Clean Air) Regulation (the Regulation) expanded the VR requirements, with gasoline service stations from Port Stephens to Shoalhaven and west to the Blue Mountains having to install VR1 or upgrade their bowsers to VR2 technology. This initiative will reduce VOC emissions from service stations by approximately 5000 tones each year.

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