

# GAS FLARING AND CRUDE OIL CONTAMINANTS AS MODIFYERS OF BLOOD PRESSURE IN DELTA STATE

## Abstract:

Several toxic effects of crude oil have been reported on human reproductive, respiratory, cardiovascular, and nervous systems. An instance is seen in the negative effect on fertility resulting from prolonged exposure to fumes from exhausts of vehicles. This study therefore investigated gender-specific changes in selected cardiovascular variables of residents of gas flaring and crude oil contaminated communities of Delta State, southern Nigeria. Two Hundred and Forty (240) subjects exposed to gas flaring and crude oil contamination (Experimental group) were ethically sourced from Agbarho [Ughelli North Local government Area (LGA)] and Bomadi (Bomadi LGA); both gas flaring communities in Delta State. One hundred and twenty (120) non-exposed individuals were also recruited (control group) from Abraka, a non-gas flaring community in Ethiope East LGA of the same state. Subjects were matched by gender and duration of stay (exposure) in the target communities. The cardiovascular variables [systolic blood pressure (SBP), diastolic blood pressure (DBP)] of all the subjects were measured, while pulse and mean arterial pressures (PP and MAP respectively) were calculated. Following statistical analysis (using the student t-test), results showed (at  $p < 0.05$ ) a statistically significant increase in SBP and MAP of the experimental group. Study also found a significant increase in DBP and PP for experimental than control group; it also reflected a durational-dependent exposure of subjects to increased SBP and DBP. Exposed males showed an increase in average values of PP, MAP, SBP and DBP than their female counterparts. Also, oil contamination caused a greater negative percentage impact on MAP than gas flaring. This Study therefore ascertained the veracity of previous findings; confirming gas flaring and crude oil contamination as potent elicitors of hypertension. Hence, we recommend periodic epidemiological assessment of environmental pollutants as a factor of hypertensive individuals.

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**Keywords:** Cardiovascular variables, Gas flaring, Gender, Environmental Pollutants

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## Introduction

Pollution is the contamination of Earth's environment with materials that interfere with human health, quality of life, or the natural functioning of the ecosystems (living organisms and their physical surroundings) in relation to the body's internal environment [1-3]. Although some environmental pollution is a result of natural causes such as volcanic eruptions, most are caused by human and industrial activities [3]. In the 1950s for instance, residents of Minamata, Japan, reportedly began experiencing unusual symptoms, which include numbness, vision problems, and convulsions; and death of hundreds of people caused by mercury ingestion from toxic chemicals dumped into the Minamata Bay by a local industry [4&5].

43 With the Niger-Delta region of Nigeria famous for oil and gas production and allied  
44 industrial activities like oil drilling and local refineries, gas flaring and industrial waste  
45 disposal have become rampant, with over 130 reported flaring sites [6]. This makes Nigeria  
46 one of the highest emitters of greenhouse gases in Africa [7]. The constant exposure to  
47 hazardous chemicals as these, with accompanying deleterious health implications is therefore  
48 expected to likely be more in humans that reside close to these refineries and gas flaring sites  
49 [8].

50 Globally, environmental air pollution has been associated with the development of a  
51 number of health problems including heart disease, high blood pressure, stroke, lung cancer,  
52 as well as chronic and acute respiratory ailments like asthma, bronchitis, etc [9-11]. A More  
53 recent research has revealed that many chemical pollutants, such as DDT and PCBs, mimic  
54 sex hormones and interfere with the human body's reproductive and developmental  
55 functions. These substances are known as endocrine disrupters [12]. The mortalities and  
56 morbidities associated with aforementioned disease pose enormous health and economic  
57 consequences that reflects on increased loss of productivity, reducing labor efficiency in low  
58 to middle income nations [13].

59 Gas flaring and oil refining activities may affect the sleep-wake cycle in healthy  
60 individuals [14]. Also, long term exposure to dioxins, a major product of gas flaring and  
61 crude oil refining has been shown to cause neurological symptoms; including neuroglia, sleep  
62 disturbances, and severe headache [15&16]. Available evidence suggests that sleep  
63 deprivation is positively correlated with increased cardiovascular risk, including hypertension  
64 [17].

