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Removal of barriers to the introduction of cleaner artisanal gold mining and extraction technologies in Pak Ou and Chomptet districts. Lao PDR.

Part B: Health Assessment – Final Report.

December, 2004

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André RAMBAUD [(1)], Florence PORTET[(2)], Tayphasavanth FENGTHONG [(3)], Vanphanom SYCHALEUN[(4)], with the collaboration of Hansila PHOUPASEUTH[(5)], Khankhong MANIKHAM [(6)], Thongsy CHITTIVONGSA and Bounpheng LATSAMY[(7)]

(1) UMR HydroScience, University of Montpellier 1, France
(2) Montpellier University Hospital, France.
(3) UNIDO expert, Vientiane, Lao PDR
(4) UNIDO expert, Vientiane Lao PDR
(5) Medecine Doctor Ventiane;
(6) Science Technology and Environment Agency, Luang Prabang, Lao PDR
(7) Luang Prabang Hospital, Lao PDR

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Executive Summary

Introduction

A contract was signed in July 2003 between the United Nations Industrial Development Organisation (UNIDO) and the BRGM, in order to carry out the environmental and health surveys in the Pak Ou and Chomphet districts in the Province of Luang Prabang. The operation was carried out between French teams (BRGM, University of Montpellier and CEMAGREF) and Lao teams (Department of Geology and Mines, the Ministry of Agriculture, the Ministry of Health). The University of Montpellier headed the health assessment survey. BRGM in cooperation with the Lao Department of Geology and Mines were in charge of the coordination of the environmental assessment. The sampling campaign and health survey took place from February 29th to March 20th, 2004. A previous field report (Laperche et al., 2004) details the information collected in the field and the sampling methodology both for the health and environmental assessments.

This report is the second part the Lao survey describing the health assessment. Part A describes the environmental assessment (Freyssinet et al., 2004).

The aim of this survey was to collect environmental and health data in some selected villages of Pak Ou and Chomphet districts and to evaluate the potential impacts caused by mercury to the local population and their close environment.

Location

Based on the information reported in the sociological survey carried out by Earth System Lao (2003), four villages of artisanal miners were selected for the health survey. The villages are located in two different districts North of Luang Prabang*:*

- Houay Gno (district of Chomphet),
- Houay Koh (district of Chomphet),
- Latthahai (district of Pak Ou),
- Pak Ou (district of Pak Ou).

A fifth village was selected as a reference. The selection criteria were (i) the lack of any mining tradition in the area, (ii) a similarity in sociological and environmental conditions. The reference village, Houay Yen Gnai is located on the Khan river, south east of Luang Prabang.

In each of these villages both the environmental and health surveys were carried out.

Description of the cohort

A cohort of 191 adult people (>15 years) was recruited in 81 households selected by the sociologist in these villages, Furthermore, 126 children were included in the study and for hair sampling.

The cohort of 191 individuals was composed of 31 adults in the reference group, the rest of the cohort was selected in villages of artisanal miners.

Health Assessment Questionnaire

The health survey was based on the protocols published by UNIDO for environmental and health assessments dedicated to evaluate the impact of mercury related to artisanal gold mining. The questionnaire was slightly modified by the Health team in order to adapt it to the local conditions of Lao PDR.

Confidentiality was maintained regarding all health-related issues. The questionnaire detailing their way of working and living, their former medical problems and the perception of their health was systematically filled out.

Biological samples collection and analysis

Two nurses performed the sampling, with albuminury determination and blood pressure measurement.

Samples of blood, breast milk, urine and hair were carried out on the 191 individuals. Breast milk was sampled on 6 women of the cohort. Hair samples were also collected on 126 children coming with their parents.

Blood, breast milk and urine mercury determinations were performed by CV-AAS at Pasteur Cerba Laboratory in Cergy-Pontoise (France). Quantification limits were 1 µg.L-1.

Mercury in hair was analysed by BRGM laboratory. Hair samples were not washed before analysis as recommended by Drasch *et al.* (2001). Total mercury was determined by cold vapour – atomic fluorescence technique (CV-AFS) using the continuous flow approach.

Medical examination

Participants were examined to identify neurological disturbances, behavioural disorders, tremor, cognitive capabilities, equilibrium, gait, reflexes, etc. Drasch *et al.* (2001) have suggested to check the following mercury poisoning indicators*:*

- signs of bluish discoloration of gums
- ataxia
- tremor

- test of alternating movements
- test of the field vision
- reflexes
- pathological reflexes
- salivation
- sensory examination

Analysis of Social and occupational data

The recruited group (children and adults) concerned all classes of age and is representative of the people of these districts. The number of females was slightly higher: 52% in the children sub-group and 56% in the adults one.

Artisanal small scale mining (ASM) is a seasonal work (January to April) that begun in the mid-1970s, in this region. The sociological survey (Earth System Lao, 2003) and the analysis of questionnaires show that artisanal mining is mostly performed by women. However, both men and women operate equipment for ore extraction, while women and children transfer the alluvium to and then pan the alluviums. The majority of women (about 45%) practised gold panning during 10 to 20 years. Amalgamation and roasting is mostly performed by women in their kitchen without any precaution.

In the studied area of the 4 selected villages developing artisanal mining activities, there are about 2000 inhabitants. The gold production, according to the sociological study, is estimated at 3 kg per year. The amount of mercury used to separate gold is estimated to 2-2.5 kg. These amounts of mercury used by artisanal miners are very small, at least 2 or 3 orders of magnitude less than compared to other studies (i.e. Ghana, Brazil, and Philippines). We estimate the annual use of mercury per household to less than 50g per mining season.

Results

Results on biological samples are expressed following 4 classes of exposure, based on the HBM, BAT, BEI and WHO threshold values. This is in agreement with the strategy adopted in several studies of the UNIDO Global Mercury Project. Class 1 (below HBM 1 value) reflects a non exposure situation, class 2, a low exposure, Class 3, a medium exposure, Class 4, a strong exposure.

The exposure biomarkers (blood, urine and hair) were in class 1 (non-exposed persons) for 90.8%, in class 2 (slight exposure) for 8.3% and in classes 3 + 4 (serious exposure) for 1%.

Among 100 individuals declared using mercury (amalgamation and roasting), and 76 of them did not show abnormal biomarker value.

The cohort is weakly affected by an occupational use of mercury. The biomarker “urine” reflects preferentially an occupational exposure. Only 2.2% of the population showed analytical results exceeding the class 1 value (7 µg/L). The few positive cases concerned only females. This is pertinent as women are in charge of the amalgamation and roasting tasks.

Mercury contents in hair and blood illustrate mostly indirect exposure of people due to the food. The highest values of these biomarkers are observed in the 3 villages along the Mekong. This result could be explained by changes in the habits of local peoples between the Nam river and the Mekong villages. A more important consumption of fishes (particularly big carnivorous fishes) could provide an additional input of mercury. There is not enough information on the diet of local people to verify this hypothesis.

Neurological abnormalities were frequently observed in the cohort but observed in 56% of men and 41% of women, by comparison only 16% of men and 71% of women use mercury. In the reference group, about 38% of the population shows neurological troubles, whereas it is 48% in the exposed group. This difference is however not significant.

These neurological abnormalities are definitely not linked to mercury because the examined population was weakly exposed to small amounts of mercury and during too short periods.

Conclusion and recommendations

Even if damages related to the use of mercury appear very limited, we observed a few cases of contamination (i.e. a 2 years old boy with 16.8 µg Hg/g in hair, an 18 years old girl, with 15 µg Hg/L urine and 11 µg Hg/g hair). These results show that despite the use of small amounts of mercury, contamination cases may appear.

The most hazardous process observed is the roasting of the amalgam in the kitchens. This local practice may favor the passive exposure of the family and particularly young children. That is why prevention of sanitary risks is strongly recommended in a next step.

An awareness raising campaign is recommended. Communication should be oriented to women.

The practice of roasting in open air conditions, outside of the village, would be a first step to reduce the exposure. This would avoid contamination of houses and the passive exposure of children.

In a second step we recommend a prevention and educational programme dedicated to women to perform the roasting process using retorts . As some women already a bamboo shot to recover mercury, this kind of practice may be accepted by the local population. A shared retort for the village or a group of artisanal miners could be a cheep solution, knowing that roasting is not a daily task but in most of the cases a weekly or even monthly task.

Acknowledgements

Authors greatly appreciated the contribution and the motivation of the Lao team and the Villagers who allowed to the success the field work.

The team and villagers in Houay Koh

in Houa Yen Gnai

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APPENDIX 2: Health Assessment Questionnaire

APPENDIX 3: Biomarkers results, Blood, urine and Hair analysis

1. Introduction

A contract was signed in July 2003 between the United Nations Industrial Development Organisation (UNIDO) and the BRGM, in order to carry out the environmental and health surveys in the Pak Ou and Chomphet districts in the Province of Luang Prabang. The operation was carried out between French teams (BRGM, University of Montpellier and CEMAGREF) and Lao teams (Department of Geology and Mines, the Ministry of Agriculture, the Ministry of Health). The University of Montpellier headed the health assessment survey. BRGM in cooperation with the Lao Department of Geology and Mines were in charge of the coordination of the environmental assessment. The sampling campaign and health survey took place from February 29th to March 20th, 2004. A previous field report (Laperche et al., 2004) details the information collected in the field and the sampling methodology.

This report is the second part of the Lao survey describing the health assessment. Part A details the environmental assessment (Freyssinet et al., 2004).

The aim of this survey was to collect environmental and health data in some selected villages of Pak Ou and Chomphet districts and to evaluate the potential impacts caused by mercury to the local population and their close environment.

2. Data collection

2.1. LOCATION OF THE STUDY

Based on the information reported in the sociological survey carried out by Earth System Lao (2003), four villages of artisanal miners were selected for the health survey. The villages are located in two different districts North of Luang Prabang (Fig. 1):

- Houay Gno (district of Chomphet),
- Houay Koh (district of Chomphet),
- Latthahai (district of Pak Ou),
- Pak Ou (district of Pak Ou).

A fifth village was selected as a reference. The selection criteria were (i) the lack of any mining tradition in the area, (ii) a similarity in sociological and environmental conditions. The reference village, Houay Yen Gnai is located on the Khan river, south east of Luang Prabang.

In each of these villages both the environmental and health surveys were carried out.

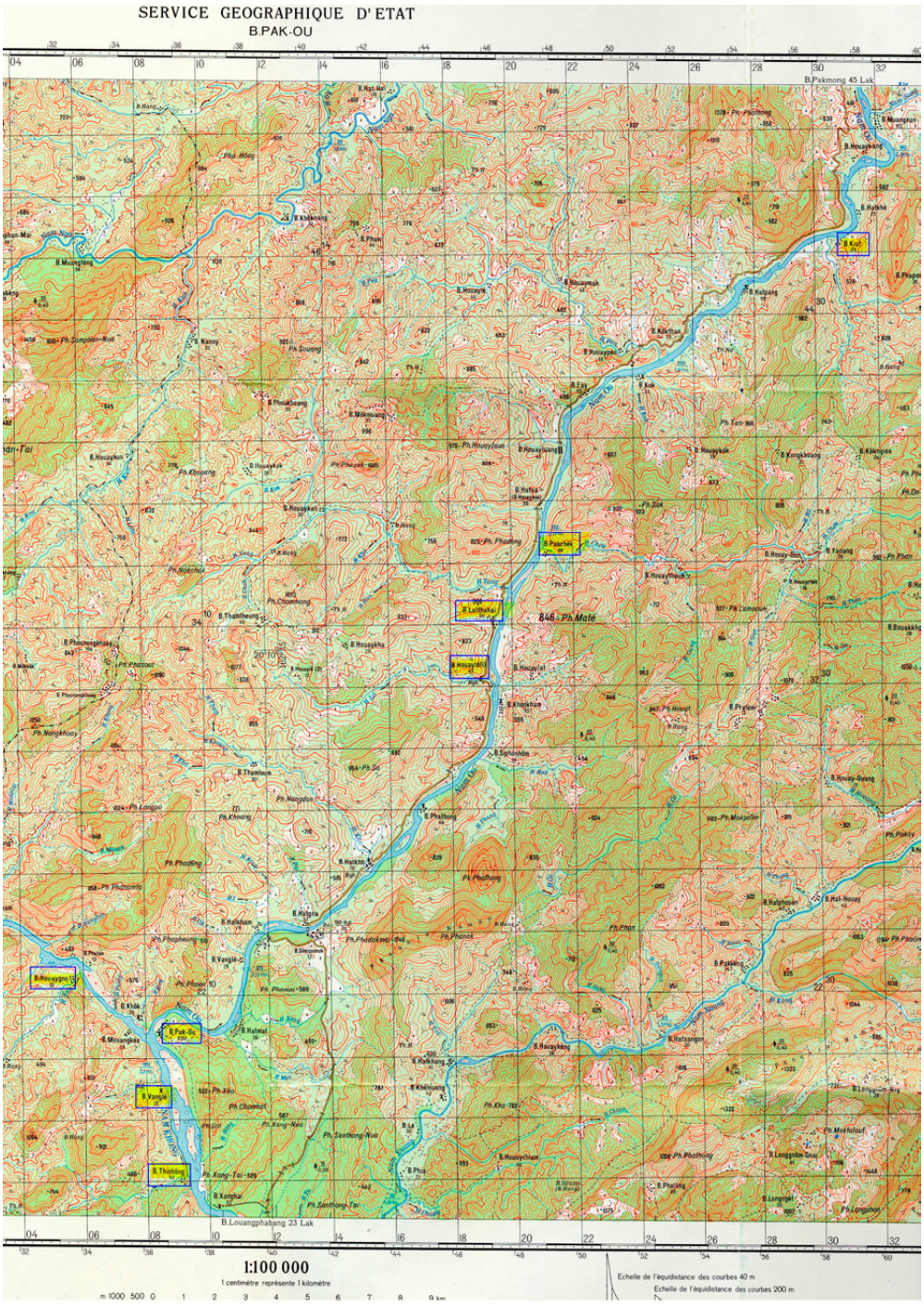

Figure 1- Map of the region with the 8 selected villages (based on topographical map 1:100,000 – Pak Ou sheet F-48-133). There is a mistake on the map, the name of one of the village is Houay Koh instead of Vangle.

