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## Contamination by oil crude extraction – Refinement and their effects on human health<sup>☆</sup>



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### ABSTRACT

The harmful effects of oil on various species of flora and fauna have been studied extensively; however, few studies have studied the effects of oil exposure on human health. The objective of this research was to collect information on the acute health effects and serious psychological symptoms of the possible consequences of such exposure to crude oil. Some studies focused on the composition of different chemicals used in the extraction process, and wastes generated proved to be highly harmful to human health. Thus, studies have shown that individuals who live near oil fields or wells – or who take part in activities of cleaning oil spills – have presented health conditions, such as irritation to the skin, eyes, mucous membranes, kidney damage, liver, reproductive, among others. In Ecuador, this reality is not different from other countries, and some studies have shown increased diseases related with oil crude and oil spills, like skin irritation, throat, liver, lung, infertility, and abortions, and it has been linked to childhood leukemia. Other studies suggest a direct relationship between DNA damage because of oil resulting in a genetic instability of the main enzymes of cellular metabolism as well as a relationship with some cancers, such as leukemia.

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## 1. Introduction

The importance of oil began after WWII where large economic growth was seen worldwide (Guseo et al., 2007). With the use of these fossil fuels, new problems arose as evidence suggested that the processes of the extraction, refinement, storage, transportation and combustion of oil and its derivatives caused major global problems, such as the greenhouse effect, depletion of the ozone layer as well as acid rain and pollution. In addition to representing a problem to the environment, it ultimately poses a great danger to life on our planet due to the damage that it causes to the health of entire populations and ecosystems (Ogri, 2001; Veziroğlu & Şahin, 2008). For example, human health effects can result from consuming contaminated food or by bathing in polluted water mainly of rivers (Badawy et al., 1993).

This article briefly reviews the main compounds that are used or produced as waste in the process of oil extraction – as well as

products exposed by spills – and their relationships with health problems, since for years, studies have reported health effects, ranging from skin irritation to cancer. Furthermore, we review research both globally and locally, including studies from Ecuador.

## 2. Study strategy

We performed a literature review using different databases and several key words, including 'health effects caused by oil', 'oil spill health effects', and 'effects of oil derivatives on health'. Our objective was to identify research results where they were assessed; we sought to identify both the physical and psychological health effects on people working in disaster areas associated with oil spills as well as the effects of different exposures (e.g., exposure to workers vs. People living near extraction sites). We organized globally reported data related to health problems and its direct connection with crude oil, oil spills, worker exposure, and, in some cases, the effects of derivatives of crude oil. We sought to better understand this connection since this compound directly affects the lives of people living near oil wells and refining factories or those who have been present at the time of spills either because they lived in the area or near clean-up activities.

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### 3. Contaminants associated with the extraction of crude oil

Oil exploitation involves operational steps including exploration, extraction, refinement, and transportation. Extraction is responsible for bringing natural hydrocarbons (e.g., crude oil) to the surface; for this activity, there are several methods (e.g., mechanical pumping, hydraulic pumping, use of acids). All of these processes produce serious environmental damage, including deforestation and pollution in the air, water, and soil.

The exploration phase, which determines the location and size of oil reserves, is the stage in which several extractions are performed daily in order to evaluate the product. The residuals are placed in pools and in other cases are burned; this generates a large part of the waste and increases the impact on nearby ecosystems and the health of surrounding populations (Bravo, 2007). Moreover, countries like Mexico, Taiwan, Finland, Austria, Spain, among others have expressed concern about the impact of crude oil on their ecosystems and inhabitants (Maldonado and Narváez, 2003; Shcroeder et al., 1999).

As mentioned above, some countries have already expressed concern about the presence of petroleum-derived pollutants, since oil is a complex mixture of several chemical compounds and contains a variety of agents of various toxicological power, including benzene, toluene, xylene, and polycyclic aromatic hydrocarbons, among others. Table 1 summarizes the main reported effects of the chemicals used in the oil extraction process as well as the harmful substances resulting from this process.

Exposure to compounds such as detailed in Table 1 are of concern, and most are ubiquitous in various environmental compartments. They can bioaccumulate in food chains where they disrupt the biochemical or physiological activities of many organisms, thus causing carcinogenesis of some organs, mutagenesis in genetic material, and impairment in reproductive capacity in exposed population (Onwurah et al., 2007).

These pollutants come in direct contact with nature in the form of large atmospheric emissions, waste generation, and effluents that pollute the air, water, and soil in addition to the biota associated with these means (Bravo, 2007; Rico et al., 2007).