65 A meta-Analysis of epidemiological studies has established a positive correlation  
66 between cardiovascular risk and exposure to such environmental pollutants as polycyclic  
67 aromatic hydrocarbons, sulfur oxides, nitrogen oxides, and polycyclic biphenyls [16].  
68 Findings have also found that inflammatory dose of particulate matter (PM) is linked with  
69 increased plasma fibrinogen and blood viscosity, as well as systemic and local inflammatory  
70 events [17]. Attenuations in blood coagulability and endothelial dysfunction have also  
71 recently been associated with health implications of human exposures to gas flaring [18].  
72 Specifically, in chronic doses, acute exposure to these PM in high concentrations reportedly  
73 increases the risk of cardiovascular disorder [19&20]. Currently, reviewers have found that  
74 the prevalence of hypertension and other cardiovascular risk factors are significantly higher  
75 in urban than rural communities [14]. Though this may be traceable to nutritional and  
76 industrialization factors, the situation may differ in the Niger Delta rural communities where

77 environmental oil and gas pollution has been reported to increase in recent times with a  
78 likely, but unexplored impact on health outcomes, particularly cardiovascular health risk.  
79 Hence, this study was undertaken.

80

### 81 **Aim of Study**

82 This study was designed to examine changes in selected cardiovascular parameters of  
83 subjects residing in gas flaring and crude oil contaminated communities in Delta State,  
84 Nigeria. Specifically, study determined the comparative effects of gas flaring and crude oil  
85 contamination on systolic and diastolic blood pressures, as well as pulse and mean arterial  
86 pressures of resident male and females. Study also investigated the duration-dependent  
87 effects of exposures to gas flaring and crude oil contamination on systolic and diastolic blood  
88 pressures of samples male and female subjects.

89

## 90 **Materials and Methods**

### 91 **Scope of Study**

92 Study was non-invasive, and was designed to examine in humans, the comparative changes in  
93 cardiovascular parameters by gender, and their durational impact, following exposure to gas  
94 flaring and oil contamination in selected communities of Delta State, Nigeria. The work was  
95 exclusively designed to involve communities where gas flaring and/or refining activities  
96 occur. Abraha, a non-gas flaring community was targeted for non-exposed subjects (control)  
97 while Bomadi and Agbarho communities were the gas-flaring sites for experimental subjects.

98

### 99 **Study Design**

100 Study adopted the cross sectional design, geared towards comparing selected  
101 cardiovascular parameters by gender and also between residents of gas flaring and oil  
102 contaminated communities; and those of non-flaring and non-oil-contaminated areas of Delta  
103 State.

104

### 105 **Study Location**

106 Three different communities each with similar social-economic and cultural  
107 characteristic features, from three different local government areas (LGA) of Delta State,  
108 Nigeria were chosen for the study. Bomadi, a rural community in Bomadi LGA of the state  
109 was chosen. Bomadi covers an area of 129 km<sup>2</sup>, with a population density of about

110 918.6/km<sup>2</sup>. The community is about 118, 500 populated and represented crude oil  
111 contaminated communities in this study. Agbarho, another gas flaring community was also  
112 selected from Ugheli North LGA of the state. The community is estimated to have 170,000  
113 people in an 818 km<sup>2</sup> area of land. Abraka, a non-gas-flaring, non-oil-contaminated  
114 community was selected as control. Abraka is a rural community in Ethiope East LGA of  
115 Delta State, and is 276,000 populated

116

### 117 **Ethical Clearance**

118 Ethical approval was obtained from the Research and Ethics committee of the Faculty of  
119 Basic Medical Sciences, Delta State, University, Abraka, Delta State. Informed Consent  
120 forms were carefully structured and given to those who volunteered to participate in the  
121 study.

122

### 123 **Selection Criteria**

124 For participants to be qualified for selection, several factors were considered in the course of  
125 this study; most importantly were; age, non-disability and exceptions to use of heavy drugs.

126

### 127 **Eligibility/Inclusion Criteria**

128 Subjects who reside in the study area for more than two consecutive years, who were within  
129 the age brackets of 18-45 years were selected for this study.