Figure 2 - Map of the region with the reference village (based on topographical map 1:100,000 – Luang Prabang sheet E-48-1).

2.2. DESCRIPTION OF THE COHORT

A sample of 191 adult people (>15 years) was recruited in 81 households selected by the sociologist in these villages, on the basis of a job description written by the epidemiologist team of University of Montpellier (see Appendix 1) and sent to the Lao sociologist via UNIDO, several months before the field work.

The cohort of 191 individuals was composed of 31 adults and 25 children in the reference group, the rest of the cohort was selected in villages of artisanal miners. A questionnaire detailing their way of living, their former medical problems and the perception of their health was systematically filled out with the participation of Mrs Dr Vanphanom Sychaleum, sociologist, Mr Dr Hansila Phoupaseuth, and Mr Khamkhong Manikham (Fig. 3).

Figure 3 - Drs V. Sychaleum, A.Rambaud, K. Manikham (foreground) and P.Hansila (middle ground) filling out questionnaire with recruited persons.

	VILLAGES					Total (81 Hhs)
	HouayYen Gnai(10Hhs)*	Houay Gno (17 Hhs)	Houay Koh (20 Hhs)	Latthahai (18 Hhs)	Pak Ou (16Hhs)	
Adult Male	15	23	24	14	8	84
" Female	16	25	26	20	20	107
Children M.	14	15	13	13	6	61
Children F.	11	8	18	19	11	67
Total	56	71	81	66	45	319

*(Hhs) = Households

Table 1- Number of recruited people according to their age and gender in the 5 selected villages

2.3. HEALTH ASSESSMENT QUESTIONNAIRE

The health survey was based on the protocols published by UNIDO for environmental and health assessments dedicated to evaluate the impact of mercury related to artisanal gold mining (Veiga and Baker, 2003). The “Health Assessment Questionnaire” proposed by UNIDO was slightly modified by the Health team in order to adapt it to the local conditions of Lao PDR (see Appendix 2).

Confidentiality was maintained regarding all health-related issues. The questionnaire descrbing the way of working and living, the former medical problems and the perception of the health was systematically noted.

2.4. BIOLOGICAL SAMPLES COLLECTION AND ANALYSIS

Two nurses, Mrs Thongsy Chittivongsa and Mr Bounpheng Latsamy, of the Luang Prabang Hospital performed the sampling, with albuminury determination and blood pressure measures.

Ultra-clean sampling procedures, handling, and preparations are of most importance if precise and exact results are required in the analysis of mercury. The materials and vessels to be used for the sampling were preserved under very strict protocol. Polyethylene gloves are worn at all times during washing and handling.

Samples of blood, breast milk, urine and hair were carried out on the 191 individuals. Six opportunities of sampling breast milk were perfomed. Hair samples were collected as well on 126 children coming with their parents.

The collected volumes for each kind of biological tissues was:

- 10 mL of blood collected in EDTA-coated vials and stored at 4 °C (NOT frozen) in a refrigerator.

- 10 mL of breast milk – or as much as possible - collected in PVC-bottles and stored at 4 °C (NOT frozen) in a refrigerator.

- 20 mL of spontaneous urine collected.; the samples were acidified after sampling by adding some drops of 10% nitric acid.

- a tuft of hair (3-4 cm long, approx. 100 mg) cut close to the scalp from near the occipital portion of the head. The samples were stored in plastic bags.


Figure 4 - blood and hair sampling.

2.4.1. Sample preservation and shipping

All samples, sealed in double zip-lock bags, and sometimes tied together with magnetic tapes were transported in pre-cooled ice-chests filled with frozen ice packs. Suspected highly contaminated samples were preserved separately from less contaminated ones.

Urine and blood samples were preserved in a refrigerator at the hotel in Luang Prabang.

Hair were kept in their secured bags at ambient temperature until analysis.

The samples of blood, breast milk and urine were transported by the Aramex Company from Luang Prabang to the Pasteur Cerba Laboratory in isolated boxes with frozen packs but without specific cooling. Air shipping via Bangkok was about 48 h, before reaching the analytical laboratory in Paris.

2.4.2. Analysis of blood, urine and breast milk samples

Blood, breast milk and urine mercury determinations were performed by Laboratoire Pasteur Cerba in Cergy-Pontoise (France). Blood was mineralised previous to analysis using a MAXIDIGEST MX350 (Prolabo). Total mercury was determined with an automate, by cold vapour – atomic absorption technique FIMS 400 (Flow Injection Mercury System Perkin Elmer) using the continuous flow approach. The procedure involves organic mercury decomposition giving inorganic mercury by using $KMnO_4$ and KBr/KbrO3 mixture. Quantification limits were 1 µg L^{-1}.

2.4.3. Analysis of hair samples

Mercury in hair was analysed by BRGM laboratory. Between 20 mg to 50 mg of the hair samples were weighed in a beaker and then transferred in a polypropylene bottle in order to avoid errors in the weight measurement introduced by electrostatic forces between the samples and the walls of the polypropylene containers. Hair samples were not washed before analysis as recommended by Drasch *et al.* 2001. A 3mL volume of aqua regia was added. The propylene bottle is corked and placed on a shaker to agitate overnight (16 hours). Then the solutions were diluted with deionised water.

Total mercury was determined by cold vapour – atomic fluorescence technique (CV-AFS) using the continuous flow approach. The procedure involves an online reduction of Hg2+ to Hg0 vapour by SnCl2. Typically, the reductant is 5%m/v SnCl2 in 15%HCl. The mercury vapour is swept by argon as carrier gas to the AFS detector. Quantification limit was 0.25 µg.g-1.

2.4.4. Analysis of creatinine in urine samples

Creatinine was analysed by Pasteur Laboratories following the “Jaffé Method" , a kinetic test without deproteinisation. Creatinine, in an alkaline picrate solution, forms a colored orange-red complex. The delta absorbance at fixed times during conversion is proportional to the concentration of creatinine in the sample.

The reagents and the standard are ready-to-use and stable up to the end of the indicated month of expiry, if contamination is avoided and stored at 2 – 25 °C.

- R1: Sodium Hydroxide 0.16 mol/l

- R2: Pikric acid 4.0 mmol/l

- Standard: 2 mg/dl (177 µmol/l)

- Specimen*:* dilute urine 1 + 49 with distilled water

Normal range*:*

- Urine: 1000 - 1500 mg/24 h.

- Creatinine clearance; Men: 98 – 156 ml/min; Women: 95 – 160 ml/min.

The following table summarises the distribution of biological samples and the analytical techniques used for mercury determination.

	Number	Detection limit	Method / Laboratory
Questionaires	191		Univ. Montpellier
Blood samples	190	1 (µg/l)	CV-AAS / Pasteur Cerba
Urine samples	191	1 (µg/l)	CV-AAS - Pasteur Cerba
Breast milk	6	1 (µg/l)	CV-AAS - Pasteur Cerba
Hair samples	317	0.25 mg/kg	CV - AFS - BRGM

Table 2: Summary of questionnaires and biological samples collected during the field campaign.

2.5. MEDICAL EXAMINATION

A specific part of the epidemiological survey was dedicated to neurological health examination, as mercury is particularly noxious to the nervous system. The clinical examination included a general questionnaire, neurological evaluation with a standardized and extensive examination*:* analyse of standing, gait, movement, motricity, sensibility, reflexes and cognition (global functionning, episodic memory, short term memory, orientation to space and time, visuo-spatial skills). Details are displayed in the questionnaire in Appendix 2.

A descriptive analysis of the neurological abnormalities has been performed.

Participants were examined to identify neurological disturbances, behavioural disorders, tremor, cognitive capabilities, equilibrium, gait, reflexes, etc. Drasch *et al.* (2001) have suggested to check the following mercury poisoning indicators*:*

- signs of bluish discoloration of gums
- ataxia
- tremor
- test of alternating movements
- test of the field vision
- reflexes
- pathological reflexes
- salivation
- sensory examination

Figure 5 – Medical examination (a) reflex control, (b) coordination test, (c) memory test and (d) reflex control.

3. Results

3.1. ANALYSIS OF SOCIAL AND OCCUPATIONAL DATA

3.1.1. Age distribution of the cohort

The recruited group (children and adults) concerned all classes of age (Fig. 6) and is representative of the people of these districts. The number of females was slightly higher: 52% in the children sub-group and 56% in the adults one.

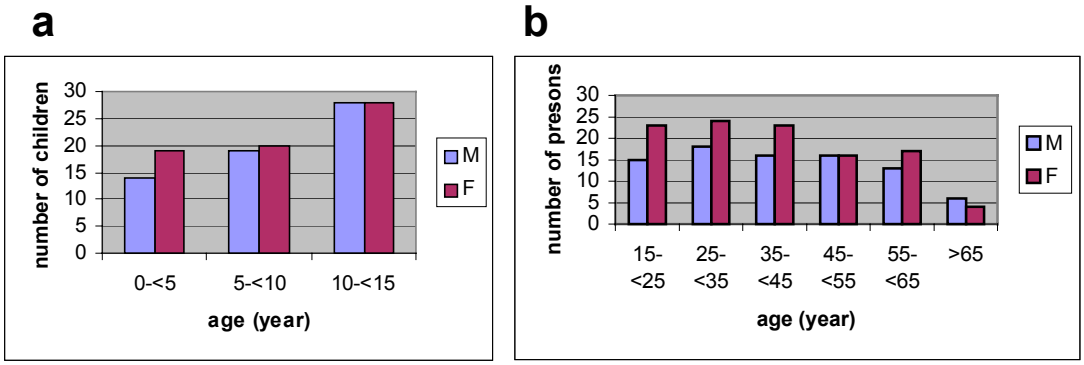

Figure 6 - Age distribution in the cohort according to the gender: (a) Children (b) Adults.

The age distribution was homogeneously distributed between the 5 villages (Tab. 3 and 4).

Age (year)	Houay Yen Gnai		Houay Gno		Houay Koh		Latthahai		Pak Ou	
	M	F	M	F	M	F	M	F	M	F
0-<5	4	8	1	3	4	4	3	2	2	2
5-<10	6	0	7	1	3	9	3	8	0	2
10<15	4	3	7	4	6	5	7	9	4	7
Total	14	11	15	8	13	18	13	19	6	11

Table 3 - Children age distribution in each village according to the gender.

Age (year)	Houay Yen Gnai		Houay Gno		Houay Koh		Latthahai		Pak Ou	
	M	F	M	F	M	F	M	F	M	F
15-<25	4	4	7	7	3	5	1	4	0	3
25-<35	4	4	3	5	5	9	4	4	2	2
35-<45	2	4	6	7	7	4	1	5	0	3
45-<55	4	2	2	1	3	5	3	4	4	4
55-<65	0	1	4	5	3	2	5	3	1	6
>65	1	1	1	0	3	1	0	0	1	2
Total	15	16	23	25	24	26	14	20	8	20

Table 4 - Adults age distribution in each village according to the gender.

3.1.2. Artisanal mining occupation

Artisanal small scale mining (ASM) is a seasonal work (January-April) that begun in the region in the mid-seventies.

The sociological survey (Earth System Lao, 2003) and the analysis of questionnaires show that artisanal mining is mostly performed by women. However, both men and women extract the alluvium. Women and children transfer the alluvium to the riverbank and pan the alluviums (figures 7 & 8). Most of the women (about 45%) included in the cohort practised gold panning for 10 to 20 years.

Figure 7 - (a) Houay Gno digging of the alluvium in the riverbed of the Mekong; (b) panning of the alluviums.

In most cases, women perform the gold extraction processes (panning and amalgamation) with mercury and roasting which are usually carried out in the home). Roasting is a task devoted almost exclusively to women, systematically performed at

home in the kitchen's houses. There was no reported case where roasting was usually performed outdoor, excepting in Pak Ou (See Freyssinet et al., 2004, pp. 30-36).

