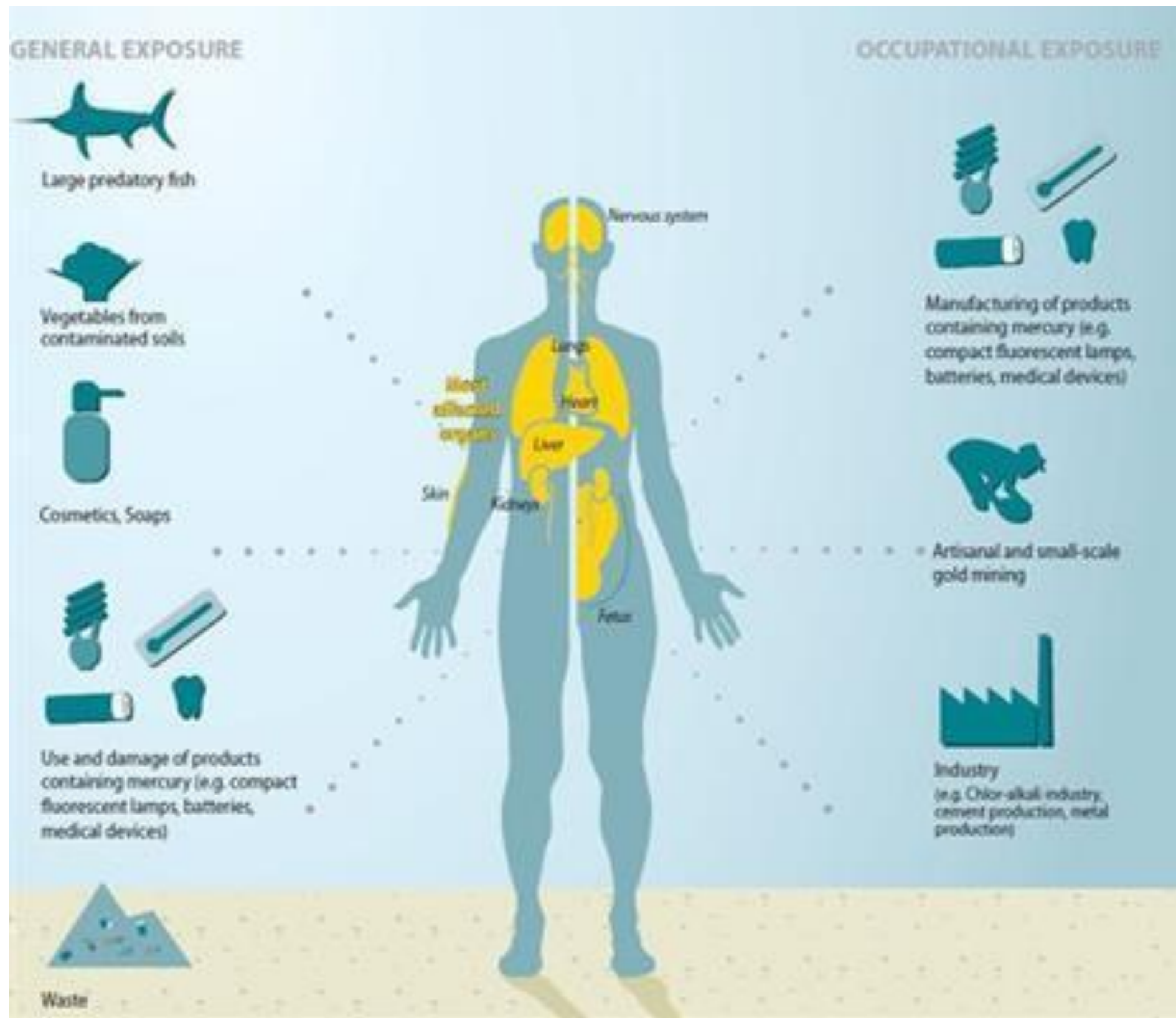


Assessment of the levels of mercury in students aged 12 to 18

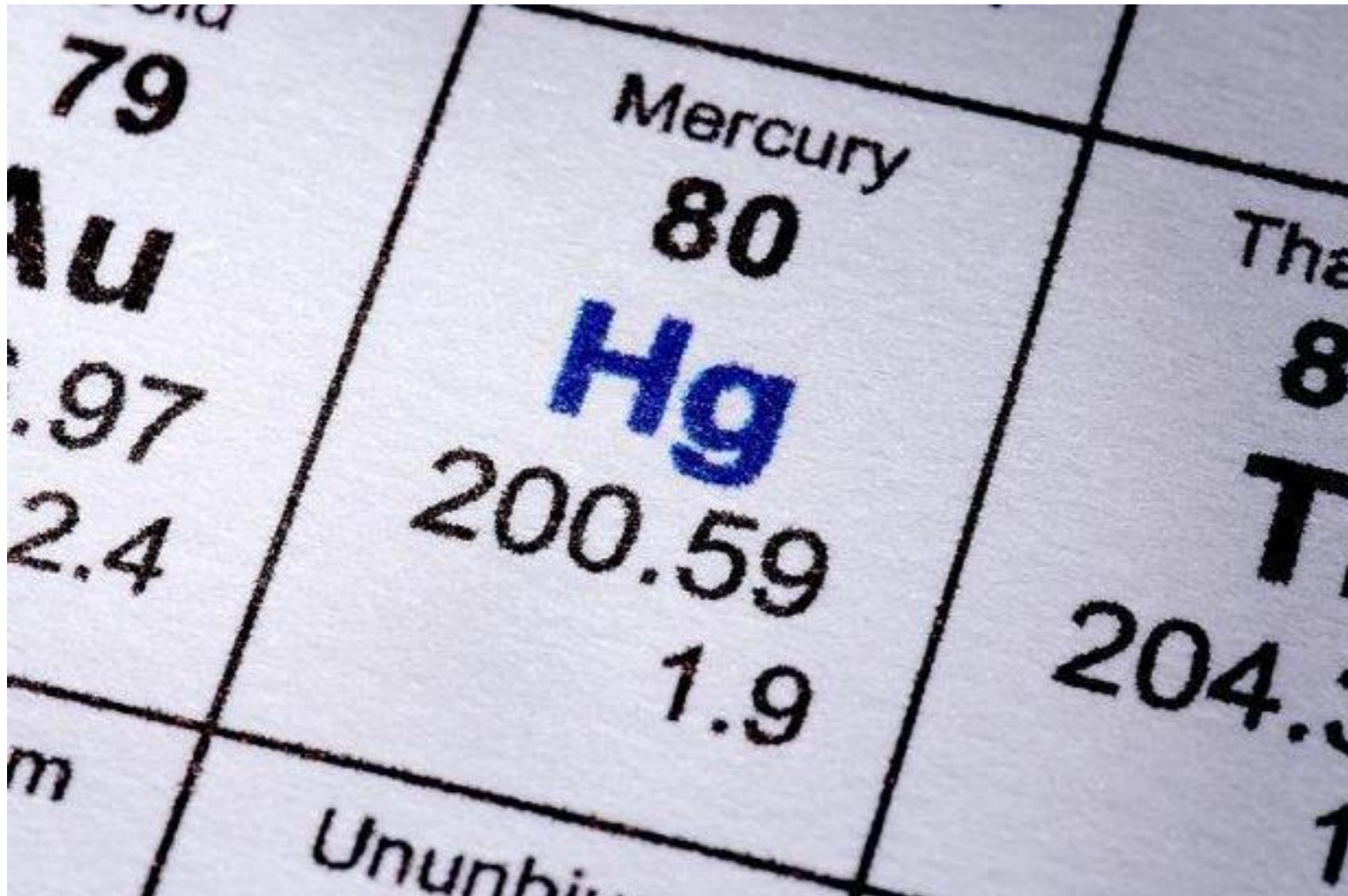
Afonso Mota, Bernardo Alves, João Leal
Portugal