130

### 131 **Exclusion Criteria**

132 Structured questionnaires and interview were used to exclude residents less than 18 years,  
133 and those who were above 45 years; also excluded were residents who have lived less than 2  
134 years in various target communities. Subjects who smoke, consume alcohol, and suffer from  
135 disorders like diabetes mellitus, hyperlipidaemia, peripheral vascular disease, renal disease,  
136 and chronic ailments like sickle cell and asthma were also exempted.

137

### 138 **Sample Size**

139 Three hundred and sixty (360) subjects were drawn from three LGAs of Delta State. The  
140 sample size of eligible adults was calculated based on the assumed prevalence of  
141 hypertension of 18% as earlier reported [21].

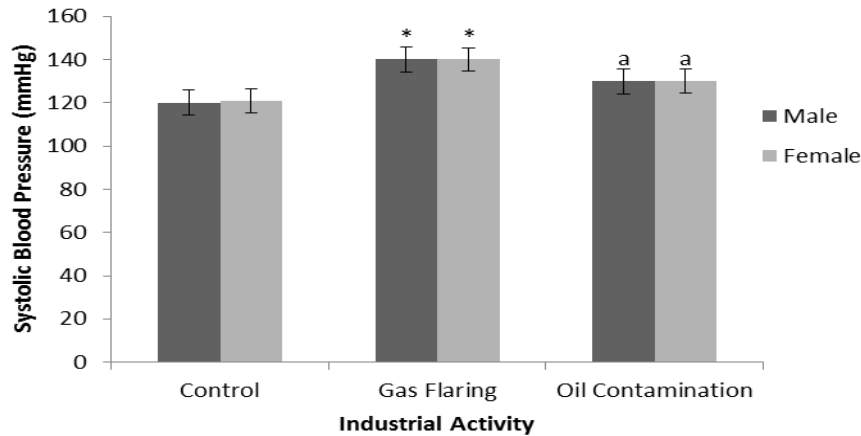
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### 143 **Statistical Analysis**

144 Results obtained from the study were expressed as Mean  $\pm$  SEM (Standard Error of  
145 Mean). With P-value of less than 00.05 ( $p < 00.05$ ) considered to be statistically significant, a  
146 one-way analysis of variance (ANOVA) was used to determine the mean differences for  
147 variables between groups.  
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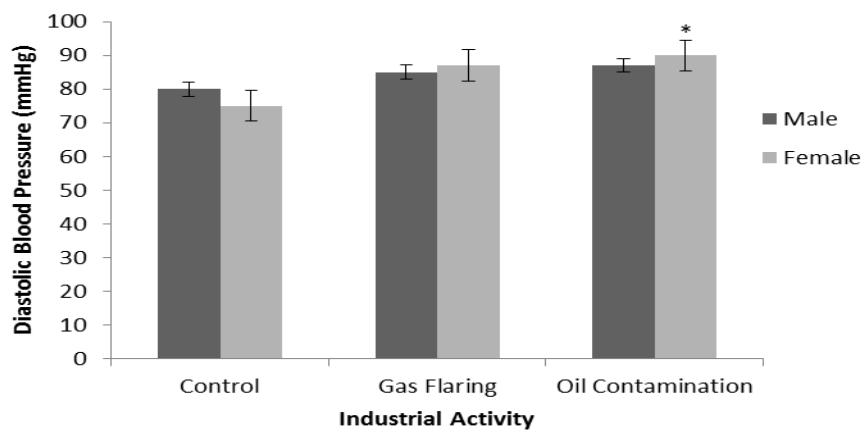
## 149 Results

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151 **Figure I: Comparative Effect of Gas Flaring and oil Contamination on Systolic Blood**  
152 **Pressure (SBP)**