The mercury-gold amalgam is not heated on a daily basis, but rather stored until a suitable amount is accumulated to be sold to a gold merchant. The rythm of roasting depends on the gold production of the village, it may be on a weekly or monthly basis.

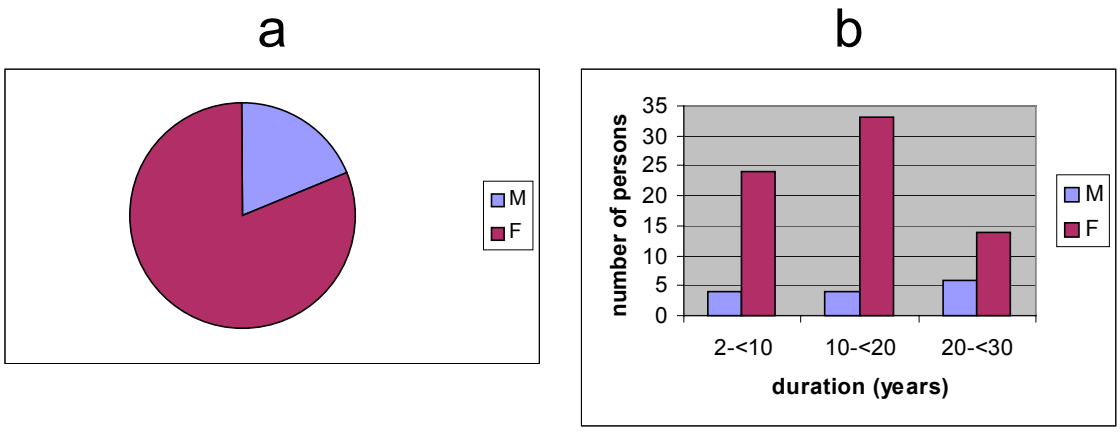

Figure 8 - (a) Practice of artisanal mining activity in the cohort according to the gender (%); (b) duration of mining activities according to the gender.

Artisanal mining is a traditional activity in the studied villages. About 20-30 % of population practiced ASM for 20 to 30 years in each village. There is a young generation of people (20-40%) having a mining experience between 2 to <10 years, except in Pak Ou which is the only village being influenced by the tourism activity. There, the young generation is much less involved in artisanal mining activity, however the middle generation remains strongly involved in the ASM with 70% of the sub-group having 10-20 experience.

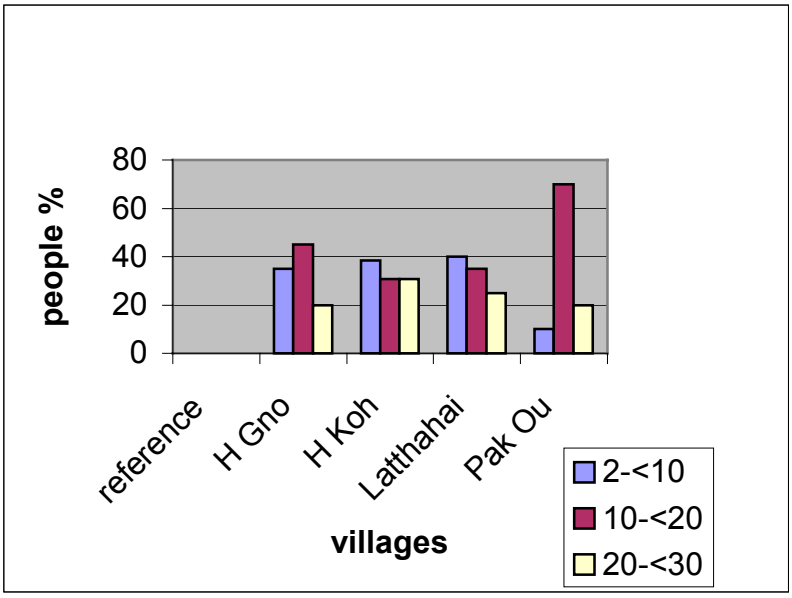

Figure 9 - Duration in years of mining activities in each village.

There is a Lao unit for mercury, the “Hung” (38 g of Hg), frequently preserved in a penicillin flask (Fig. 10). An other unit is the “hun”, unit of gold (approx. 0.39 g). The amount of mercury used in the villages is generally small and may vary from 1 to 2 hungs per season and per household of miners. There is one reported case in Pak Ou that declared using about 10 hung per season.

We considered in agreement with the sociological survey (Earth System Lao, 2003) that the average consumption of mercury does not exceed 50g per mining season per household.

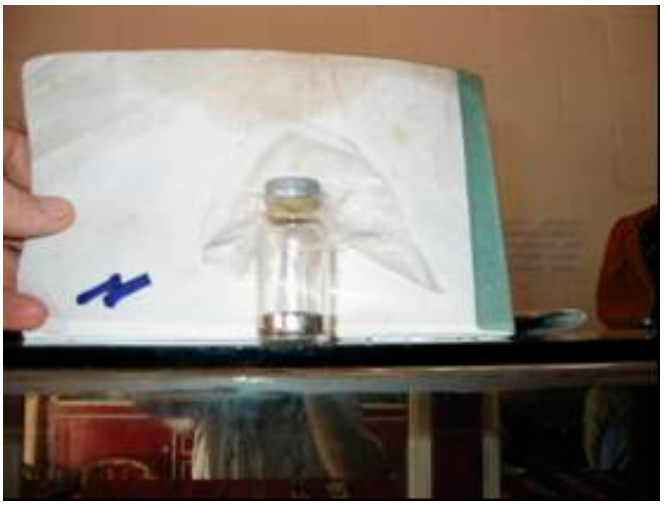

Figure 10 - A penicillin flask, sold at a jeweller’s, with one “hung” of mercury.

3.2. EXPOSURE ASSESSMENT

3.2.1. Standards and limit values for mercury

World Health Organization (WHO) considers a value of 4 µg/L in urine as a normal Hg level and 50 µg/L as the maximum occupational exposure limit. In order to compare Hg levels from different individuals, urine values should be normalised to creatinine, and should be expressed in µg Hg/gram creatinine. If urine is very diluted (relative density <1.010), interpretation of the result may be difficult. In the case of people not professionally exposed to mercury, urine levels rarely exceed 5 µg Hg/g creatinine. (Veiga, M.M. and Baker, R. 2003).

In blood, the normal concentration of total Hg ranges between 5 - 10 µg/L (in individuals without regular consumption of Hg contaminated fish). A MeHg level of 200 µg/L in blood, corresponding to Hg concentration of about 50 µg/g in hair, is associated with a 5% risk of neurological damage to adults (Veiga, M.M. and Baker, R. 2003) .

The normal Hg level in hair is less than 1-2 ppm (µg/g). Hazardous effects to the fetus are likely above 20 ppm Hg in the hair of pregnant women. Levels of 10 ppm must be considered as the upper limit guideline for pregnant women. Recent evaluation considers 5 ppm Hg in hair as a safety guideline for pregnant women. The WHO reports that, based on statistical analyses, pregnant women with Hg concentrations in hair above 70 µg/g exhibit more than a 30% risk to show a neurological disorder in the offspring.

Drasch *et al.* (2001) described the Human Biomonitoring (HBM) system for mercury contamination taking into account Hg concentrations in blood, urine and hair . It is based on a two threshold values system. The HBM-values are assessed by toxicological considerations. The value HBM I was set to be a ‘check value’. This means a mercury concentration in blood or urine, above which the source of the Hg-burden should be sought and, as far as possible, eliminated. However, even when exceeding this HBM I value, Drasch *et al.* (2001) claimed that a health risk is not to be expected. The HBM II value is an ‘intervention value’. For blood or urine levels above HBM II, especially for a long exposure, adverse health effects cannot be excluded, therefore interventions are necessary. The source should be found and reduced urgently; a medical check for possible symptoms should be performed.

Other toxicological limits are occupational threshold limits. Such limits are established for mercury, e.g. in France and the USA (biological exposure indices BEIs) or in Germany (BAT value= Biologischer Arbeitsstoff-Toleranz-Wert). From the definition, these BAT-values are exclusively valid for healthy adult workers under occupational medical control. The occupational burden must be stopped if this threshold is exceeded.

These occupational threshold limits are not valid for the total population, especially not for risk groups like children, pregnant women, older or ill persons. Nevertheless, the BAT-values were taken for a further classifying of our high results, if any. BAT-values for mercury are established only for blood and urine, but not for hair.

Table 5 provides an overview of the HBM, BAT and BEI values for blood and urine.

	Hg- blood	Hg-urine	
	µg/L	*µg/L*	*µg/g creat*
HBM I - Human Bio Monitoring	5	7	5
HBM II - Human Bio Monitoring	15	25	20
BEI - Biological Exposure Index	15 a) a) after working	35 b) b) before working	
BAT-Biologischer Arbeitsstoff-Toleranzwert	25	100	

Table 5 - Mercury threshold values according to Drasch et al.(2001).

3.2.2. Classification of mercury body burden.

In this study we defined 4 classes of exposure (Tab. 6), following the HBM, BAT, BEI and WHO systems and according to the strategy adopted in several studies of the Unido Program (The Philipines, Ghana, Sudan and Laos). It allows to combine all biomarkers (blood, urine and hair).

	HBM 1	HBM2	BAT	
BLOOD	5 µg Hg /l	15 µg Hg /l	25 µg Hg /l	
URINE	7 µg Hg /l	25 µg Hg /l (BEI)	100 µg Hg /l	
HAIR	2 µg Hg /g	5 µg Hg /g	7 µg Hg /g (WHO)	
Class	***1***	***2***	***3***	***4***
	no exposure	low exposure	medium exposure	high expos.

Table 6 - Classes of mercury body burden.

3.2.3. Mercury in blood, urine, breast milk and hair samples

The number of obtained analytical results from the collected samples were:

- 1 blood samples: 190
- 2 urine samples: 181
- breast milk: 5
- hair samples: 315 (including 126 children)

Table 7 displays the results obtained on biomarkers according to our classification of exposure.

	BLOOD		**URINE**		**HAIR**				
	Adult		Adult		Adult		Children		
	Male	Female	Male	Female	Male	Female	Male	Female	Total
Class 1	71	95	84	93	77	83	59	61	623
Class 2	**13**	**11**	**-**	**4**	**7**	**17**	**1**	**3**	56
Class 3	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**1**	4
Class 4	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	3
Total	84	106	84	97	84	105	61	65	686

Table 7 - number of individuals in each class of mercury body burden related to age and gender in the cohort, including the reference group.

The comments about the results displayed in table 7 can be summarized as followed:

- The majority of the cohort is in class 1 (non-exposed people): 87.4% for blood, 97.7% for urine and 84.6 % for hair; children being only controlled for hair, 95.2 % are in class 1. In the 6 milk samples, one had insufficient quantity to be analysed and 5 were below detection limit.
- About 8.3% of the cohort is in class 2 at least for one of the 3 biomarkers (blood, urine and hair).
- The positive cases (class 3 and 4) are mostly composed of women (5/105) and children (2/126) and only in hair samples. Men show only cases belonging to class 2 with positive concentrations in blood and hair.

The tables 8 and 9 show the number of samples related to the level of exposure in each of the 5 selected villages.

Village	*Ref. village Houay Yen Gnai*	Houay Gno	Houay Koh	Latthahai	Pak Ou	total
blood	*0*	10	2*	0	12[x]	24
urine	*1*	0	3*	0	0	4
hair	*2*	4	4	2	16 [x]	28
Total	*3*	14	9	2	28	56

Table 8 - Number of samples in class 2 in each village, (*) 1 person with the 2 concurrent biomarkers, (x) 10 persons with the 2 concurrent biomarkers.

Village	*Ref. village Houay Yen Gnai*	Houay Gno	Houay Koh	Latthahai	Pak Ou	**total**
Blood	*0*	0	0	0	0	0
Urine	*0*	0	0	0	0	0
Hair	*1*	2	3	0	1	7
Total	*1*	2	3	0	1	7

Table 9 - Number of samples in classes 3 and 4 in each village.

The reference village (Houay Yen Gnai) which was selected to constitute a control group showed three positive cases *:*

- one class 4 case, an 18 year old woman, just married, with 15 µg/L urine (class 2) and 11 µg/g hair (class 4)! Her family (5 examined persons) did not show any trace of contamination (see Fig. 11). There is no explanation for such a contaminated case. Further verification is required for that.

- two cases belong to class 2, represented by two 28 years old women with respectively 2.1 and 2.8 µg/g hair, but nothing in urine and blood samples.

The village of Latthahai (Fig. 12), composed of miners, shows the minimum of exposed cases and presented only 2 cases belonging to the class 2 with 2.3 and 2.4 µg/g in hair

In the cohort, only one person, a 25 years old woman in Houay Koh (Fig. 13), showed 3 concurrent high biomarker values: blood , urine (7.8, 12 µg/L) and hair (5.4 µg/g). An other women shows 12.2 µg/L urine and 13µg/L blood (Fig. 14). She mined since she was 15 years old , burning in the kitchen with her 2 girls (15 and 9 years old).