Mercury exposure, an “invisible” problem



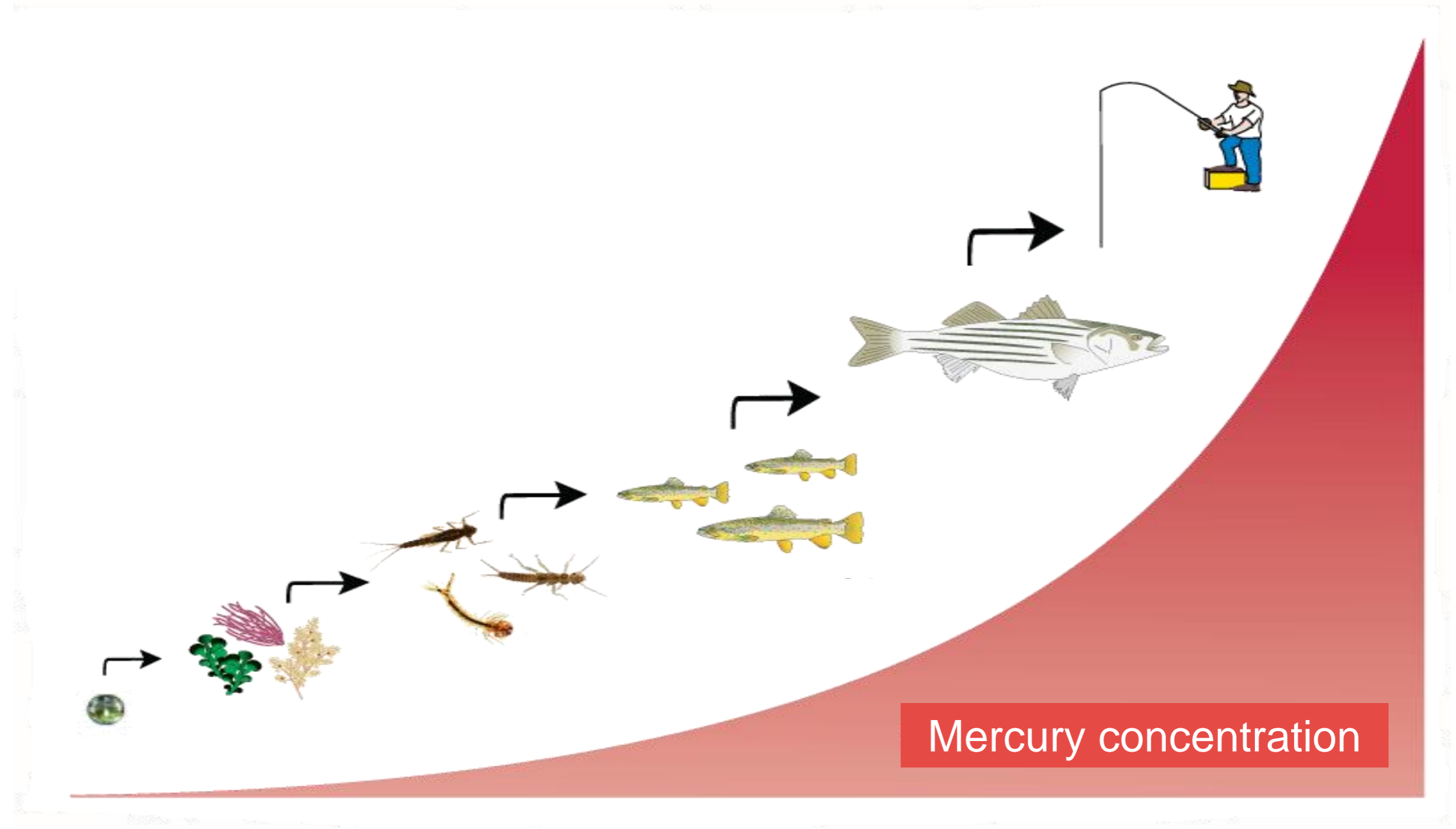
Mercury exposure



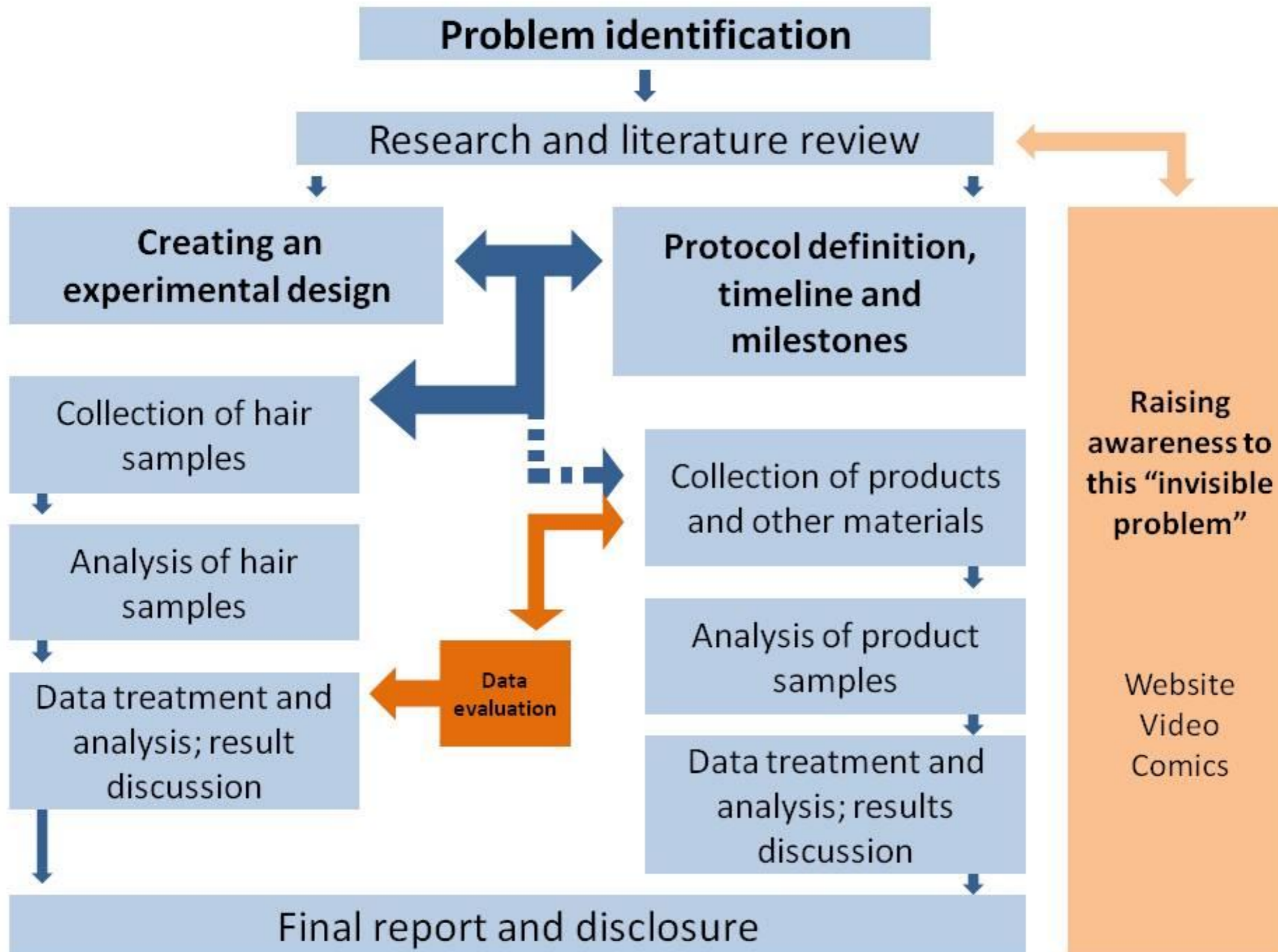
Chemical composition of methylmercury, one of the most toxic variants of the studied substance.

Source: Clarkson & Magos (2006).





Experimental design



Methodology



- The experimental protocol followed the instructions provided by the **COPHES project**, an European project which looks to harmonize the collection and treatment of samples for biomonitoring studies.
- The process of biological sample collection (human hair) was approved by **Colégio Valsassina's Pedagogical Direction (ethics commission)** and **authorized by the Portuguese National Data Protection Commission.**



Methodology

Defining the target sample

Sample collection + Questionnaire

Preparing the samples for mercury quantification

Quantifying mercury
Technique used: direct thermal decomposition
NIC (Nippon Instruments Corporation) *Direct Thermal Decomposition Mercury Analyzer MA-3000.*

Data treatment

Data analysis and discussion



Protocolo de Investigação Avaliada em relação às concentrações de mercúrio nos cabelos do Colégio Valsassina

CÓDIGO DA AMOSTRA: _____

QUESTIONÁRIO

1. Caracterização do indivíduo

Sexo (M/F): _____ Data de Nascimento: _____

Peso (Kg): _____ Altura (m): _____

2. Localização geográfica da área de residência

Localização: _____

Urbana

Rural

Industrial

Outra: _____

3. Características do cabelo:

Liso Natural

Ondulado Pintado

Encaracolado Molhado

Outro: _____

Comprimento do cabelo (cm): _____



Assim, nos termos das disposições constantes do n.º 2 do artigo 7.º, de alínea a) do n.º 1 do artigo 23.º e do artigo 26.º do DL n.º 73/2017, de 23 de agosto, e do n.º 1 do artigo 10.º da Lei de Investigação Clínica, com as alterações e demais alterações, na Deliberação do CDS n.º 1762/2018, que não se dá por replicadas, autoriza e permite a realização de todos os procedimentos aqui descritos.