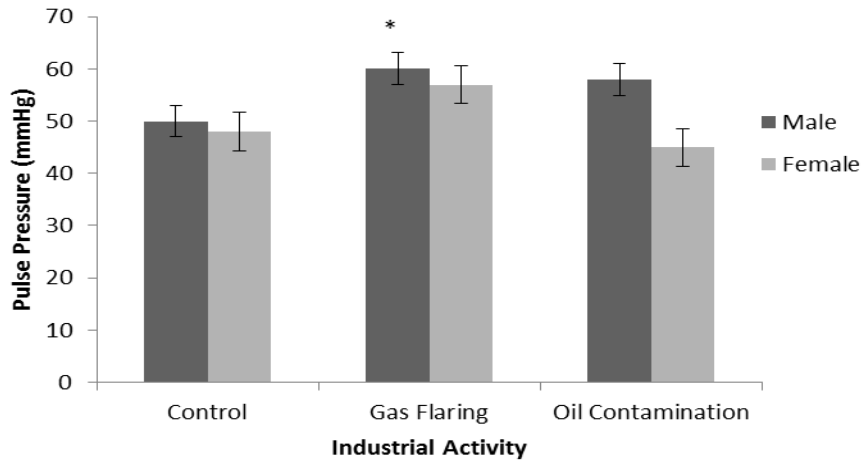
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154 *\*: significant at  $p < 0.05$  as compared to control*  
155 *a: significant at  $p < 0.05$  upon comparison between gas flaring and oil contamination exposed*  
156 *subjects*  
157

158  
159 **Figure II: Comparative Effect of Gas Flaring and oil Contamination on Diastolic Blood**  
160 **Pressure (DBP)**



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162 *\*: significant at  $p < 0.05$  as compared to control*

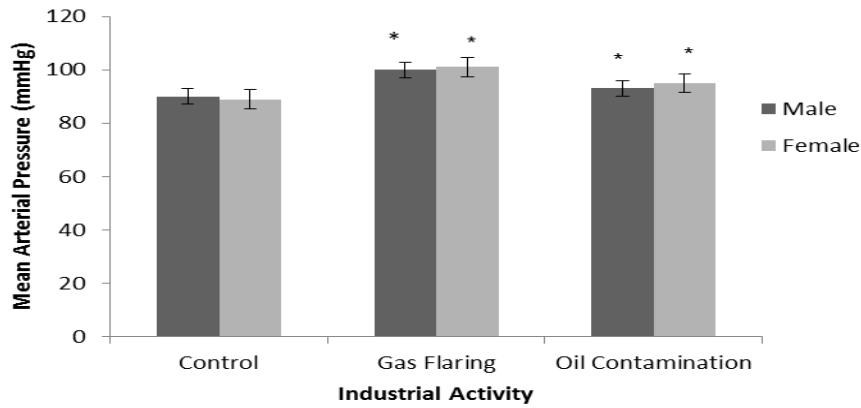
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164 **Figure III: Comparative Effect of Gas Flaring and oil Contamination on Pulse Pressure**  
165 **(PP)**



\*: significant at  $p < 0.05$  as compared to control

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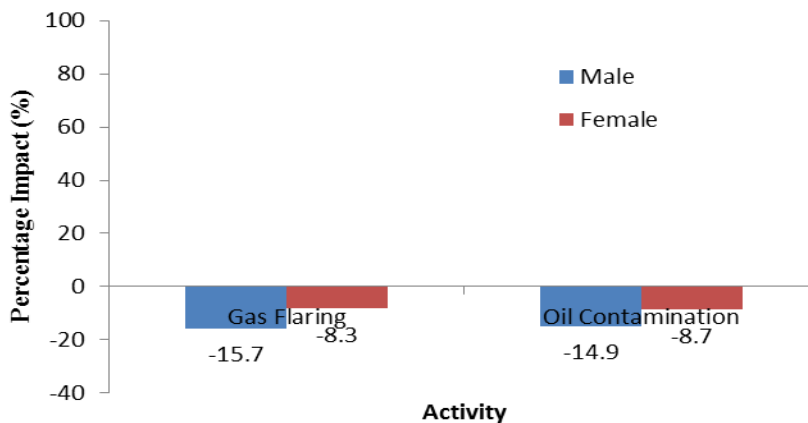
**Figure IV: Comparative Effect of Gas Flaring and oil Contamination on Mean Arterial Pressure (MAP)**