Figure 11 - HouayYen Gnai: the 18 year old woman with 15 µg/L urine and 11 µg/g hair (on the right side, near her husband).

Figure 12 - Latthahai: cases in the village.

Figure 13 - Houay Koh: the 25 old woman with 3 concurrent biomarker values (with a red shirt in the middle of her family).

Figure 14 - Houay Koh: the 41 old woman with 12.2 µg/L urine and 13 µg/L blood (on the right side of her family).

If we only consider the people declaring using mercury and those who assist to the roasting of the amalgam, without using mercury by themselves, we obtain a sub group of about 100 individuals potentialy exposed to mercury. Among this sub-group, 24 people showed at least one biomarker in the class 2 at least (see appendix C), and 76 do not show any abnormal biomarker value.

Among the 219 other individuals not declaring any use of mercury, 21 (9.6%) showed one class 2 value at least.

There was a possibility of passive exposure, especially for children, as suggested by the environmental assessment. But finally the number of people with class 2 abnormal mercury concentrations is about 10%. We cannot conclude to a probable passive exposure in that case.

In the five selected villages, there were 26 households with concurrent environmental and health survey. Soil, air and domestic dust were sampled (see part A of the Final report -Chapter 6). In the selected houses, were living 111 adults and children of the cohort. Only 10 households showed peoples with biomarkers abnormal values and two of them were included the reference group with class 2 biomarkers (see Tab. 10). Cases belonging to class 3 and class 4 biomarkers are observed in the villages of artisanal miners.

4 households presented high values (classes 3 and 4) in hair samples. There is no statistical relationship with a high contaminated environment like contaminated domestic dust.

Household Id. (Health survey)	Household Id. (Envir. Survey)	Number of persons with biological sampling	Abnormal values of biomarkers
1	Houayen Gnai	6	0
3	-	6	1 hair cl. 2
6	-	4	1 hair cl. 2
8	-	8	0
9	-	5	1(urine cl. 2 +**hair cl. 4**)
51	C Houay Gno	4	1 blood cl. 2 ; 2 hair cl. 2
58	**A**	**4**	**1 hair cl. 3**
62	B	5	0
65	D	8	3 blood cl. 2
67	E	1	0
71	A Houay Koh	3	1 hair cl. 2;**1 hair cl. 4**
75	B	8	0
91	E	2	0
93	D	6	0
95	C	2	0
152	D Latthahai	5	0
172	G	1	0
177	E	6	0
181	H	5	0
188	F	1	0
189	B	6	0
212	A Pak Ou	3	1 (blood + hair cl.2)
213	B	2	0
215	C	2	0
223	D	3	**1 hair cl. 3**
229	E	5	1 (blood + hair cl.2)

Table 10 - Households with soil, domestic dust sampling and health survey.

3.2.4. Interpretation of the biological results

The biomarker “urine” emphasizes an occupational exposure. There were very few abnormal values for urine: 4 on 181, 3 in Houay Koh and 1 in the reference group. The other villages involved in ASM (Houay Gno, Latthahai and Pak Ou) do not show a positive case. The albuminury was negative or in trace for 97.5% of the cohort.

This cohort is weakly affected by an occupational use of mercury. Despite the low number of positive cases, these results seem coherent with the observations performed in the environmental assessment where it was noted that people use more mercury in the process in Houay Koh, particularly when they complete the panning process. Skin contact, and maybe inhalation is probably more important in that village compared to the others.

Females are more affected (65%) than males, which is relevant as women are the most exposed to mercury in the mining process.

Mercury contents in hair and blood illustrate mostly passive exposure of people through food (Veiga and Baker, 2003). The 3 villages on Mekong River (Houay Gno, Houay Koh and Pak Ou), presented the highest and most numerous positive values in blood (but only at a class 2 level), but also in hair (class 3 and 4 levels). It is probable that an

additional exposure to mercury could be provided by the input of food consumption (fish and maybe seaweeds). Fishes seem to be weakly contaminated by mercury (see Part A, Freyssinet *et al.*, 2004), but they represent a large part of the diet (Earth System Lao, 2003). The difference between the villages along the Mekong and the Nam river could be interpreted as a change of habits in the fish consumption, with a preferential consumption of big carnivorous fishes from the Mekong than in the Nam river ? The environmental assessment showed as well that seaweed, which seems to be important source of vegetables, at least during the dry season, can present Hg contents between 0.1 to 0.7 µg/g (dw). This type of concentration is significantly above ubiquitous concentrations for aquatic plants and should be considered in the evaluation of the daily intake of mercury.

Classes 3 and 4 represent a significant exposure to mercury: 7 cases (5 female and 2 children) are concernedout of 686 samples. That represents 1% of the cohort, children included. It is very few, compared with the previous Ghanaian studies (Rambaud et al.; 2001 & 2003), where a ratio of 92 / 561 (16.4%), for the class 4 only, was detected.

The maximum of mercury concentrations observed in that study in blood, urine and hair were respectively of 12.2 µg/l, 15 µg/l and 18.6 µg/g. The table 11 compares the maximum concentrations detected in the previous UNIDO studies (i.e. Philippines and Ghana) and the present study.

	Ghana	Ghana - 2003	Mindanao - 2001	Laos - 2004
	Rambaud *et al.*, 2001	Rambaud *et al.*, 2003	Drasch *et al.*, 2001	Present study
Blood (µg/L)	96	45	110	12.2
Urine (µg/L)	253	206	511	15
Hair (µg/g)	45	41	42	18.6

Table 11 - Comparison of maximum concentrations of mercury in biological samples detected in Ghana, Philippines and Lao PDR.

Figure 15 - Pak Ou: seaweed and tomatoes drying.

Figure 16 - Pak Ou: fishermen on the Mekong River.

3.3. CLINICAL EXAMINATION

3.3.1. Results

We observed neurological abnormalities in 56% of men and 41% of women, knowing that only 16% of men and 71% of women were using mercury (Tab. 12).

	Male (83)	Female (107)	**Total (191)**
Without Neurological Disorders	37	63	**100**
With Neurological Disorders	**47**	**44**	**91**

Table 12 - Number of adults by gender with or without neurological disorders

There was no evident relationship between the neurological examinations in each village (Fig. 17).

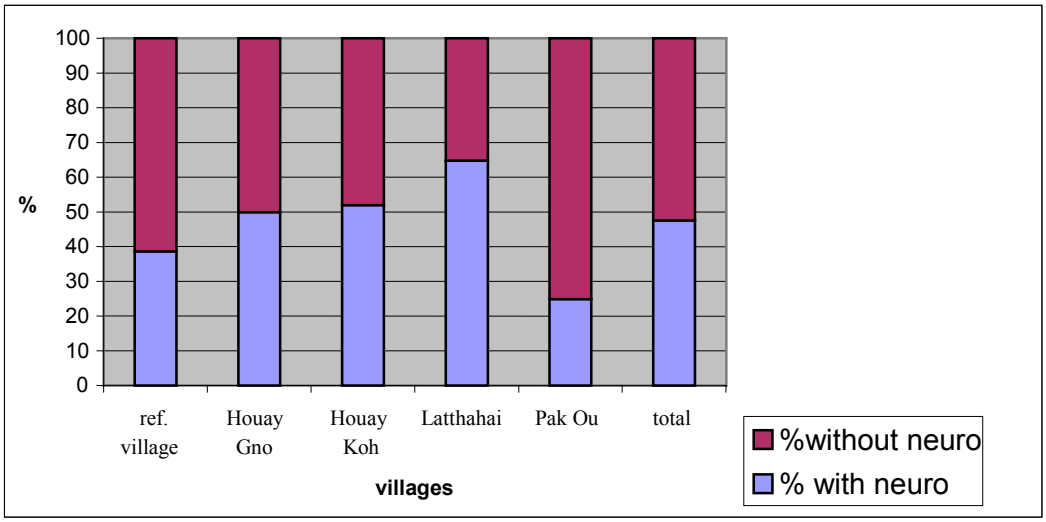

Figure 17 - Percentage of individuals with and without neurological disorders in each village.

The more frequent neurological abnormalities were movement disorders (intentionnal tremor), abnormal reflexes (hypo or hyper-reflexia) and frontal signs.

In Houay Gno, two persons had high level of mercury in their hair (class 3), but none of them had abnormal neurological examination. Among the other adults showing

mercury biomarkers higher than the class 1 group, 8 persons among 14 had neurological symptoms (intentional tremor, brisk reflexes).

In Houay Koh, a 2-years old child had high level of mercury in hair, but its family did not show up abnormal values. Six persons presented mercury biomarkers higher than the class 1 level, among them, two had abnormal reflexes (hypo or hyperreflexia) and one had intentional tremor.

In Latthahai, there is definitely no link between neurological examination and mercury biomarkers, as the whole group shows biomarkers in class 1.

In Pak Ou, thirteen adults showed mercury biomarkers higher than the class 1 threshold. One had intentional tremor, one had archaic reflexes with abnormal episodic memory.

The profile of the neurological abnormalities was similar in the different sub-groups, with or without mercury biomarkers higher than the class 1 level (hair and/or urine and/or blood)

3.3.2. Discussion

The occurrence of neurological effects certainly needs stronger exposures than in the conditions observed in that study. It is known that minimum levels for occurrence of effects are 200 µg/l in urine, 40 µg/g in hair and 40 µg/l in blood.

Most of the persons of this cohort with the highest mercury concentrations in biological samples did not show up any neurological disorder: 66 % of the biomarkers values above the class 1 threshold were found in the sub- group without neurological disorders (Fig. 18).

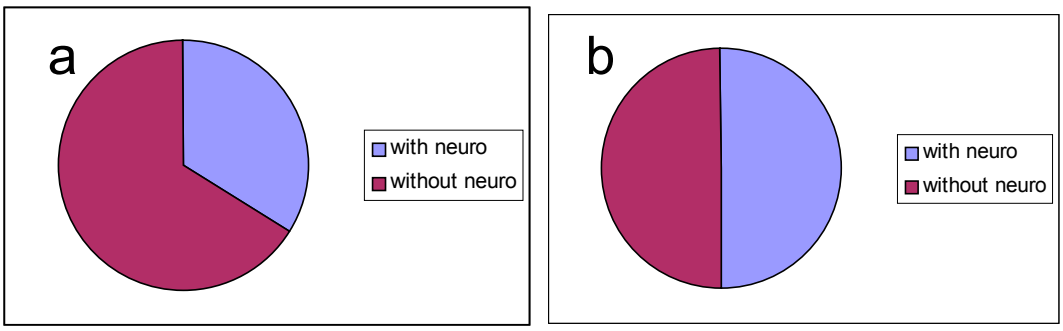

Figure 18 - Percentage of population with neurological disorders (a) in the sub-group showing biomarkers above the class 1 threshold; (b) in the < class 1 sub-group.

Neurological abnormalities were frequently observed in the cohort with no direct link to mercury biomarkers. No specific profile can be described. The examined population was too weakly exposed to allow us any significant conclusion.

Sociological factors (war, poor standard of living, general health conditions,etc), genetic factors, other environmental factors (but not mercury), could be put forward to explain such a high level of neurological disorders. Males presented more frequently neurological symptoms, but other toxic factors should be considered. In this cohort, alcohol drinking does not seem to be not an important confounder.

The important frequency of the neurological abnormalities has to be taken into account for further similar studies. This study points out that neurological problems could be measured in a population where no causal relationship can be detected with mercury exposure. Due to this specific context, neurological tests does not allow to conclude a probable effect of mercury contamination on the neurological system. There are obviously other environnemental (but not mercury) and genetic factors that has to be considered.

4. Conclusions

In the 4 selected villages of artisanal miners, there are about 2000 inhabitants. According to the sociological survey, the gold production is estimated to about 3 kg per mining season with a mercury consumption of 2-2.5 kg. The amount of mercury used by the artisanal miners is very restricted. By comparison, in the previous UNIDO project in Ghana where there was approximately 2000 inhabitants, the gold production was estimated to 75 kg per year with a use of mercury use of about 300 kg. Women are the most exposed as they are in charge of the amalgamation and roasting tasks. Skin contact and inhalation are the main occupational exposure routes. There could be some passive exposure, particularly for children, as roasting is performed without precaution on the fireplace of the kitchens.

The exposure biomarkers (blood, urine and hair) of the cohort showed that 90.8% of the popoulation is in class 1 (non-exposed persons). There are 8% of people in class 2 (slight exposure) and 1% belongs to the classes 3+4 (serious exposure).

Among the 100 individuals declaring using mercury (amalgamation and roasting), 76 did not show any abnormal biomarker values.

The biomarker “urine” can be considered as a good indicator for the Hg contamination related to occupational exposure. About 2.2% of the cohort shows Hg concentrations in urine above the German BAT threshold (100 µg/L). The cohort is weakly affected by an occupational use of mercury, however despite the little use of mercury, a few people may show significant contamination. The people concerned by this contamination live in the Houay Koh village, where the environmental assessment showed that the use of mercury is slightly more developed than in the other villages. Further detailed control would be required to check if this contamination is really related to artisanal mining.