Responsável: Colégio Valsassina

Finalidade: Estudo Clínico em Intervenção, desenvolvido no âmbito do projeto de investigação em saúde do Colégio Valsassina

Categoria de dados pessoais tratados: Códigos de participantes, identidades de investigadores, dados de contacto, dados de identificação

Destino de dados de acesso: Acesso dos investigadores, exclusivamente por escrito

Conservação, retenção e fluxo de informações de dados pessoais: Identificação no âmbito do projeto

Para efeitos de conservação de dados: É o responsável o Colégio que garante a identificação íntima de cada indivíduo em relação ao projeto e ao estudo.

O CDS e a Lei de Investigação Clínica, nos termos e condições previstas no presente documento, e autoriza, na Deliberação do CDS n.º 1762/2018, a realização de todos os procedimentos aqui descritos, desde que se verifique a totalidade dos requisitos aqui descritos e que não haja qualquer impedimento.

Study sample



Hair sample analysis

Education level	Number of students available to participate	Samples collected	Total per age group
7 ^o	9	9	32
8 ^o	9	9	
9 ^o	24	14	
10 ^o	36	17	43
11 ^o	25	18	
12 ^o	13	8	
Total	116	Total (sample)	75



- Sample made up of 75 individuals
- 29 males and 46 females, between 12 and 18 years old.
- Average age was $14,76 \pm 1,63$ years.



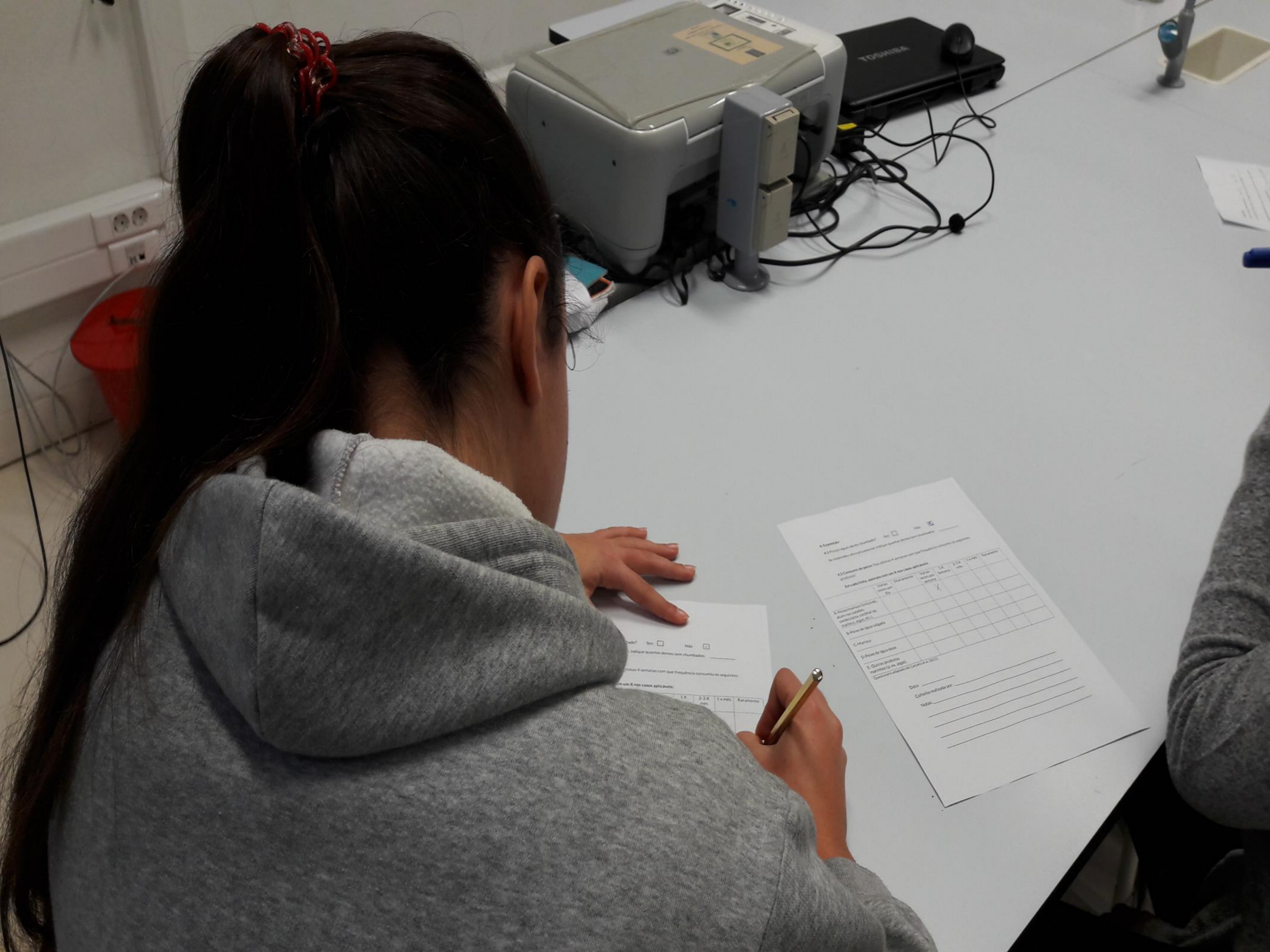
Product sample analysis

Education level	Female	Male	Total
7 ^o	1	1	2
8 ^o	1	1	2
9 ^o	1	1	2
10 ^o	1	1	2
11 ^o	1	1	2
12 ^o	1	1	2
Total students	6	6	12

Number of samples collected by student	10
Total of samples collected (12 students x 10 samples)	120







4. Exatidão
4.1 Possui algum dente faltando? Sim Não

4.2 Consumo de pasta-dente utilizado? Sim Não

Se responder "Sim" a qualquer uma das perguntas anteriores, indique quando ocorreu a última ocorrência.

Em qual data, semana ou mês a pasta-dente foi utilizada?	Fluoreto de cálcio	Fluoreto de estanho	1º mês	2º mês	3º mês	4º mês	5º mês	6º mês