\*: significant at  $p < 0.05$  as compared to control

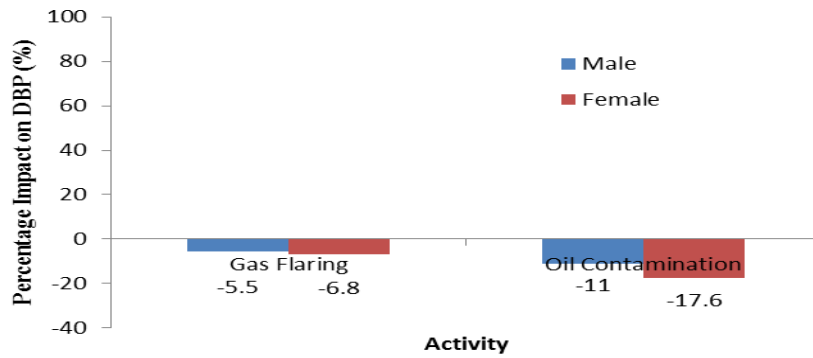
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**Figure V: Comparative Percentage Effect of Gas Flaring and oil Contamination on Systolic Blood Pressure (SBP)**

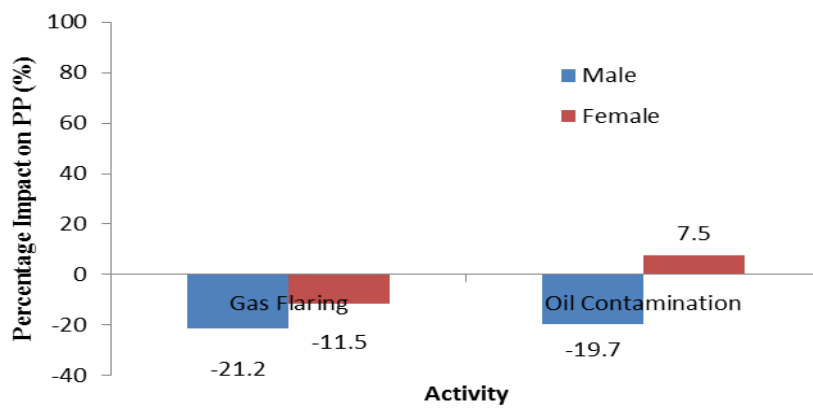


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**Figure VI: Comparative Percentage Effect of Gas Flaring and oil Contamination on Diastolic Blood Pressure (DBP)**

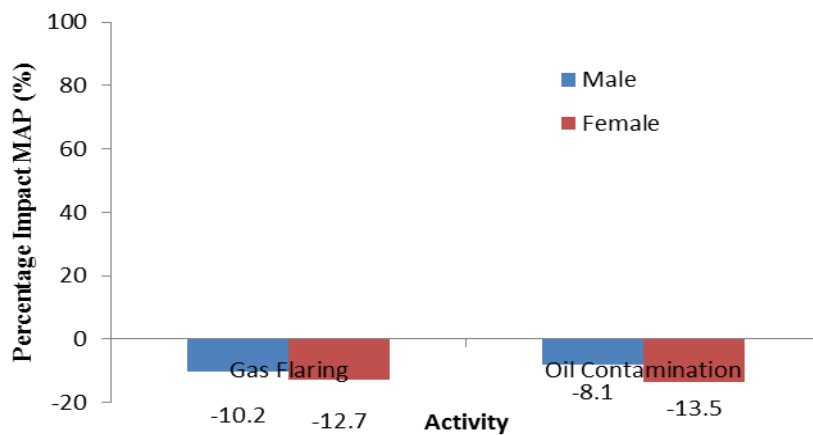


181  
 182 **Figure VII: Comparative Percentage Effect of Gas Flaring and oil Contamination on**  
 183 **Pulse Pressure (PP)**  
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-%: Negative Impact, +%: Positive Impact

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 189 **Figure VIII: Comparative Percentage Effect of Gas Flaring and oil Contamination on**  
 190 **Mean Arterial Pressure (MAP)**  
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## 195 Discussion

196  
197 Blood pressure (BP) is an important predictor of cardio-vascular events. In recent  
198 times, clinicians have traditionally recognized its importance to systolic BP, especially in  
199 older adults (JNCP. 1997). Blood pressure may be steady (Mean Arterial Pressure -MAP) or  
200 pulsatile (Pulse Arterial Pressure –PAP). This study examined the changes in selected  
201 cardiovascular parameters of subjects residing in gas flaring and crude oil contaminated  
202 communities of Delta State, Nigeria.