Females are more affected (65%) than males; this is relevant as the women perform the amalgamation and the roasting of the amalgam at home.

Mercury contents in hair and blood illustrate mostly indirect exposure of people with food. The highest Hg concentration in blood and hair are observed in the 3 villages along the Mekong. The difference between the villages along the Mekong and the Nam river could maybe be interpreted as a change of habits in the fish consumption, with a preferential consumption of big carnivorous fishes from the Mekong, whereas consumption of fishes from the Nam river would be more diversified ?

Neurological abnormalities were frequently detected in the cohort, but observed in 56% of men and 41% of women, knowing that only 16% of men and 71% of women are exposed to mercury. Thus, these abnormalities are not linked to a mercury exposure. The population of the cohort is not enough exposed to mercury as it uses small Hg amounts and during relatively short periods.

This study points out that neurological problems can be measured in a population where no causal relationship could be found with the use of mercury. In this type of

context, specificity of neurological tests does not allow to conclude on a potential impact.

Nevertheless, even if contamination of the population is restricted to a few cases, we noted that a 2 year old boy shows hair value (16.8 µg Hg/g) comparable to a professional worker. Another case should be pointed out: a 18 years old girl, showed 15 µg Hg/L in urine and 11 µg Hg/g in hair. These results show that despite the use of small amounts of mercury, contamination cases may appear.

In this region, artisanal small-scale mining activity is a seasonal work mostly dedicated to women. The most hazardous process observed is the roasting of the amalgam in the kitchens. This local practice may favor the passive exposure of the family and particularly young children.

The practice of roasting in open air outside of the village, and only by women, would be a first step to reduce the exposure. This would avoid contamination of houses and the passive exposure of children. In a second step we recommend a prevention and educational programme dedicated to women to perform the roasting process using a retort. As some women already use a bamboo shot to recover mercury, this kind of practice may be accepted by the local population. A shared retort for the village or a group of artisanal miners could be a cheep solution, knowing that roasting is not a daily task but in most of the cases a weekly or even monthly task.

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Appendix 1

Questionnaire for the sociologist

OBJECTIVES OF THE PRELIMINARY SOCIOLOGICAL INVESTIGATION
(23 mai 03 A.Rambaud & Cl.Casellas)

The objectives to be waited through the preliminary sociological investigation gather in 2 categories:

1 - Knowledge of the overall population sociology;

2 - Informations concerning individuals.

1 - Knowledge of the overall population sociology;

The location of the site using precise maps and, if it is possible, satellite pictures would be appreciated .

THE VILLAGE AND ITS POPULATION :

- overview of the population : number of males, females , children; distribution of ages
- Description of the type of habitat:
  How many households? How many people by household (mean)?
- Ethnic diversity
- Education: local school(s) ? levels ? number of pupils
- Infrastructure: sources of drinking water and of other water uses, hygiene and sanitation (toilets…), health facilities, sources of energy, market …..
- Political Authority: chief(s), assembly …..
-Types of activity: mining, farming (importance of agriculture and animal rearing in this area. Is there pesticides use in agriculture. Describe the proximity of rice fields.), trading,……

ARTISANAL GOLD MINERS (AGM) COMMUNITY

- General description of this community: number, sex, age, other occupational activities, where do they live.
- Detailed description of the overall process of gold production; what is the role of each AGM operator in this process. Where does mercury amalgamation, burning, occur: in the field? In the household? or other? Is it a seasonal activity (dry and wet season), local organisation of gold and mercury market. Is there child labor.

Amount of mercury yearly used in the village, ratio gold/mercury for gold production in the different seasons.

DIET HABITS

Type of food consumed. Fish consumption: Name the fish they consume regularly. List from the most consumed species to the least (try to obtain a % of each species consumed in each season).

2 - Informations concerning individuals.

See the individual questionnaire.

This questionnaire must be filled for 150 to 200 individuals in the AGM site and 50 approximately in the control site.

Name of interviewer: ID number:

Small-scale gold mining and mineral processing in Laos

Questionnaire for the sociologist

Introduction and Informed Consent

(Introduce yourself, explain the purpose of the interview and request consent to be interviewed)

Personal Data ID Number:

_____

Participant

Surname

First Name

Date of Birth Age:.....

Sex: □ **Male** □ **Female**

Status □ **Living alone** □ **Married** □ **Number of wives??**

Education level (to be defined by sociologist**: (none, basic, primary, secondary?))**

Number of children and dependants living in the house: …….

Chlidren or dependants name						
Sex						
Age						
Education level						

Address: To be defined by the sociologist after 4 to 5 zones identification in the village

How long do you live in this area? _____ year(s)

Work Exposure

Detailed description of the job

____ Miner (in an industrial plant)

____ Artisanal gold miner (AGM)

____ Gold smelter (gold buyer)

____ Mercury seller

____ Farmer

____ Trader

____ Office Job

____ Driver

____ Other job.....

How long do you work as an artisanal gold miner (AGM) Years

Who is working as an AGM

□ yourself □ Spouse

Number of children: ….. Number of other dependants: …..

For how long do you work as an AGM (Years)

Yourself: ….. Spouse: …..

Child 1*:* ….. Dependant 1: ….

Child 2: ….. Dependant 2: ….

Number of months per year of activity as an AGM

Yourself: ….. Spouse: …..

Child 1*:* ….. Dependant 1: ….

Child 2: ….. Dependant 2: ….

Occupation (Detailed description of the job)

- **Washing**
- **Sieving**
- **amalgamation**
- **Burning**

comments:.....

Do you handle mercury?

Yes No Uncertain

Where do you get mercury for amalgamation and other inputs?

a) Gold Dealers

b) Spouse

c) Relative

d) Others (specify)

Are you aware of any health or environmental hazards that may be caused by mercury use in gold mining?

☐ Yes

☐ No

If yes, what are the hazards?

Diet Issues

How many times per week do you eat each of the following foods:

a) Meat

b) Fish

c) Chicken

d) Eggs

e) Milk

f) Rice

g) Vegetables

h) Fruits

i) Other (specify).....

Training

Have you received any training regarding your mining activities?

☐Yes ☐ No

Where……. What type of training ……..

Who facilitated the training? ……..

Has the training helped in your activities: ☐Yes ☐ No

How? ……

(The interviewer should read a short description of the improved mining technology and explain it if necessary)

What are your comments in case of the introduction of proposed improved mining and processing technology?

……

……

Would you be willing to learn this technology?

☐Yes **☐ No**

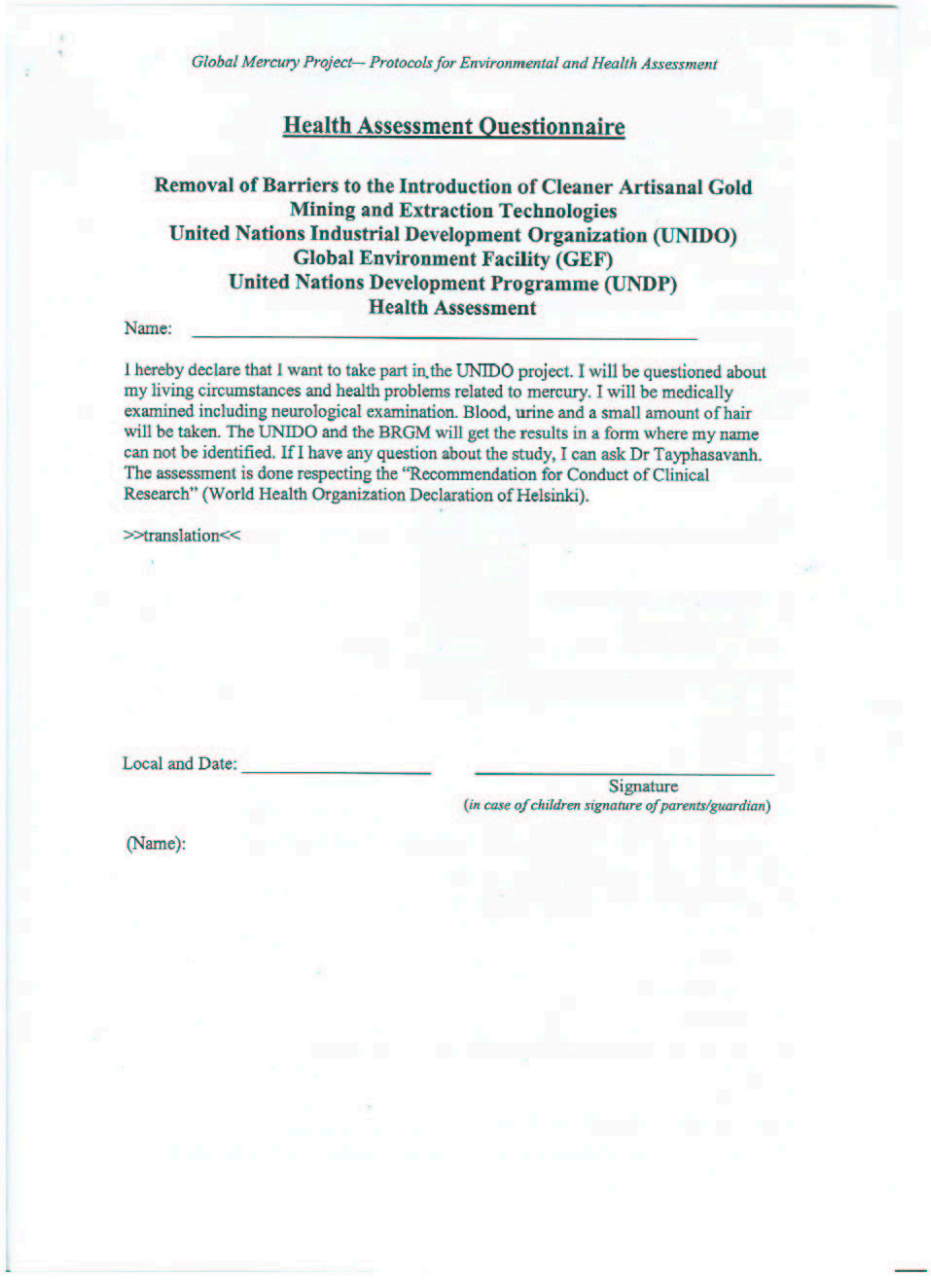
You will be questioned about your living circumstances and health problems related to mercury. you will be medically examined including neurological examination. Blood, urine and a small amount of hair nail will be taken.would you participate? ***Yes*** ***No***

Thanks for your cooperation, do you have any questions?

SUMMARY of the questionnaire

Name	
ID	
Sex of Respondent	
Location (zone in the village)	
Age of Respondent	
Level of Education of Respondent	
Residential Status (native/migrant)	
Status (married…)	
Number of children	
Other Economic Activities Outside AGM	
How long working as AGM	
Persons working AGM in your house	
Respondent Mercury Use Status	
No. of times Respondent burns amalgam	
Knowledge of hazards associated with exposure to Mercury	
First source of Food	
Second source of Food	
Third source of food	
Participation: Readiness to take Medical Exams	

APPENDIX 2:
Health Assessment Questionnaire



Global Mercury Project-- Protocols for Environmental and Health Assessment

Health Assessment Questionnaire

Removal of Barriers to the Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies
United Nations Industrial Development Organization (UNIDO)
Global Environment Facility (GEF)
United Nations Development Programme (UNDP)
Health Assessment

Name: _____

I hereby declare that I want to take part in the UNIDO project. I will be questioned about my living circumstances and health problems related to mercury. I will be medically examined including neurological examination. Blood, urine and a small amount of hair will be taken. The UNIDO and the BRGM will get the results in a form where my name can not be identified. If I have any question about the study, I can ask Dr Tayphasavanh. The assessment is done respecting the "Recommendation for Conduct of Clinical Research" (World Health Organization Declaration of Helsinki).

>>translation<<

Local and Date: _____ _____

Signature
(*in case of children signature of parents/guardian*)

(Name):

Date of interview:.....

Name of the interviewer:.....Code of the interviewer _____

1. Personal Data

Participant ID Number: _____

Family Name: .....

First Name: .....

Date of Birth: .....Age:.....(years)

Gender: ____ Female ____ Male

Address: .....

Number of children: .....

Have you ever attended school No 0 Yes 1

If yes
What is highest level of education completed? Know write 1 Primary 2 Secondary 3

2. General Questionnaire

2.1. Work Exposure

How long have you been living in this area? _____ year(s)

Occupation (Detailed description of the job)
__1__ Miner : Artisanal Scale Miner (ASM)
__2__ Farmer
__3__ Trader
__4__ Office Job
__5__ Other job.....

How long have you been working as ASM number of years

How long have you been working as ASM in this area? number of years

If yes, for how many year(s) in all?_____

Occupation (Detailed description of the job)

- ☐ Washing
- ☐ Sieving
- ☐ amalgamation
- ☐ Burning

Have you ever worked as a miner with direct contact with mercury?
0 ____ No
1 ____ Yes

If yes from when to when (for how long) _____

Have you ever worked burning amalgam in open pans or melting gold in inadequate fume hoods (stuffy room)?

