



## Human mercury exposure associated with artisanal gold miners in Sudan

By

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# Background

- Mercury (Hg) is a ubiquitous and highly toxic environmental pollutant (Chunying et al, 2005).
- It is found in three forms with different toxicities: elemental, inorganic and organic (Orloff et al., 1997)
- Mercury concentration in the blood is one of mercury exposure biomarkers.

# Uses

- One of the most common uses of mercury is for the extraction of gold from gold-containing ores (Kampalath & Jay 2015).

# The risk

- In artisanal small scale gold mining sites, the heating of the gold-mercury mixture with little or no personal protection, results in the evaporation of mercury and exposures through inhalation (WHO 1991).
- The vapor emitted from metallic mercury is a potent neurotoxic agent (Sofya & Thomas, 2009); this vapor is a colorless and odorless substance (Gonul et al, 2014); approximately 80% of it is absorbed via the lungs (WHO, 1976).

# Mills for powdering stones(Sudan)



# Mercury in an open dish(washing)- Sudan



# Hands and legs effects (Sudan)



# Mercury measurement

- Serum mercury was measured by direct mercury analyzer (DMA-80).



# Partner institutions (Sudan)

- Ministry of Minerals
- Federal Ministry of Health
- Khartoum State (**environmental section**)
- Ministry of Petroleum (**petroleum laboratory**)

# *Heating of mercury in a pan*



# Why traditional gold mining?

- Traditional gold mining merged strongly in Sudan in last 5 year after Southern Sudan referendum, and after loosing more than 70% of petroleum income.

# The Objectives

- To measure the blood mercury and lung function in gold miners at the River Nile State, Sudan.
- The function included forced expiratory volume in the first second (**FEV1**), and forced vital capacity (**FVC**).

# Study design

Descriptive, analytic, prospective study.

# Study area

1. River Nile State (Abohamad) and the National Ribat University Hospital (Khartoum).
  2. Faculty of Environmental Sciences and Disaster Management.
  3. Faculty of Medical Laboratory Sciences.
  4. Faculty of Medicine.
- Abu Hamad google satellite map; this place is situated in Northern, Sudan, its geographical coordinates are **19° 32' 0" North, 33° 19' 0" East.**

# **Study duration**

December 2012 – January 2014.

# Study population

- Sudanese male miners working in the traditional mining sites in River Nile State, in Abohamad and surrounding area.
- Aged **18-55** years.
- Working in the field of traditional gold mining for not less than **6 months**.





# Sample size

- 83 traditional gold miners:
  - wells (39)
  - mills (26)
  - mercury washing (14)
  - mercury burning (5)
- 50 normal healthy controls, from Khartoum State not been in mining areas.

# Data collection

- 10 ml venous blood in plain container (no anticoagulant), from both traditional gold miners and controls.

# Manual spirometer



# Ethical considerations

- Ethical approval was obtained from ethical committee in National Ribat University; any patient gave approval consent.

# Data analysis

SPSS version (20), and Microsoft Excel 2007

# funding

- The National Ribat University

# Results

- The study revealed that the serum mercury in the traditional gold miners was **(24.9 ± 32.24mg/l)** versus **(1.40 ± 0.94mg/l)** in the non-exposed control group; with P value **(p= 0.000)**.



# Results of lung function

Parameters	Traditional gold miners (n=83) (Mean ± Std)	Non exposed healthy controls (n= 50) (Mean ± Std)	P value
Age (years)	30.46±10.01	28.1±5.39	
Weight (kg)	63.14±10.51	63.00±10.96	
Height (cm)	169±6.44	168.45±6.46	
Mercury (Hg) (mg/l)	<b>24.9±32.24</b> Range (0.86–124mg/l)	<b>1.4±0.94</b> Range (0.29–3.6 mg/l)	<b>0.000</b>

# Results of lung function

Parameters	Traditional gold miners (n=83) (Mean ± Std)	Non exposed healthy controls (n= 50) (Mean ± Std)
Mean FEV1 (L)	3.24±0.57	3.40±0.39
Mean FVC (L)	3.7±0.69	3.86±0.60
FEV1/FVC ratio (%)	86	89

# Results: clinical symptoms

- coughing 35(42.2%),
- headache 31(37.3%),
- excessive sputum production 28(33.7%),
- dizziness 27(32.5%),
- chest pain 26(31.3%),
- shortness of breath (SOB) 25(30.1%),
- weight loss 22(26.5%),
- wheezing 17(20.5%),
- hemoptysis 6(7.2%),
- burning micturition 31(37.3%)
- constipation 17(20.5%) .

# Discussion

- Human absorption of liquid Hg<sup>0</sup> is minimal, and acute toxicity does not occur easily, but the problem arises when liquid mercury is heated and bursts into the gaseous phase, which causes acute interstitial pneumonia when inhaled at a high concentration.

## Discussion (continue...)

- In the present study the traditional gold miners, work in a hot climate in a deserting area.
- As seen in the field; Sudanese traditional gold miners do not take any safety measure when dealing with mercury, even gloves or masks.

## Discussion (continue...)

- They treat the mercury as if; non-toxic substance; especially in washing stage to extract gold from washed stoned powder, and when heating the gold-mercury mixture to evaporate mercury and remain gold in metallic pans.

## Discussion (continue...)

- The second source of exposure is that all the serious stages occur in the same area not exceeding few meters between stone milling, washing and modling.





# Discussion (continue...)

## ...Risk..

- This means that these miners and their families are exposed to dangerously high levels of mercury in the workplace. Similar finding was also reported earlier in **Brazil by Castilhos *et al* (2015)**, and in Iran by **Babak *et al* (2013)**.

## Discussion (continue...)

- These gold miners complain from multi symptoms like persistent cough, headache, dizziness, chest pain, shortness of breath, wheezing and even hemoptysis.
- These health effect may be associated with repeated exposure to mercury, which influence enzymes, cell membrane and neuron functioning as reported by (Hong et al; 2012).

## Discussion (continue...)

- most of the above clinical signs especially cough, headache, dizziness, muscle weakness were also reported in artisanal gold miners in Burkina Faso by Tomicic *et al* (2011), and Indonesia by Bose-O'Reilly *et al* (2010).

# Conclusion

- Serum mercury levels significantly increase in the traditional gold miners working in Abuhamed, River Nile State, Sudan; while forced expiratory volume in the first second (FEV1) and forced vital capacity (FVC) and forced expiratory volume decrease.

# Conclusion

- Occupational exposure to mercury is prevalent among traditional gold mining workers in Sudan.
- Medical surveillance for all artisanal gold miners, including, quarterly and semiannual serum mercury assessment, and self-safety measures should be adopted.

THANKS