5. Períodos de consulta
5.1 Quantas vezes consultou um dentista nos últimos 4 meses?

5.2 Quantas vezes consultou um dentista nos últimos 12 meses?

5.3 Quantas vezes consultou um dentista nos últimos 24 meses?

5.4 Quantas vezes consultou um dentista nos últimos 36 meses?

5.5 Quantas vezes consultou um dentista nos últimos 48 meses?

5.6 Quantas vezes consultou um dentista nos últimos 60 meses?

5.7 Quantas vezes consultou um dentista nos últimos 72 meses?

5.8 Quantas vezes consultou um dentista nos últimos 84 meses?

5.9 Quantas vezes consultou um dentista nos últimos 96 meses?

5.10 Quantas vezes consultou um dentista nos últimos 108 meses?

5.11 Quantas vezes consultou um dentista nos últimos 120 meses?

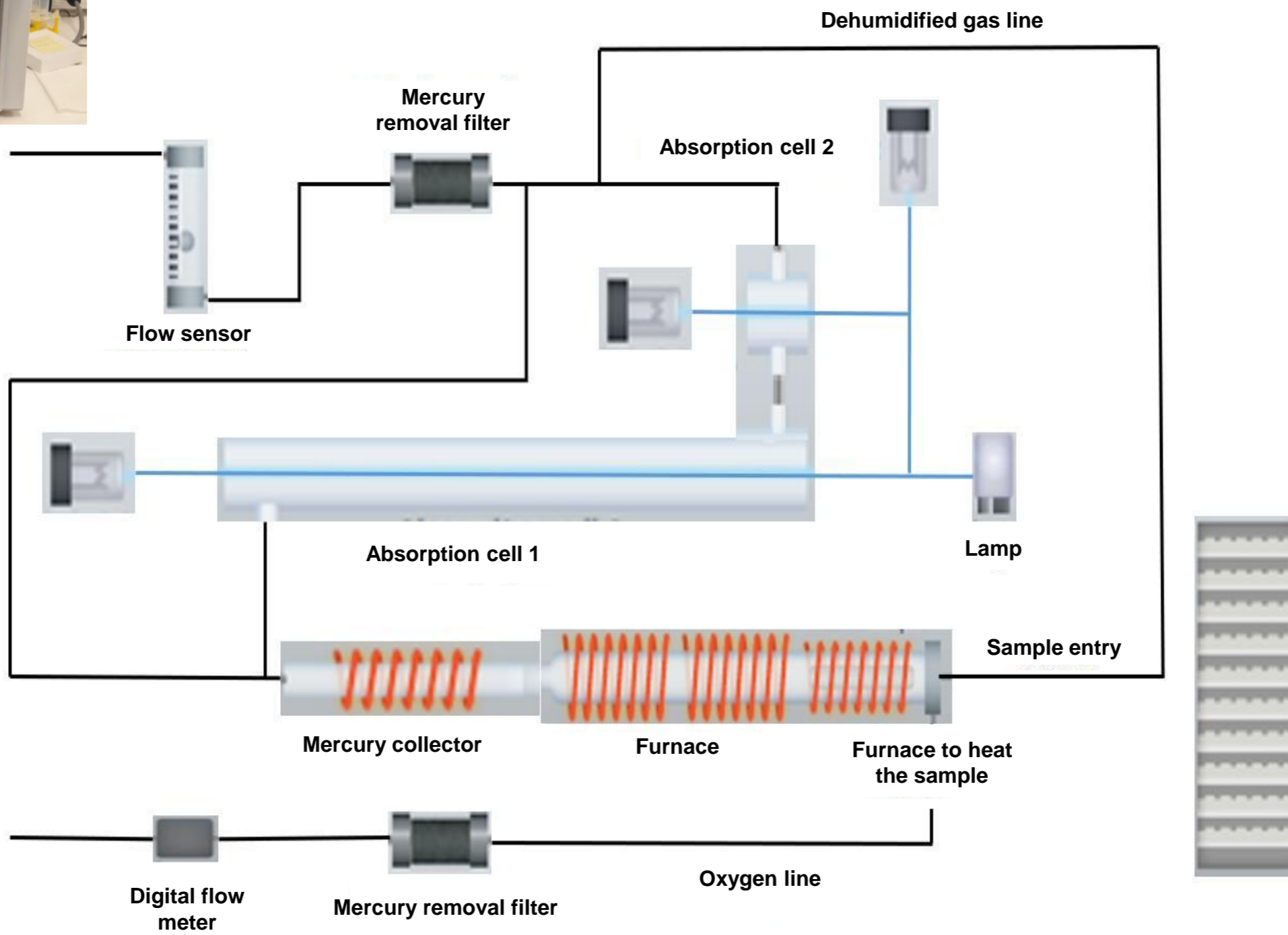
Data: _____
Coléxia realizada por: _____
Nota: _____



NIC-MA-3000 (Nippon Instruments Corporation).



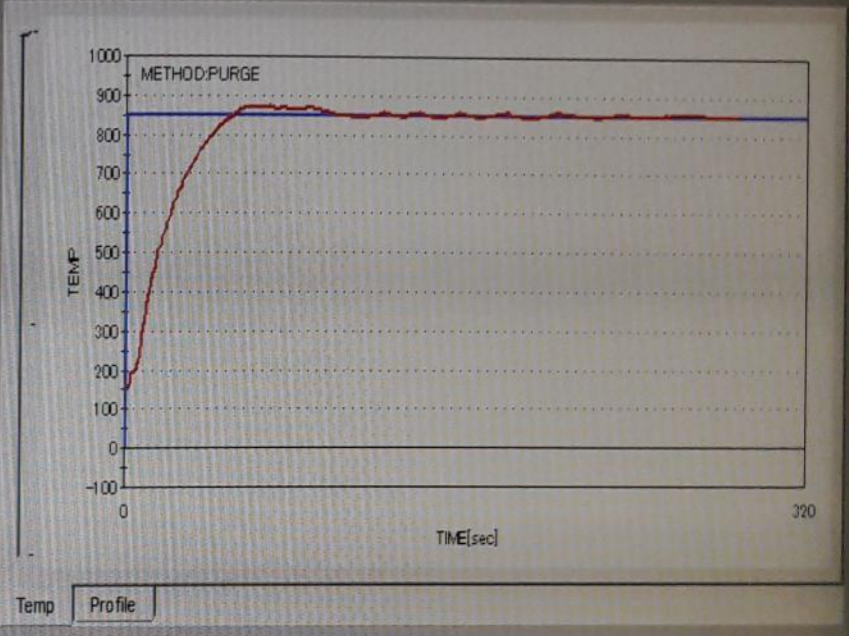
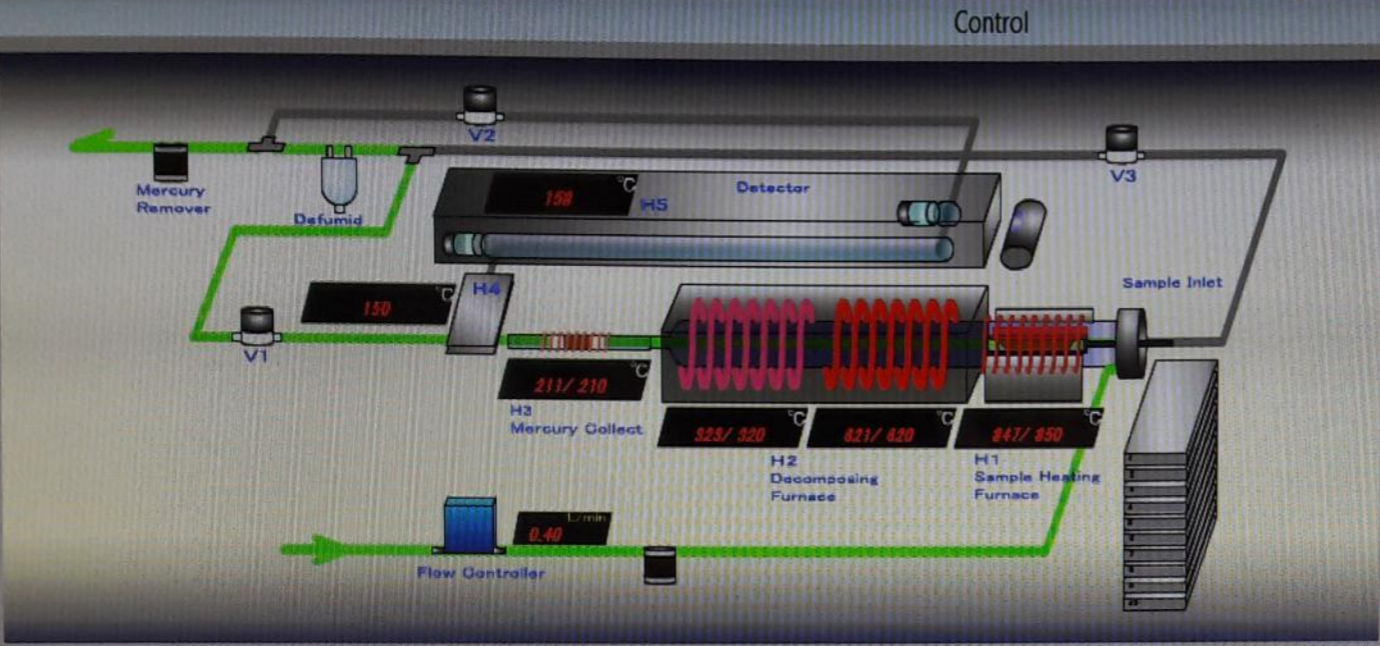
NICMA-3000
MERCURY ANALYZER



NIC MA-3000 (Nippon Instruments Corporation) functioning diagram
Adapted from: Barros, 2016