203 Upon data collection and careful observation, results from this study showed a  
204 statistically significant increase in the levels of systolic blood pressure (SBP), Diastolic blood  
205 pressure (DBP), and mean arterial pressure (MAP) for subjects exposed to gas flaring and oil  
206 contamination. This finding was consistent with Bogers *et al* report of 2007, who observed  
207 that prolonged exposure to gas flaring increases the risk of hypertension. Also from this  
208 study, MAP was observed to increase significantly with duration, following prolonged  
209 exposure of participants to gas flaring and oil contamination. With map saying lot about  
210 perfusion pressure, which is the continuously regulated pressure, necessary to maintain end  
211 organ-tissue perfusion as required for adequate cellular oxygenation. Thus, though tissue  
212 oxygenation was improved with increased MAP, the detrimental changes induced by gas  
213 flaring and crude oil contamination could be restricted to the effect on vascular tissues. In  
214 accordance with current study, findings from Opie et al., (2007) and Bogers et al., (2007)  
215 showed increased risk of hypertension for polluted environments; Similar to an  
216 environmental impact assessment study conducted by UNEP (UNEP, 2011). Therefore,  
217 inhabitants of oil polluted communities like Bomadi and Agbarho are not only exposed to  
218 various air and soil pollutants, but also to water and food pollutants, especially due to  
219 bioaccumulation of heavy metals and other agents. Investigations from this study also  
220 showed that gas flaring caused more negative impacts on systolic and pulse pressures than  
221 crude oil contamination effects when compared (Figure V). Furthermore, the less negative  
222 impact of gas flaring on MAP compared to the more negative impact of crude oil  
223 contamination could imply that gas flaring has a potent cardio-toxic effect on cardiovascular  
224 parameters.

225 Also noticeable from our result was the prevalence of all blood pressure variables  
226 (SBP, DBP, PP and MAP) that were higher in males than in females. This compared male  
227 than female increase was statistically significant ( $p < 0.05$ ) in control than test subjects.  
228 Physiologically, the increased BP in males may be attributable to the influence of different



229 developmental renal injury that is reportedly worse in men [22]. In fact, a drop in androgen  
230 levels in men with cardiovascular and other chronic diseases has also been implicated. Many  
231 investigators now believe that it is the reduction in androgen levels that frequently  
232 accompanies chronic disease, and may exacerbate cardiovascular diseases in men [23 & 24].  
233 Here, men tend to have higher blood pressure than women upon comparison; irrespective of  
234 race, culture and ethnicity [25 & 26]. It has also been observed in other species such as rats,  
235 mice, dogs, and chickens to be same.

236 Again, noise pollution has been proven to aggravate chronic illnesses like  
237 hypertension and other cardiopulmonary diseases [27]. Noise pollution does not only  
238 contributes to cardiovascular diseases, but it also affects sleep, disrupting its cycle, causes  
239 social handicap, hearing loss, increased drug use, impaired teaching, as well as diminished  
240 productivity and learning. Recent studies have established a relationship between noise and  
241 cardiovascular diseases (CVDs), with the causal route ascribed to neuroendocrine alterations  
242 characterized by increased release of cortisol and catecholamine. Furthermore, chronic noise  
243 exposure has been associated with hyperlipidaemia, which is a corollary to hypertension [28].

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245

## 246 **Conclusion**

247 Current study confirmed past findings that gas flaring and crude oil contamination  
248 causes hypertension. This implies that environmental pollutants may be useful for screening  
249 purposes in the identification of high-risk pollution, long before a diagnosis of hypertension  
250 is established. This will help in targeting appropriate intervention. This study has also shown  
251 that gas flare and crude oil contamination create a great risk to the cardiovascular system.

252

## 253 **Recommendations**

254 While routine surveillance and management of hypertensives remain an important  
255 public health priority, periodic epidemiological assessment of environmental pollutants in  
256 human tissues is important

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## 258 **References**

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