0 ____ No
1 ____ Yes
If yes, from when to when (for how long): _____

Have you a system for reusing mercury?
0 ____ Yes 1 ____ No

Have you stored mercury containers or flasks?
0 ____ Never
1 ____ At work
2 ____ At home

Have you kept your dirty working clothes at your home?
0 ____ No
1 ____ Yes

For how many years have you been working with mercury?
0 ____ not applicable (have not working directly with mercury)
1 ____ year(s)

Are you aware of any health hazard associated with the use and handling of mercury
0 ____ No
1 ____ Yes

2.3. Confounders

Have you ever had any neurological disorders?
0 ____ No
1 ____ Yes
Which disease (problem)? _____

Have you ever had malaria?
0 ____ No
1 ____ Yes
If yes, how many time ago you had your last malaria? _____ (days or months or weeks)

Do you have fever at the moment?
0 ____ No
1 ____ Yes

Have you been constantly handling gasoline and kerosene? (*this can develop tremors*)
0 ____ No
1 ____ Yes
If yes, how many years you have been doing this? _____ (years)

Have you been constantly handling insecticides or pesticides?
0 ____ No
1 ____ Yes
If yes, how many years you have been doing this? _____ (years)

Do you smoke?
0 ____ Never
1 ____ Rarely (0-10 cigarettes per day)
2 ____ Medium (10-20 cigarettes per day)
3 ____ Lots (more then 20 cigarettes per day)

Do you drink alcohol?
0 ____ Never
1 ____ at least once a **month**
2 ____ at least once a **week**
3 ____ at least once a **day**

Do you or did you suffer from leprosy?
0 ____ No
1 ____ Yes

Did you ever have tuberculosis?
0 ____ No
1 ____ Yes
When did this happen ? _____ (days or weeks or months or years) ago

Have you ever had any other major infectious disease?
0 ____ No
1 ____ Yes
Which disease (problem)? _____

Did you have any serious accidents (did you have to go to hospital)?
0 ____ No
1 ____ Yes, but not severe
2 ____ Yes, and it was severe (more then 1 hour unconsciousness)
When did this happen ? _____ (days or weeks or months or years) ago

Exclusion criteria from statistical evaluation
Severe neurological disease such as Parkinson, stroke, severe accident (brain injury), birth trauma, tetanus, polio, hyperthyroidism, epilepsy, malaria or any acute severe disease, etc. may introduce too many factors that confound with Hg intoxication symptoms.

*Based on the confounders, should this individual be **excluded** from the Health Assessment?*

To be filled in by project doctor (A. Rambaud).
____ No
____ Yes

Why this individual should be **excluded** from the assessment:
_____
_____
_____

3. Health Questionnaire

Date of interview:.....

Name of the interviewer:.....Code of the interviewer

Do you feel a kind of a metallic taste?

0 ____ Never
1 ____ at least once a **month**

2 ____ at least once a **week**
3 ____ at least once a **day**

Do you suffer from excessive salivation?
0 ____ Never
1 ____ at least once a **month**
2 ____ at least once a **week**
3 ____ at least once a **day**

How is your appetite?
0 ____ ☺ (OK)
1 ____ 😐 (medium)
2 ____ ☹ (bad)

Have you been coughing within the last year for more then for 3 month?
0 ____ No
1 ____ Yes

Have you ever had kidney disease except urinary tract infection?
0 ____ No
1 ____ Yes
Which disease (problem)? _____

Have you ever had severe respiratory problems (asthma, pneumonia)?
0 ____ No
1 ____ Yes
Which disease (problem)? _____

Are you healthy now?
0 ____ Yes
1 ____ No
Why not? _____

TREMORS
Have you had any problems with tremor (shaking)?
(Clinical Tremor Rating Scale)
0 ____ I have no tremor or tremor does not interfere with my job
1 ____ I am able to work, but I need to be more careful than the average person
2 ____ I am able to do everything, but with errors; poorer than usual performance because of tremor
3 ____ I am unable to do a regular job, I may have changed to a different job due to tremor; it limits some housework, such as ironing
4 ____ I am unable to do any outside job; housework very limited

SLEEP DISTURBANCES
How do you feel after a usual night of sleep?
0 ____ ☺ (OK)
1 ____ 😐 (medium)
2 ____ ☹ (bad)

FATIGUE
Score to estimate the state of fatigue (Wessely S, Powell R: Fatigue syndrome)

Have you got tired easily?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you need to rest more?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you feel sleepy or drowsy?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Can you no longer start anything?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you always lack energy?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you have less muscle strength?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you feel weak?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Can you start things without difficulties, but get weak as you go on?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Physical fatigue sum: _____ score sum

MENTAL FATIGUE

Do you have problems concentrating?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you have problems thinking clearly?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you have problems to find correct words when you speak?
0 ____ Same as usual
1 ____ Worse then usual
2 ____ Much worse than usual

Do you have problems with eyestrain?
0 ____ Same as usual

1 ___ Worse then usual
2 ___ Much worse than usual

Do you have problems with memory?
0 ___ Same as usual
1 ___ Worse then usual
2 ___ Much worse than usual

Mental fatigue sum: _____ score sum

WELL BEING

Do you feel nervous?
0 ___ Never
1 ___ at least once a **month**
2 ___ at least once a **week**
3 ___ at least once a **day**

Do you feel sad?
0 ___ Never
1 ___ at least once a **month**
2 ___ at least once a **week**
3 ___ at least once a **day**

How is your current sexual life? (for men)
0 ___ ☺ (OK)
1 ___ ☹ (average)
2 ___ ☹ (bad)

Do you have palpitations?
Feeling the heart beating
0 ___ Never
1 ___ at least once a **month**
2 ___ at least once a **week**
3 ___ at least once a **day**

Do you have a headache?
0 ___ Never
1 ___ at least once a **month**
2 ___ at least once a **week**
3 ___ at least once a **day**

Do you have nausea?
0 ___ Never
1 ___ at least once a **month**
2 ___ at least once a **week**
3 ___ at least once a **day**

Do you feel numbness, prickling, aching at any location of your body?
Mainly perioral dysesthesia and sensory impairment of the glove and-stocking type
0 ___ Never
1 ___ at least once a **month**
2 ___ at least once a **week**
3 ___ at least once a **day**

4. Clinical-Neurological Examination

Date of neurological examination:.....

Name of the neurological examiner:.....Code _____

Weight and Height

Weight: _____ Kg

Height:_____ cm

Blood pressure:_____/_____ mmHg

MOUTH AND TEETH CONDITIONS

Clinical signs of stomatitis
0 ___ No
1 ___ Yes

Clinical signs of gingivitis
0 ___ No
1 ___ Yes

Bluish discoloration of the gums
0 ___ No
1 ___ Slight
2 ___ Yes, obvious

How many teeth with dental fillings (Amalgam)?
0 ___ None
(n) ___ One or more → how many _____

Examination of the eyes:
0 _____ No changes
1 _____ abnormal colored eye

WALKING

Person is asked to walk up and down, first with eyes open, then with eyes closed.

Ataxia of gait (walking)
Examiner is watching for signs of ataxia (Klockgether Score p 435)
0 ___ Absent
1 ___ Slight (ataxia only visible when walking on tandem or without visual feedback)
2 ___ Moderate (ataxia visible in normal walking; difficulties, when walking on tandem)
3 ___ Marked (broad-based, staggering gait; unable to walk on tandem)
4 ___ Severe (unable to walk without support; wheelchair bound)
5 ___ Most severe (bedridden)

Rigidity of gait (walking)
Examiner is watching the gait, the swing of the arms, general posture and rates
0 ___ Normal
1 ___ Mild diminution in swing while the patient is walking
2 ___ Obvious diminution in swing suggesting shoulder rigidity
3 ___ Stiff gait with little or no arm swinging noticeable
4 ___ Rigid gait with arms slightly pronated; this would also include stopped-shuffling gait with propulsion and retropulsion

STANDING

Tremor - Visible tremor in the attitude
0 ___ None
1 ___ Slight
2 ___ Moderate
3 ___ Marked
4 ___ Severe

Tremor - finger to nose test
Person is asked to stand still, legs together– arms outstretched. Eyes closed. Finger tip should touch the nose. Examiner is watching and rates the **tremor** (*modified Clinical Tremor Rating Scale*)
0 ___ None
1 ___ Slight to moderate (amplitude < 0,5 cm – 1cm); may be intermittent, may be intermittent
2 ___ Marked amplitude (1-2 cm)
3 ___ Severe amplitude (> 2 cm)

Dysmetria - finger to nose test
Person is asked to stand still, legs together – arms outstretched, eyes closed. Finger tip should touch the nose. Examiner is watching and rates the dysmetria
0 ___ Normal
1 ___ Moderate pathologic
2 ___ Severe pathologic

Dysdiadochokinesis
Person is asked to twist hands very quickly (alternating movements of the wrists (*Klockgether Score*)
0 ___ Absent
1 ___ Slight (minimal slowness of alternating movements)
2 ___ Moderate (marked slowness of alternating movements)
3 ___ Severe (severe irregularity of alternating movements)
4 ___ Most severe (inability to perform alternating movements)

Tremor – eye lid
Eyes closed. Examiner is watching and rates the **tremor** (*Davao Pool score*)
0 ___ None
1 ___ Slight
2 ___ Marked

LYING
Person is asked to lie on the examination bench.

Mentolabial reflex
0 ___ Negative
1 ___ Positive

Babinski reflex
0 ___ Negative
1 ___ Positive

Hoffmann reflex
0 ___ Negative
1 ___ Positive

Sucking reflex
0 ____ Negative
1 ____ Positive

Grasp
0 ____ Negative
1 ____ Positive

PSR (quadrizeps reflex)
A No reflex
B Hyporeflexia C Normal
D Hyperreflexia E Clonus

BSR (bizeps brachii reflex)
0 ____ Normal
1 ____ Hyporeflexia
1 ____ Slight hyperreflexia
2 ____ No reflex
2 ____ Very brisk or reflex zone enlarged or clonus

AR - Achillean tendon reflex, ankle jerk
0 ____ Normal
1 ____ Hyporeflexia
1 ____ Slight hyperreflexia
2 ____ No reflex
2 ____ Very brisk or reflex zone enlarged or clonus

OTHER TESTS

Rigidity in the movement of arm
0 ____ Normal
1 ___ Slight
2 ___ Modcratc
3 ___ Marked
4 ___ Severe (unable to extend the arm)

Intentional Tremor - heel-to-shin test
Person is asked to touch with his heel the knee of the other leg. Then to move with the heel along the shin to the foot. Repeat and do it with both sides. Eyes first open, then closed. Rate tremor during heel-to-shin test (*Klockgether Score*)
0 ____ Absent
1 ____ Slight (slight terminal tremor)
2 ____ Moderate (marked terminal tremor)
3 ____ Marked (kinetic tremor throughout intended movements)
4 ____ Severe (severe kinetic tremor heavily interfering with everyday life)
5 ____ Most severe (maximal form of kinetic tremor making intended movements impossible)

Dysmetria - heel-to-shin test
Rate ataxia (*Klockgether Score*)
0 ____ Absent
1 ____ Slight (slight hypermetria in heel-to-shin test)
2 ____ Moderate (hypermetria and slight ataxic performance of heel-to-shin test)
3 ____ Marked (marked swaying: unable to stand with feet together)
4 ____ Severe (pronounced ataxia in performing heel-to-shin test)
5 ____ Most severe (unable to perform heel-to-shin test)

Sensory disturbances
Sensory disturbances such as sensory impairment of the glove and-stocking type
0 ____ Absent
1 ____ Present
Comments_____

Bradykinesis
Rate your observation whether there was any sign of bradykinesis during the examination (slower active movements, absent or altered synkinesis of upper extremities during gait)
0 ____ Absent
1 ____ Present

Hypo-mimia
Rate your observation whether there you observed an hypo mimic expression of the face during the examination) -t
0 ____ Absent
1 ____ Present

5. Specific Tests

Date of the test…… Name of the tester:.....Code

Memory Disturbances: (different memory tests can be used)
Forward digit span test (part of *Wechsler Memory Scale)*
Please repeat each column of numbers. Score longest series correctly repeated forward

	Score	Test
	4	6-4-3-9
	4	7-2-8-6
	3	4-2-7-3-1
	3	7-5-8-3-6
	2	6-1-9-4-7-3
	2	3-9-2-4-8-7
	1	5-9-1-7-4-2-3
	1	4-1-7-9-3-8-6
	0	5-8-1-9-2-6-4-7
	0	3-8-2-9-5-1-7-4

Match Box Test (from *MOT*)
Put **20 matches** on a table , half of each on one side of an open matchbox, approx. 15 cm away. Take the time until all matches are put into the box. Use left and right hand alternatively.
_____ seconds

Finger Tapping Test (from *MOT*)
Sitting at a table. Elbows should be placed on the table. Try to do as many points as possible on a piece of paper with a pencil. Count the amount of points within **10 seconds**.
_____ points

Words to be registered in the good order: Fish
Ball
Tree

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Frostig Score
Draw a line from one symbol to the other. Do not interrupt while drawing. Do not touch the lines.