- 1.ATOMIZE1
- 2.ATOMIZE2
- 3.ATOMIZE3
- 4.ATOMIZE4
- 5.PURGE1
- 6.PURGE2
- 7.MEASURE
- 8.PURGE3
- 9.COOL
- TOTAL



Table

No.	MEAS	SAMPLE No.	METHOD	NAME	SVOL [mg]	ADD.STD [ng]	AREA[ON]		MEAS [ng]	CONC [ppb]	ECOVER [%]	OX	RANGE	DATE	REMARKS
							LOW	HIGH							
13	<input type="checkbox"/>	10	ORGANISM(SOL	32A	10.200		9.08591	0.04764	11.492	1126.66667	-	o	HIGH	4/11 15:14	
14	<input type="checkbox"/>	0	PURGE	BLANK CHECK			0.01786	0.00049	0.017		-	o	LOW	4/11 15:23	
15	<input type="checkbox"/>	11	ORGANISM(SOL	32A-DUP	10.200		9.36688	0.05076	12.447	1220.29412	-	o	HIGH	4/11 15:31	
16	<input type="checkbox"/>	0	PURGE	BLANK CHECK			0.02014	0.00079	0.020		-	o	LOW	4/11 15:40	
17	<input type="checkbox"/>	12	ORGANISM(SOL	32B	10.000		9.71081	0.05406	13.458	1345.80000	-	o	HIGH	4/11 15:48	
18	<input type="checkbox"/>	0	PURGE	BLANK CHECK			0.01132	0.00038	0.006		-	o	LOW	4/11 15:57	
19	<input type="checkbox"/>	13	ORGANISM(SOL	33A	10.000		5.02569	0.02679	8.132	813.20000	-	o	LOW	4/11 16:04	
20	<input type="checkbox"/>	14	ORGANISM(SOL	33B	10.500		7.68450	0.04215	9.810	934.28571	-	o	HIGH	4/11 16:12	
21	<input type="checkbox"/>	15	ORGANISM(SOL	34	9.300		7.77226	0.04031	9.247	994.30108	-	o	HIGH	4/11 16:20	
22	<input type="checkbox"/>	16	ORGANISM(SOL	35	3.900		3.42093	0.01847	5.532	1418.46154	-	o	LOW	4/11 16:27	
23	<input type="checkbox"/>	17	ORGANISM(SOL	36	11.000		11.75973	0.06247	16.034	1457.63636	-	o	HIGH	4/11 16:35	
24	<input checked="" type="checkbox"/>	0	PURGE	BLANK CHECK											
25	<input checked="" type="checkbox"/>	18	ORGANISM(SOL	37A	10.700										
26	<input checked="" type="checkbox"/>	19	ORGANISM(SOL	37B	10.500										

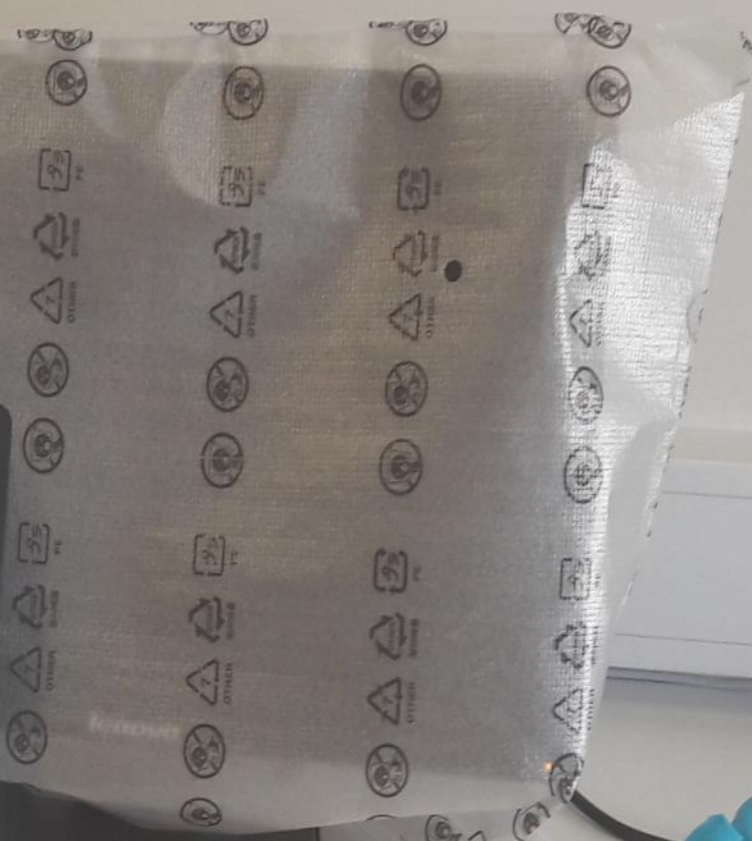
Results (hair samples)



	Hair length(cm)	Age (years)	Body mass index (BMI)	[Hg] (ng g ⁻¹)
Average	29,19	14,85	20,19	1148,48
Standard deviation	17,66	1,69	2,40	688,57
Minimum	2,00	12,00	15,06	12,6
Maximum	70,00	18,00	26,96	3314,74
N (total)	70	70	70	82



Data de aquisição (Produto)	Atividade	Compartimento (categoria)	Localização	Espécie
2012/08/01	2012/08/01	2012/08/01	2012/08/01	2012/08/01
2012/08/02	2012/08/02	2012/08/02	2012/08/02	2012/08/02
2012/08/03	2012/08/03	2012/08/03	2012/08/03	2012/08/03
2012/08/04	2012/08/04	2012/08/04	2012/08/04	2012/08/04
2012/08/05	2012/08/05	2012/08/05	2012/08/05	2012/08/05
2012/08/06	2012/08/06	2012/08/06	2012/08/06	2012/08/06
2012/08/07	2012/08/07	2012/08/07	2012/08/07	2012/08/07
2012/08/08	2012/08/08	2012/08/08	2012/08/08	2012/08/08
2012/08/09	2012/08/09	2012/08/09	2012/08/09	2012/08/09
2012/08/10	2012/08/10	2012/08/10	2012/08/10	2012/08/10
2012/08/11	2012/08/11	2012/08/11	2012/08/11	2012/08/11
2012/08/12	2012/08/12	2012/08/12	2012/08/12	2012/08/12
2012/08/13	2012/08/13	2012/08/13	2012/08/13	2012/08/13
2012/08/14	2012/08/14	2012/08/14	2012/08/14	2012/08/14
2012/08/15	2012/08/15	2012/08/15	2012/08/15	2012/08/15
2012/08/16	2012/08/16	2012/08/16	2012/08/16	2012/08/16
2012/08/17	2012/08/17	2012/08/17	2012/08/17	2012/08/17
2012/08/18	2012/08/18	2012/08/18	2012/08/18	2012/08/18
2012/08/19	2012/08/19	2012/08/19	2012/08/19	2012/08/19
2012/08/20	2012/08/20	2012/08/20	2012/08/20	2012/08/20
2012/08/21	2012/08/21	2012/08/21	2012/08/21	2012/08/21
2012/08/22	2012/08/22	2012/08/22	2012/08/22	2012/08/22
2012/08/23	2012/08/23	2012/08/23	2012/08/23	2012/08/23
2012/08/24	2012/08/24	2012/08/24	2012/08/24	2012/08/24
2012/08/25	2012/08/25	2012/08/25	2012/08/25	2012/08/25
2012/08/26	2012/08/26	2012/08/26	2012/08/26	2012/08/26
2012/08/27	2012/08/27	2012/08/27	2012/08/27	2012/08/27
2012/08/28	2012/08/28	2012/08/28	2012/08/28	2012/08/28
2012/08/29	2012/08/29	2012/08/29	2012/08/29	2012/08/29
2012/08/30	2012/08/30	2012/08/30	2012/08/30	2012/08/30
2012/08/31	2012/08/31	2012/08/31	2012/08/31	2012/08/31