For example, people that live in small communities scattered along rivers that receive oil industry waste use this water as a food source (e.g., fishing) as well as to facilitate the growth of crops, yet this water contains polynuclear aromatic hydrocarbons (PAH) at 10 to 10 000 times greater than the U.S. EPA guidelines (Hurtig and Sebastián, 2002).

Crude oil or its components can travel a number of routes to come into contact with the human body, including i) absorption through the skin; ii) ingestion of food and drink; and iii) inhalation through breathing. Oil exposure is not limited to the area close to the pollution. The heavier components tend to deposit sediment where they can contaminate water sources repeatedly or be consumed by organisms that can enter the human food chain. This article describes various pathologies related to exposure to oil, its derivatives, or its residues.

## 4. Findings and discussion

### 4.1. Human health impacts

As mentioned, phases of exploration and exploitation of oil produce environmental risks and often take months to produce a disease and in some cases can lead to death (Guilbert, 2003). Currently, there are multiple studies on crude oil spills in coastal areas (Campbell et al., 1993; Lyons et al., 1999), but in most of these studies, the post-impact assessments do not highlight the long-term human health effects on impacted communities (Ordinoha

and Brisibe, 2013).

The majority of crude oil spills are technological disasters (Picou, 2011). Major oil spills have been reported in Mediterranean Europe, North Africa, and in North America. Considering the high population density of these geographical areas (Linnet et al., 2015a; Tabacova and Balabaeva, 1993a; Torres-bustillos, 2006), they are of major interest from an epidemiological point of view (Aguilera et al., 2010; M. a. D'Andrea and Reddy, 2014a).

Adverse human health symptoms associated with crude oil usually include hematopoietic, hepatic, renal, and pulmonary abnormalities (M. a. D'Andrea and Reddy, 2014b), changes in mood and cognitive functions (Ismail and Lewis, 2006), psychological problems (Gill et al., 2012), damage to reproductive health (Tabacova and Balabaeva, 1993a), respiratory tract involvement (Campbell et al., 1993; Lyons et al., 1999; Ordinoha and Brisibe, 2013), cancer (Yang et al., 2000), and general health problems (Aguilera et al., 2010; M. a. D'Andrea and Reddy, 2013, 2014a).

Fig. 1 summarizes health disorders associated with exposure to crude oil. Moreover, some of the major health problems related to exposure to petroleum are detailed.

### 4.2. Psychological health

It is known that many people exposed to crude oil pollution due to accidents (oil spills) experience psychological health problems (M. a. D'Andrea and Reddy, 2014a; Jernelöv, 2010). In all cases where crude oil pollution affects a community, either directly or through other means, there can be negative psychological symptoms, such as stress, anxiety, and depression (Gay et al., 2010). Symptoms like anxiety were significantly associated with exposure and the known toxicological effect of oil, suggesting a direct health effect on the exposed population by extraction activity (Lyons et al., 1999).

An example of this is shown in crude oil spills like the Exxon-Valdez in March 1989 in Alaska. In this case, results suggest that the oil spill's impact on the psychosocial environment was as significant as its impact on the physical environment (L. A. Palinkas et al., 1992; L. a Palinkas et al., 1993). Studies regarding oil spills like the Exxon Valdez and the 2010 BP spill showed that the strongest stresses were from family health concerns, commercial ties to renewable resources, and concern about economic future, economic loss, and exposure to the oil. On the other hand, it is interesting to understand the effects that produced income loss after the spill may have a greater psychological health impact than the presence of oil on the immediately adjacent shoreline (Grattan et al., 2011; L. A. Palinkas et al., 1992; L. a Palinkas et al., 1993) (Fig. 1).

Moreover, several studies have observed that people living in areas where spills have been reported in some cases have witnessed changes in the behavior of children and increased economic instability. Also, a high percentage of people move away from the area and experience the stress associated with these situations (e.g., mood, anxiety) (Aguilera et al., 2010; David et al., 2010; Morris et al., 2013).

Although, in the case of oil spills, it is not clear whether the observed psychological effect is due to the emotional impact or chronic exposure to crude oil. Kilburn & Warshaw mention that those who have been exposed to hydrogen sulfide (H<sub>2</sub>S) as a result of working at or living downwind from crude oil processing facilities have persistent neurobehavioral dysfunction including depression and personality changes (Kilburn and Warshaw, 1991).

### 4.3. Blood disorders

Human exposure to crude oil can cause deterioration effects on

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