Score: ______

Please connect with a pencil the symbols. Please try to stay within the lines. ??

F1

0-2

F2

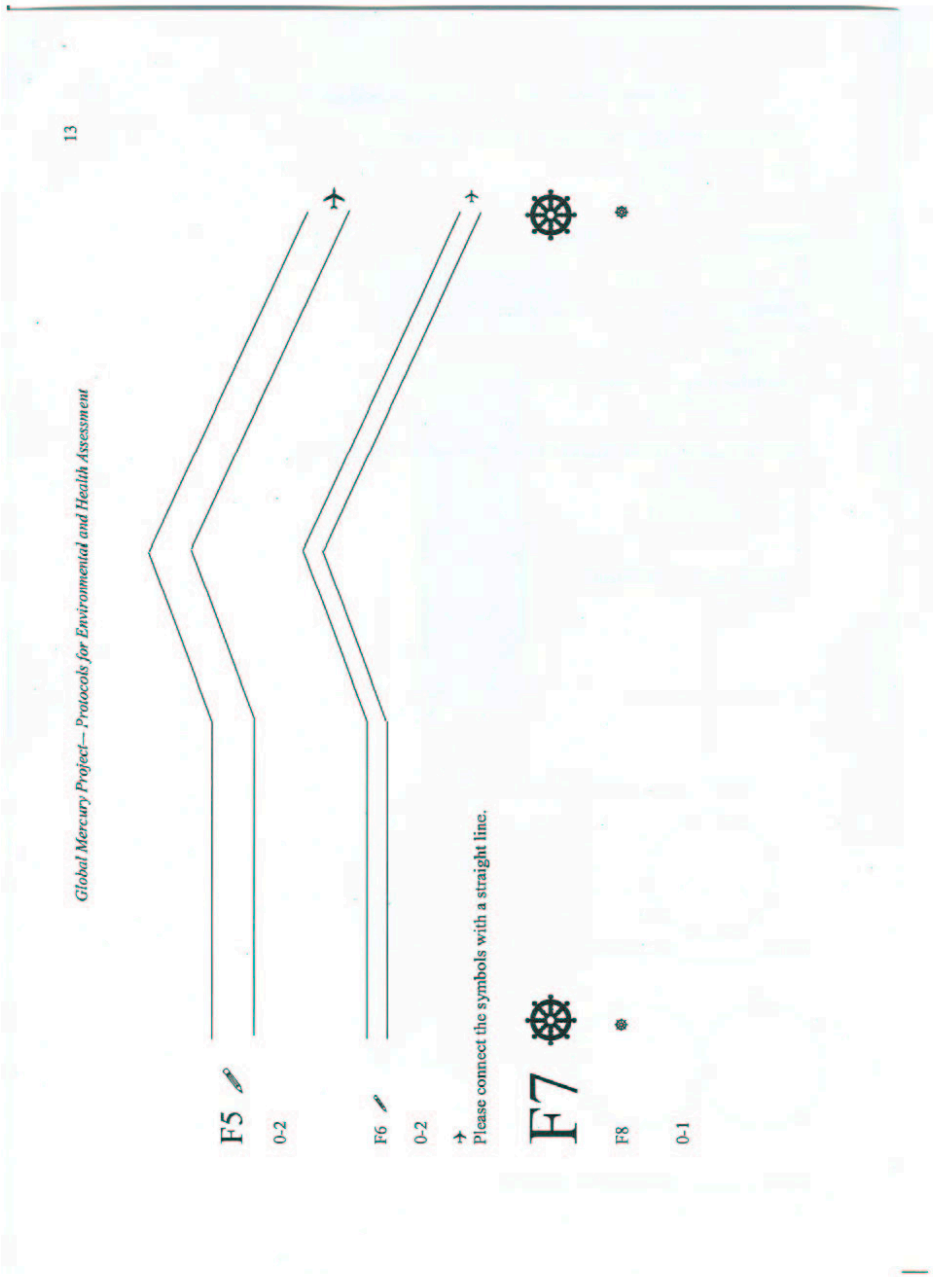
0-2

F3

0-2

F4

0-1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F5
0-2
F6
0-2
Please connect the symbols with a straight line.
F7
F8
0-1

MEMORY DISTURBANCES (new battery of tests):

Orientation to time - season:
0 ____ correct response
1 ____ incorrect response

Orientation to time - part of the day:
0 ____ correct response
1 ____ incorrect response

Orientation to place - name of the village
0 ____ correct response
1 ____ incorrect response

Orientation to place - name of the country:
0 ____ correct response
1 ____ incorrect response

Episodic memory (registration of 3 words): example: Fish, Ball, Tree
0 ____ Recalled all 3
1 ____ Recalled just 2
2 ____ Recalled just 1
3 ____ Recalled none

Dexterity and Coordination
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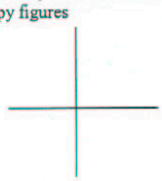
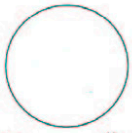


Points: _____ (0 - good; 2 – very bad)



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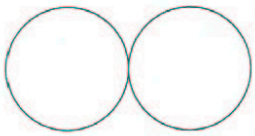

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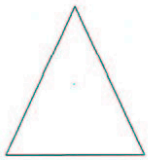

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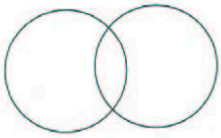
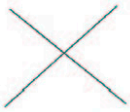
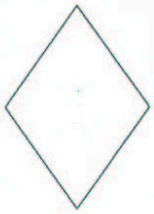


Points: _____ (0 - good; 2 – very bad)



Points: _____ (0 - good; 2 – very bad)



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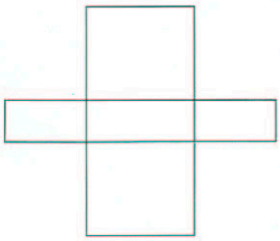

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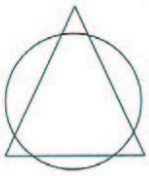
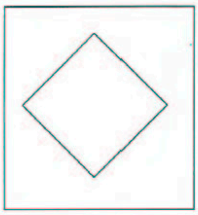
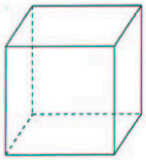


Points: _____ (0 - good; 2 – very bad)



Points: _____ (0 - good; 2 – very bad)



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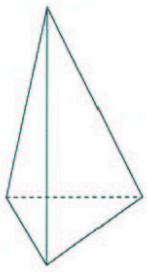

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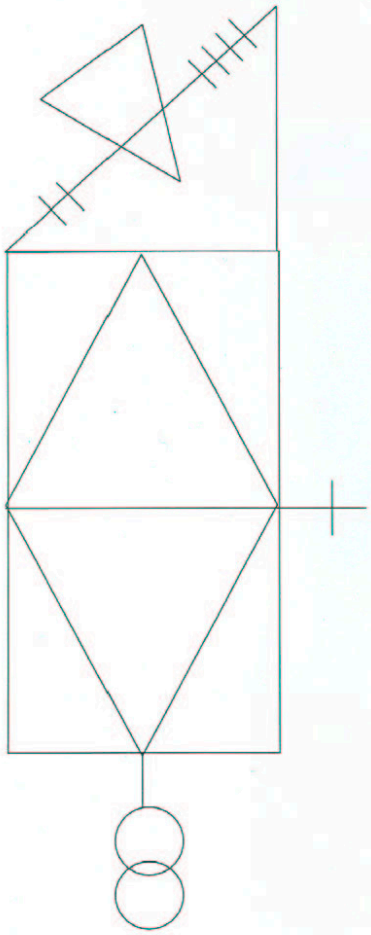
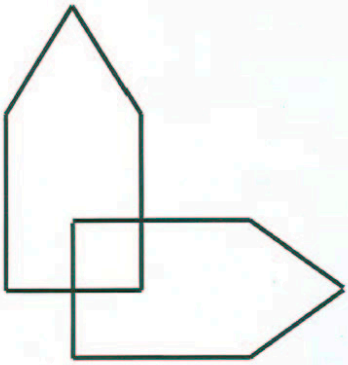


Points: _____ (0 - good; 2 – very bad)

Copy two five-sides figures



Points: _____ (0 - good; 2 – very bad)

6. Specimens

Date of the specimen.....

Time of the specimen sampling.....

Name of the specimen taker:.....Code _____

Blood (EDTA-blood 10 ml)
____ Yes
____ No

Urine (spontaneous urine sample 10 ml)
____ Yes
____ No

Proteinuria (same test should be used)
0 ____ negative
1 ____ trace
2 ____ +
3 ____ ++
4 ____ +++
5 ____ ++++

Hair
____ Yes, sample collected
____ No

6. Specimens

Date of the specimen.....

Time of the specimen sampling.....

Name of the specimen taker:.....Code _____

Blood (EDTA-blood 10 ml)
____ Yes
____ No

~~Malaria smear (only, if high prevalence of malaria in the area)~~
~~____ Negative~~
~~____ Positive~~

Urine (spontaneous urine sample 10 ml)
____ Yes
____ No

Urine total mercury (field test) (additional)
Result: ____ unit: ____

Proteinuria? (same test should be used)
0 ____ negative
1 ____ trace
2 ____ +
3 ____ ++
4 ____ +++
5 ____ ++++

Hair
____ Yes, sample collected
____ No

Hair total mercury (field test) (additional)
Result: ____ unit: ____

[1] Proteinuria 1 = more then trace, 0 = 0 or trace (correctness of this borderline needs to be checked , same testmaterial should be used, eg.)
[1] Memory test: 2 = score 0, 1 = score 1-2, 0 = score 3-4
[1] Matchbox test: 2 = 21 seconds or more, 1 = 16-20 seconds, 0 = 0-15 seconds
[1] Frostig test: 2 = 0-9 correct answers, 1 = 10-12 correct answers, 0 = 13-16 correct answers
[1] Tapping test: 2 = 0-53 dots, 1= 54-64 dots, 0 = 65 or more dots

APPENDIX 3:

Biomarkers results

Blood, urine and Hair analysis

Hg concentration (µg L^{-1}) in adult urine and blood samples- creatinine concentration (mmol/l) in instantaneous urine samples and Hg concentration (µg.g^{-1}) in hair samples of adults and children;

(sex: 1 = male and 2 = female – Result < means < LD; for urine, milk & blood, LD = <1 µg/L and for hair = <0.25 µg/g)

51- 2 (Id.House-Id.N) Person who used Hg or assisted at the burning

Ref.Houayen Gnai							
Id House	**Id.N**	**sex**	**age**	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
1	1	1	46	<	1,0	24,56	0.5
1	2	2	38	<	1,4	18,02	<
1	3	1	20	<	<	26,92	<
1	4	2	18	<	1,0	19,88	<
1	5	2	11				<
1	6	1	4				0.4
2	1	1	51	<	1,0	17,94	0.4
2	2	2	37	<	1,2	19,90	0.6
2	3	1	14				0.5
2	4	1	13				0.3
2	5	2	10				<0.25
2	6	2	4				0.3
3	1	1	28	<	2,6	7,70	0.5
3	2	2	27	<	3,4		**2.8**
3	3	1	6				0.4
3	4	2	4				0.6
3	5	1	68	<	<	25,14	<
3	6	2	63	<	2,0	6,77	<
4	1	1	44	<	1,2	20,80	0.3
4	2	2	35	<	<	25,05	<
4	3	1	12				0.3
4	4	1	4				0.5
5	1	1	34	<	1,0	16,22	<
5	2	2	28	<	1,6	16,30	0.3
5	3	1	7				0.3
5	4	2	4				0.3
5	5	2	67	<	<	11,39	<
5	6	1	25	<	1,2	17,00	1.8

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
5	7	1	8				<
5	8	2	21	<	<	18,16	pas
6	1	1	30	<	1,0	20,57	0.3
6	2	2	28	1	3,0	9,80	**2.1**
6	3	1	10				0.3
6	4	1	6				0.4
6	5	2	3				1.1
7	1	1	40	<	<	19,11	<
7	2	2	30	<	1,2	18,51	<
7	3	1	6				<
7	4	1	4				<
7	5	2	4				0.3
8	1	1	45	<	1,4	16,40	<
8	2	2	35	<	<	13,36	0.3
8	3	2	23	2	<	12,89	1.1
8	4	2	2				<
8	5	1	24	<	<	17,02	0.4
8	6	1	1				<
8	7	2	1				0.3
8	8	2	1				<
9	1	2	52	<	<	13,11	0.5
9	2	2	18	**15**	1,2	25,79	**11.0**
9	3	1	17	<	1,8	18,09	0.3
9	4	1	6				<
9	5	1	18	<	1,2	17,74	0.3
10	1	1	45	<	1,0	13,71	<
10	2	2	50	<	<	11,65	<
10	3	2	11				0.3
Houay Gno							
Id House	**Id.N**	**sex**	**age**	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
51	1	1	64	<	**5,2**	18,36	0.9
51	**2**	2	59	<	4,8	11,96	1.1
51	3	2	17	<	3,4	7,59	**3.3**
51	**4**	2	18	1	3,0	17,33	**2.7**
52	1	1	52	<	**5,0**	14,33	0.9
52	2	1	23	<	3,2	3,36	1.3
52	3	1	21	<	**6,2**	13,06	1.2
52	**4**	2	18	<	3,2	16,93	0.5
52	5	1	13				0.7
52	6	2	11				0.7