QUESTIONÁRIO

1. Caracterização do indivíduo

Nome (sobrenome): _____
Sexo: M F
Profissão: _____

2. Localização geográfica da área de residência

Localização: _____
Urbano
Rural
Industrial
Outro: _____

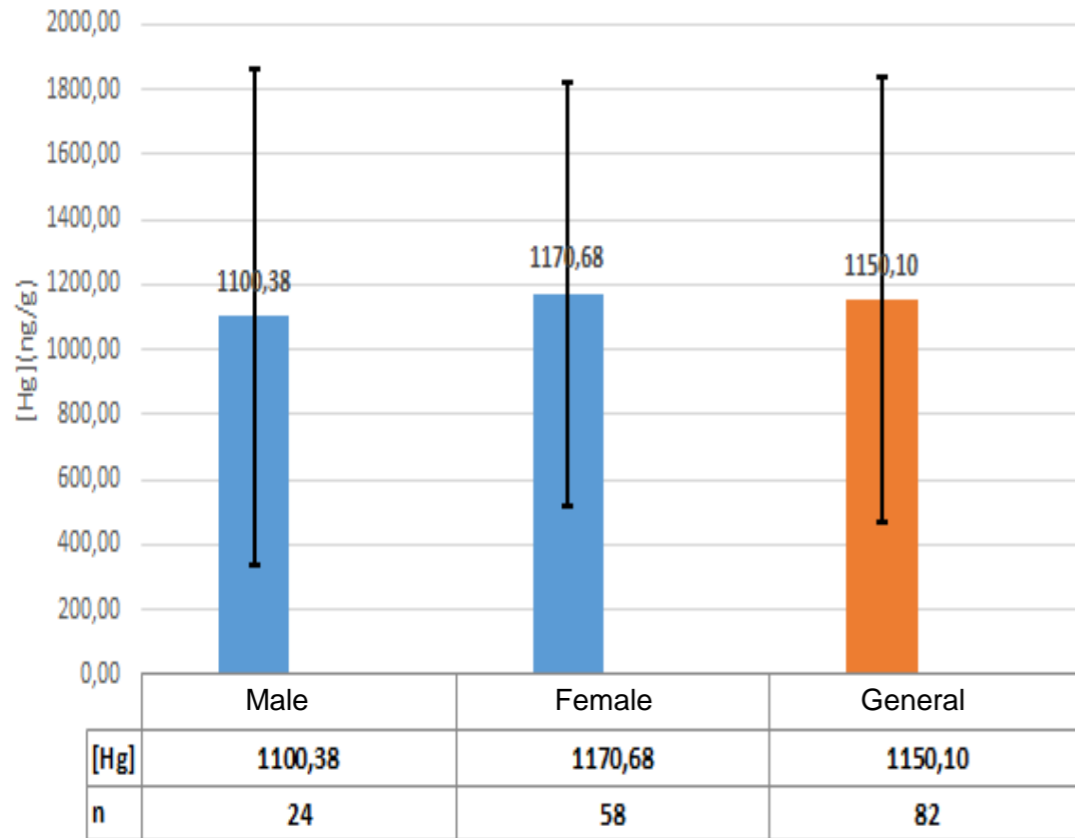
3. Características do ambiente

Uso: Natural
Gravidade: Moderado
Escala de risco: Moderado
Outro: _____

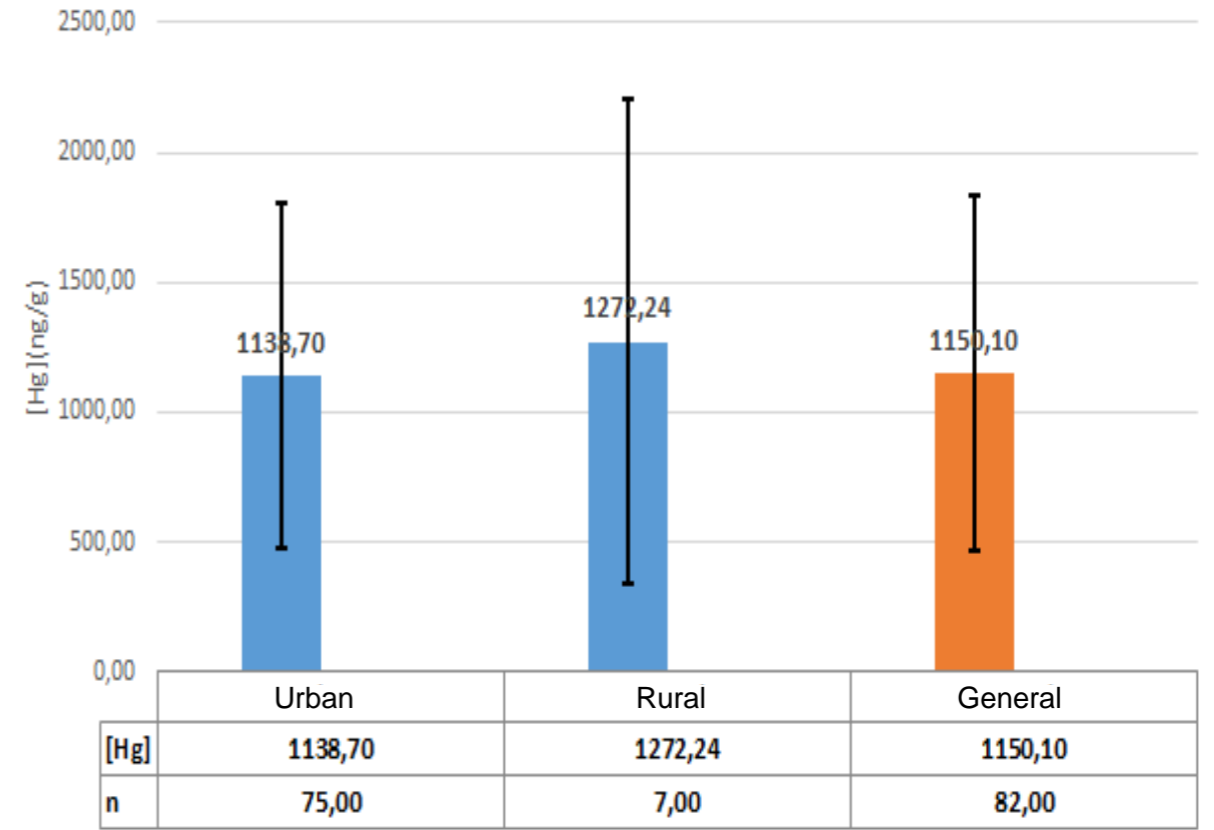
Compartimento do laboratório: _____

Consumíveis e Materiais de Utilização
2017
Janeiro

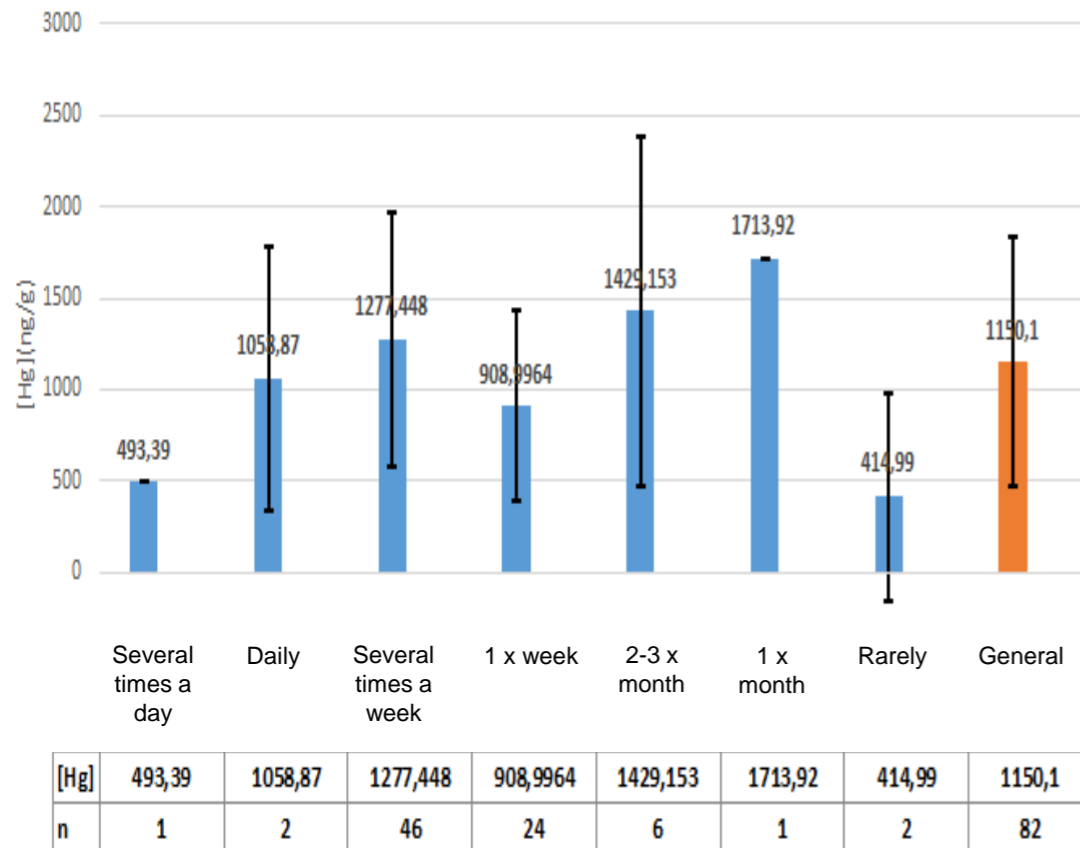
[Hg] Average by age



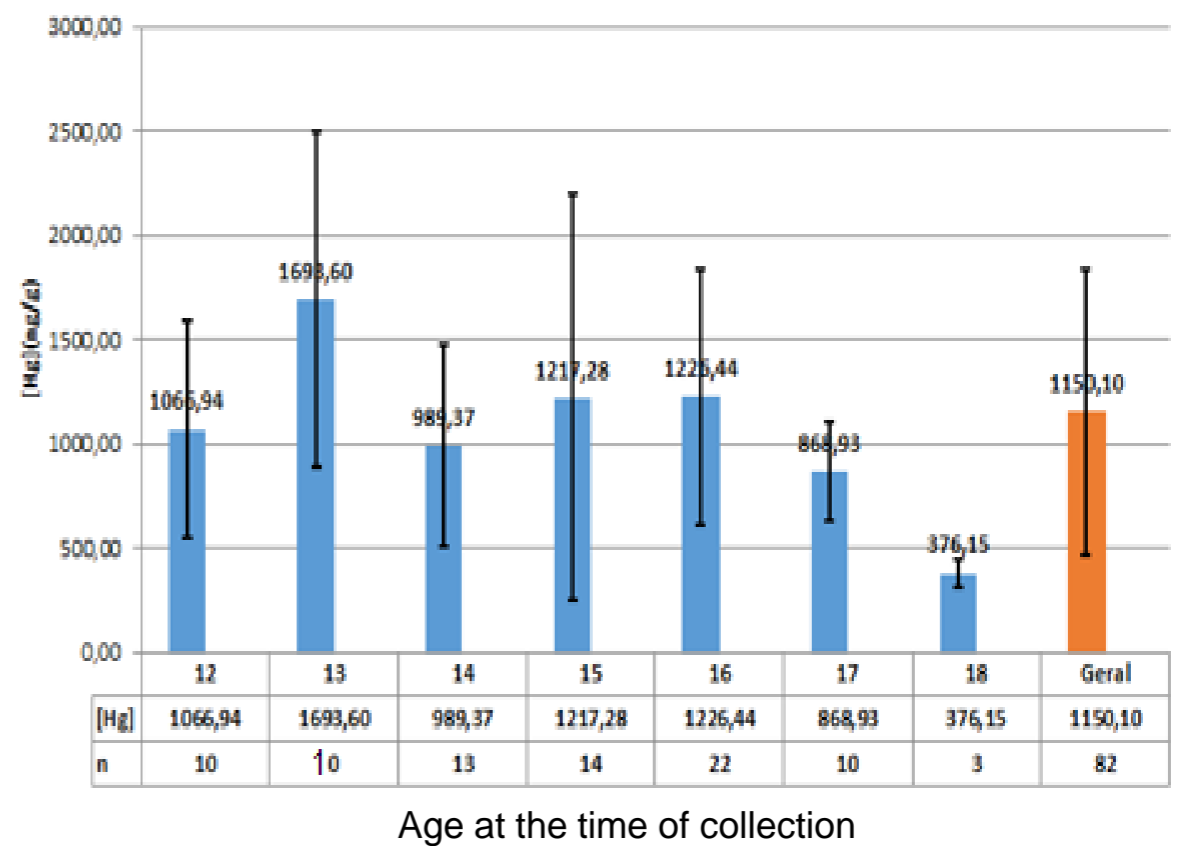
[Hg] Average per area of residence

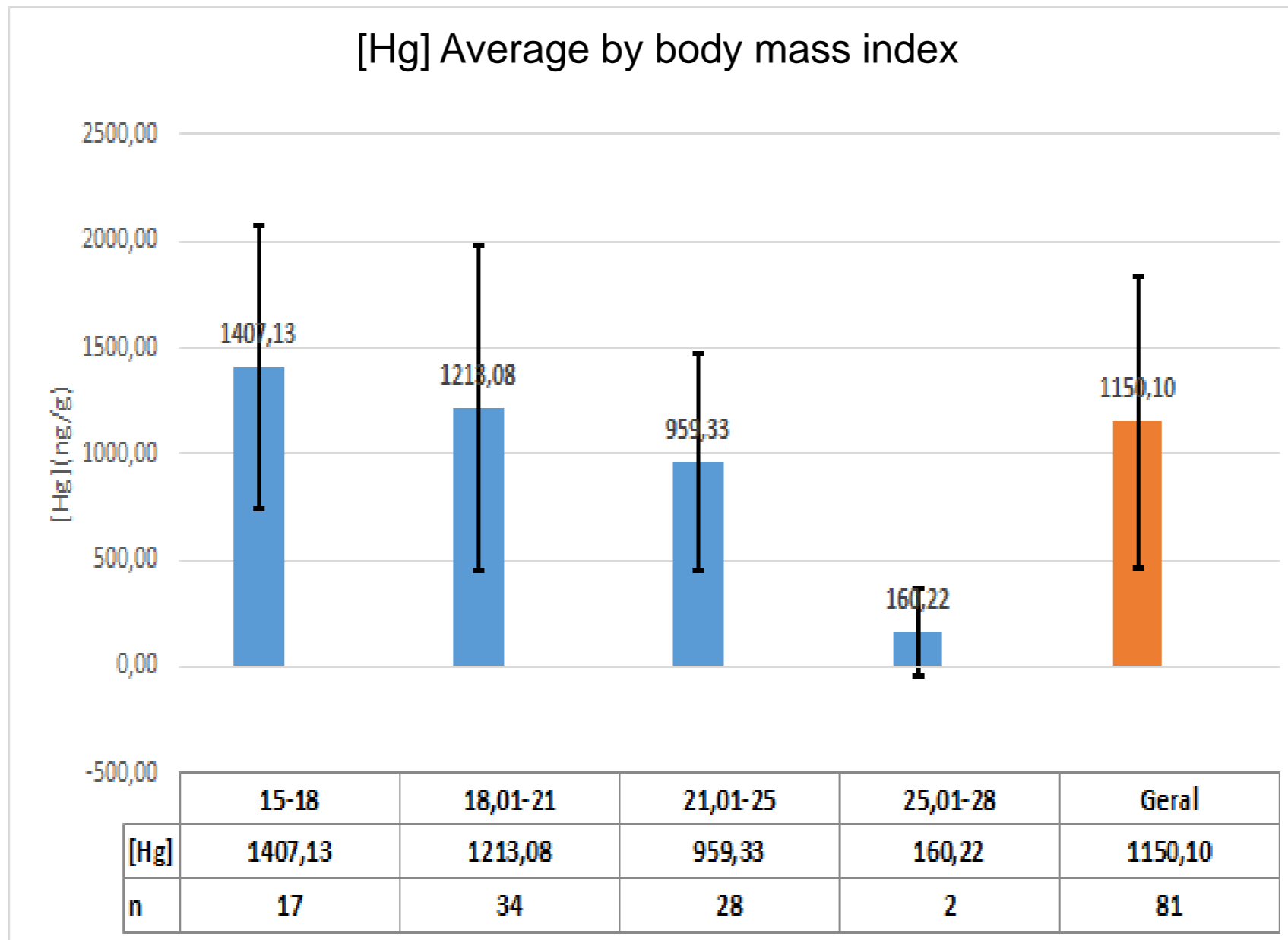


[Hg] Average per fish consumption



[Hg] Average for age



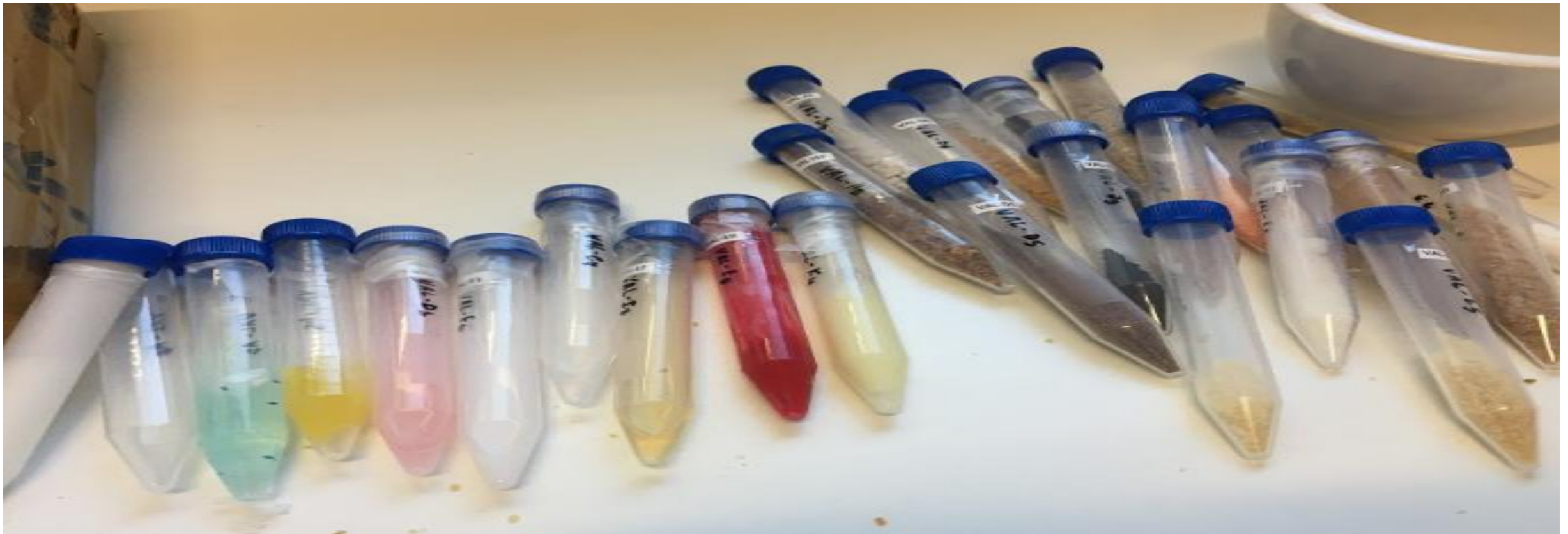


- Statistical analysis (Kruskal-Wallis test) shows a correlation between the individuals' body mass index and their mercury concentration.

Product analysis

We analyzed:

- **43** food products
- **48** cosmetics and hygiene products
- **4** office supplies











VAL-10
VAL-11
VAL-12
VAL-13
VAL-14

2



VAL-L9
VAL-L9

VAL-L9
VAL-L9

VAL-L9
VAL-L9

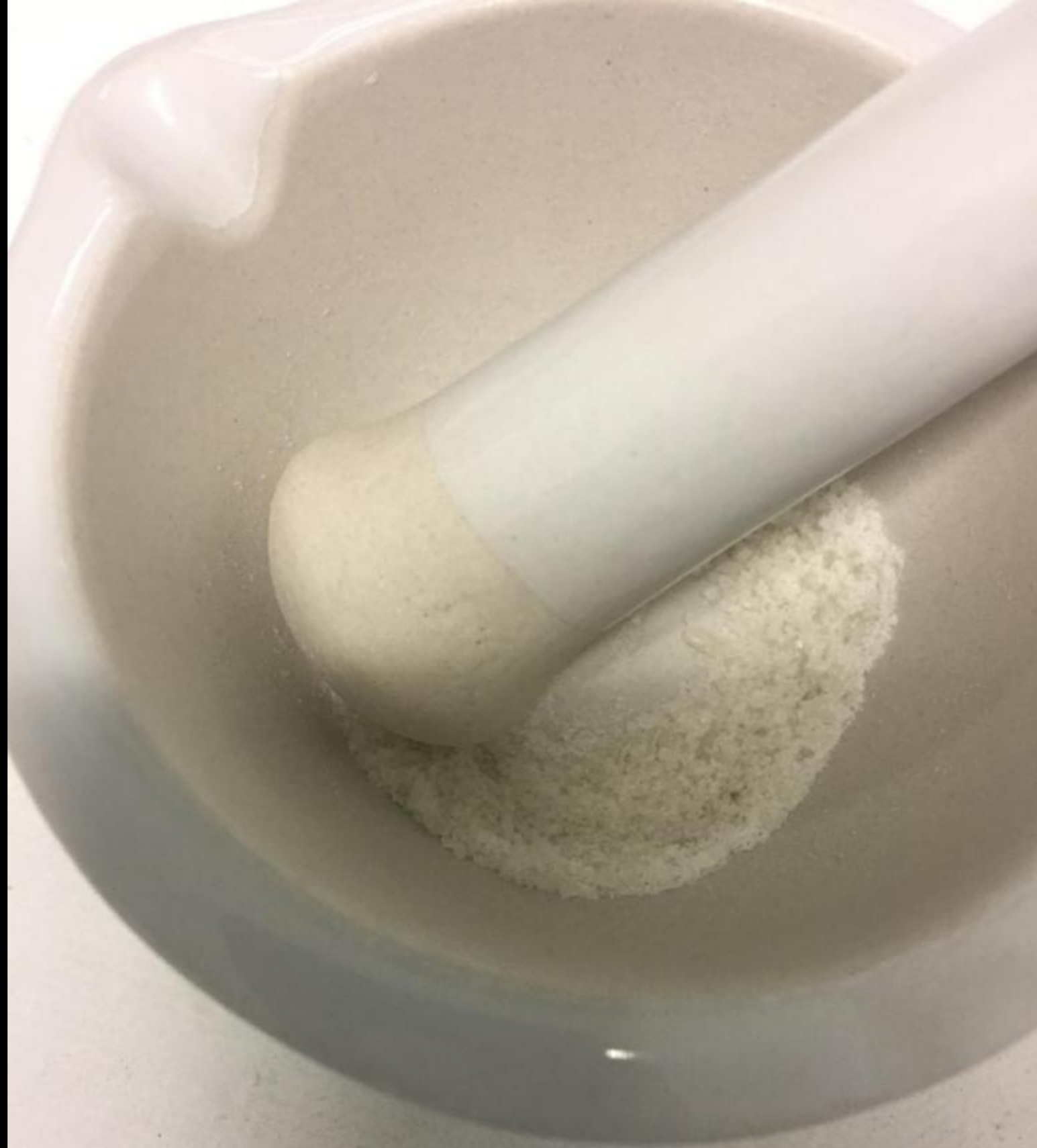
VAL-L9
VAL-L9

VAL-L9
VAL-L9

VAL-K1

VAL-K1





Product analysis



Product analysis



	Food products [Hg] (ng g ⁻¹)	Cosmetics and hygiene products [Hg] (ng g ⁻¹)	Office supplies [Hg] (ng g ⁻¹)