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
53	1	1	75	<	2,2	18,12	0.5
53	**2**	2	64	<	3,0	13,90	0.8
53	**3**	2	39	<	1,4	8,36	0.7
55	1	1	36	<	2,0	25,92	0.7
55	**2**	2	35	1	4,0	2,33	**6.0**
56	1	1	41	<	2,2	24,97	<
56	**2**	2	29	<	1,2	7,67	1.6
56	3	1	11				0.4
56	4	2	3				1.0
58	1	1	33	<	4,2	12,30	1.3
58	**2**	2	28	<	3,2	4,33	**5.4**
58	3	1	8				0.5
58	4	1	4				0.9
59	1	1	57	<	**8,4**	13,43	1.4
59	2	2	40	<	**5,0**	14,98	0.8
59	3	1	8				1.2
60	**1**	1	48	<	4,2	12,82	0.8
60	**2**	2	44	<	3,2	8,23	**2.8**
60	3	1	19	<	4,4	10,85	1.1
60	4	1	14				0.5
60	5	1	11				0.6
60	6	2	64	<	pas		0.5
61	1	1	42	<	2,0		0.6
61	**2**	2	36	<	1,0	16,24	0.6
61	3	1	11				0.3
61	4	1	8				<
62	1	1	29	<	2,8	11,84	0.9
62	2	2	28	1	2,2	16,63	1.6
62	3	2	7				1,3
62	4	2	3				0.6
62	5	2	1				0.3
63	**1**	1	37	<	3,4	13,42	1.0
63	**2**	2	32	<	3,6	14,15	0.7
63	4	1	8				0.6
63	5	1	6				0,9
63	**7**	2	62	<	3,2	2,77	1.3
65	**1**	1	62	<	**5,4**	22,33	0.9
65	**2**	2	45	<	**5,8**	11,94	0.9
65	3	1	22	<	**5,0**	14,02	0,6
65	4	2	19	<	2,6	12,20	0.5

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
65	5	2	17	<	4,0	14,15	0.6
65	6	1	15	<	4,6	10,68	0.6
65	7	2	12				0.8
65	8	1	8				1.1
66	1	1	34	<	3,0	20,28	0.5
66	**2**	2	29	<	1,6	22,61	1.3
66	3	2	12				0.4
66	4	1	9				0.6
67	**1**	1	63	<	4,0	28,94	0.9
67	**2**	2	60	<	3,8	3,85	0.4
67	3	1	21	<	1,8	5,24	0.6
67	4	2	19	<	1,6	15,20	0.3
68	1	1	36	<	3,2	12,12	0.5
68	**2**	2	35	<	2,4	10,50	0.6
68	3	1	14				0.5
68	4	2	12				<
70	1	1	42	<	**5,8**	12,16	0.9
70	**2**	2	39	<	3,6	13,00	0.6
70	3	1	20	<	**6,4**	9,63	0.9
70	**4**	2	18	<	4,8	20,22	**3.5**
70	5	1	10				0.7
Houay Koh.							
Id House	**Id.N**	**sex**	**age**	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
71	1	1	30	<	1,4	18,55	**2.8**
71	**2**	2	25	2	3,8	6,86	1.9
71	3	1	2				**16.8**
73	1	1	27	<	1,4	11,22	0.3
73	**2**	2	28	2	1,0	12,71	0.9
74	**1**	1	44	<	2,4	12,19	0.7
74	2	2	34	4	3,0	11,25	**3.5**
74		2	5				1.0
74		2	6				0.9
75	1	1	47	1	2,0	15,25	0.5
75	**2**	2	42	2	1,6	6,89	0.3
75	3	1	17	<	2,6	13,36	0.7
75	4	1	15				0.6
75	5	2	8				0.5
75	6	2	6				<
75	7	1	4				<

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
75	8	2	1				<
76	1	1	44	<	2,2	16,34	<
76	**2**	2	41	**13**	**12,2**	11,21	1.5
76	3	2	16	<	1,2	5,31	0.3
76	4	1	12				0.6
76	5	2	9				0.3
79	1	1	44	<	1,4	10,54	0.4
79	**2**	2	24	<	1,4	21,45	0.4
79	**3**	2	16	4	1,0	24,49	1.1
79	**4**	2	15	<	1,6	15,19	0.6
79	5	1	11	<			<
79	6	2	10				0.5
79	7	1	7				0.4
79	8	2	5				0.3
80	1	1	69	<	1,6	16,94	0.5
80	**2**	2	59	4	4,0	10,64	0.3
80	3	2	14				0.7
81	1	1	39	<	1,6	16,24	0.6
81	**2**	2	45	1	3,6	3,63	**18.6**
81	3	2	10				0.4
82	1	1	28	<	3,2	9,01	0.8
82	**2**	2	25	<	1,8	6,91	0.9
82	3	1	5				1.2
83	1	1	35	<	1,6	15,73	0.3
83	**2**	2	33	2	2,6	17,08	0.9
83	3	2	1				0.5
84	1	1	21	<	2,2	19,78	0.5
84	**2**	2	31	<	1,4	7,04	0.3
84	3	2	8				0,3
84	4	2	1				0,3
85	1	1	45	<	3,0	12,77	0,3
85	2	2	38	<	2,2	7,94	**4.5**
85	3	1	66	<	3,2	12,74	<
85	4	1	12				0.3
85	5	1	10				<
86	**1**	1	33	<	2,8	28,87	0.8
86	**2**	2	32	<	1,4	10,07	1.0
86	3	2	17	<	1,8	16,03	0.3
87	1	1	36	<	1,8	19,52	0.3
87	**2**	2	31	<	2,2	5,44	0.5

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
88	**1**	1	51	<	2,4	19,88	0.4
88	**2**	2	50	3	3,2	18,35	0.3
88	**3**	2	78	<	1,6	9,78	0.3
88	4	2	12				<
88	5	1	2				0.6
89	1	1	59	<	1,6	19,44	?
89	**2**	2	47	<	2,0	16,06	0.4
89	3	1	28	<	1,4	12,73	1.0
89	**4**	2	25	**12**	**7,8**	12,74	**5.4**
89	5	1	6				1.0
89	6	1	4				1.6
91	**1**	1	55	<	2,0	14,30	0.3
91	**2**	2	53	<	1,4	8,39	0.4
93	**1**	1	39	<	2,2	22,42	0.7
93	**2**	2	35	pas	1,2	pas	<
93	3	1	16				0.3
93	4	2	13				<0.25
93	5	2	8				0.3
93	6	2	6				0.5
93	7	2	1				<
94	1	1	65	<	3,0	28,91	1.0
94	**2**	2	56	**7**	4,8	16,00	0.6
94	3	1	18	<	3,6	17,59	0.8
95	1	1	55	<	1,8	5,86	0.4
95	**2**	2	50	1	3,8	10,92	2.6
Lattha Hai							
Id House	**Id.N**	**sex**	**age**	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
152	**1**	1	31	<	<	4,91	0.3
152	**2**	2	27	<	<	11,95	0.5
152	3	2	10				0.4
152	4	2	6				0.3
152	5	1	5				0.3
155	1	1	27	<	<	5,27	<
155	**2**	2	27	<	<	20,32	0.8
155	3	2	5				0.5
155	4	1	3				0.5
163	1	1	39	<	2,4	18,98	0.6
163	**2**	2	38	<	1,8	27,02	0.5
166	1	1	49	<	<	3,85	<

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
166	**2**	2	41	<	<	17,16	<
167	1	1	58	<	4,0	16,43	0.7
167	**2**	2	55	<	3,4	16,94	0.3
167	3	2	3				0.6
169	**1**	1	46	1	3,4	23,47	0.8
169	**2**	2	43	2	4,4	18,50	**2.4**
169	3	1	20				0.6
169	4	2	13				0.6
171	1	1	32	<	<	8,16	0.6
171	**2**	2	30	<	1,2	14,05	1.0
171	3	2	13				0.3
171	4	2	5				0.8
172	1	2	55	<	2,2	12,88	0.3
173	1	1	48	<	2,6	15,05	0.7
173	**2**	2	45	<	1,0	15,91	0.4
173	3	2	12				0.6
173	4	2	5				0.5
174	1	2	24			18,65	**2.3**
174	2	2	8				0.6
174	3	2	6				0.6
175	1	1	55	<	<	20,74	0.5
175	**2**	2	45	<	<	9,68	<
175	**3**	2	16	<	1,8	10,29	1.8
175	4	2	11				0.3
175	5	2	10				0.4
175	6	2	8				0.3
175	7	1	3				0.6
176	**1**	1	34	<	3,0	7,21	0.8
176	**2**	2	35	<	2,2	12,20	0.6
176	3	1	13				0.5
176	4	1	11				0.5
176	5	2	5				0.8
177	1	1	57	<	1,2	19,59	0.4
177	**2**	2	53	<	<	13,86	0.4
177	3	2	22	<	1,2	13,63	0.5
177	4	1	21	<	2,4	9,96	0.8
177	5	1	15				0.4
177	6	1	13				0.4
180	1	2	25	<	<	18,58	0.7
180	**2**	1	5				0.6

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
180	3	1	1				0.4
181	**1**	1	57	<	2,0	16,64	0.4
181	**2**	2	50	<	1,8	15,05	0.4
181	3	2	21	<	2,4	14,71	0.9
181	4	1	12				0.9
181	5	1	5				0.6
187	3	2	13	no	no	no	1,4
188	**1**	2	39	<	<	10,47	0.5
189	1	1	61	<	3,2	25,51	1.2
189	**2**	2	58	<	<		0.5
189	3	2	14				0.4
189	4	2	11				0.3
189	5	2	10				0.4
189	6	2	3				1.1
Pak Ou							
Id House	**Id.N**	**sex**	**age**	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
212	**1**	1	28	<	**5,0**	10,33	**2.0**
212	2	2	22	<	2,0	15,28	0.8
212	3	2	3				1.3
213	**1**	2	54	<	2,6	17,09	0.4
213	2	1	11				0.5
215	**1**	2	47	<	2,8	14,41	2.4
215	2	2	7				1.4
216	**1**	2	34	1	**6,0**	7,34	1.2
216	2	2	56	<	1,8	7,70	0.5
216	3	2	11				1.2
216	4	1	10				1.1
216	5	1	4				1.1
217	**1**	2	52	<	3,4	11,39	0.7
217	**2**	1	26	<	**8,8**	11,64	**2.9**
219	**1**	1	51	<	4,0	14,60	1.0
219	**2**	2	40	<	1,6	15,67	1.3
219	3	2	18				0.7
219	4	2	17				1.9
220	**1**	2	71	<	4,8	17,08	0.8
223	**1**	1	66	<	4,0	15,66	0.9
223	**2**	2	60	<	3,0	11,78	1.3
223	3						**5.2**
223	4						1.2

Id House	Id.N	sex	age	Hg ur µg/l	Hg Blood µg/l	Creat uri mmol/l	Hg hair µg/g
224	1	2	56	2	2,2	17,96	**2.0**
227	1	2	64	<	2,6	15,80	<
228	1	2	57	<	**10,0**	9,60	**2.5**
228	2	2	19	<	**7,4**	6,33	**3.7**
228	3	1	2				1.3
229	**1**	1	56	<	2,2	25,47	1.0
229	**2**	2	54	<	2,8	16,93	1.0
229	**3**	2	19	1	**5,8**	13,30	**2.0**
229	4	2	12				1.6
229	5	1	10				2.0
230	**1**	2	57	1	**8,0**	10,51	**3.4**
231	**1**	1	48	<	**5,8**	16,05	2,3
231	**2**	2	43	<	2,8	20,59	1.0
232	**1**	1	52	<	**10,6**	10,09	**2.1**
232	**2**	2	32	<	**5,6**	8,25	1.8
232	3	2	10				**2.5**
232	4	2	8				**2.5**
232	5	1	3				1.5
235	1	1	47	1	**8,8**	16,17	**2,7**
235	**2**	2	37	1	**5,8**	12,20	**2.6**
235	**3**	2	67	<	3,2	9,40	0.6
235	4	2	12				**2.2**

- Out of the 6 milk samples, one (n° 93-2) had insufficient quantity to be analysed and 5 (n° 62-2; 73-2; 83-2; 86-2; 219-2) were <LD.

Scientific and technical Centre
Division EPI
3, avenue Claude-Guillemin - BP 6009
45060 Orléans Cedex 2 – France – Tél. : +33 (0)2 38 64 34 34