Average	6,95	0,39	3,93
Standard deviation	27,9	1,2	2,82
Minimum	0,04	0	1,21
Maximum	174,58	45	7,85
n (total)	43	48	4

Results and discussion



- The 82 hair samples analyzed revealed an average mercury concentration of **1150,10 ± 685,34 ng g⁻¹**. Mercury values varied between 12,6 and 3314,74 ng g⁻¹.
 - Our study found values similar to those published in other investigations, both in Portugal and abroad (although these studies sampled adults).
 - We'd like to emphasize our study's innovative nature. There haven't been any investigations conducted in Portugal which targeted such a young age group
-

Results and discussion



- When compared with the US EPA's reference value for mercury hair concentration, 1000 ng g^{-1} , **46% of the sampled students** have [Hg] **higher than this value**, beyond which there may be consequences to human health.
 - When compared with WHO's reference value, 2000 ng g^{-1} , **12% of students** have [Hg] **higher than this limit**.
 - A recent European study suggests that the reference limit should be $0,58 \text{ } \mu\text{g.g}^{-1}$ (Kirk, 2016). **83% of individuals** have a mercury concentration **superior to this value**.
-

Results and discussion



- **Our data suggests an inverse statistical correlation between the individuals' BMI and their mercury hair concentration (Kruskall-Wallis test).**
 - We recommend further studies on this topic, focusing on an age group similar to ours, since these people are (potentially) more susceptible to damage from mercury poisoning.
-

Results and discussion



- The product samples' analysis revealed that **fish is the main source of mercury contamination**. This data is consistent with the results found in previous investigations.
- The results obtained in the collected fish samples (174,58 ng g⁻¹ in a snapper and 36,58 ng g⁻¹ in a salmon) are inferior to the safe limit set by WHO of 500 ng g⁻¹. However, both species are known to usually contain low levels of mercury, therefore our results are to be expected.



Salmo salar ♂

Next steps



• When taking into consideration that everyone can be exposed to mercury, particularly through food consumption (mainly predatory fish), we recommend **the promotion of campaigns to raise awareness to this problem and to instill better dietary habits in the population**, in relation to which food to consume more often.

Study of the levels of Mercury in students aged 12 to 18 years old

When faced with this worrying issue, we developed a study in which we looked to evaluate the mercury contamination of 82 students in our school, through the analysis of the levels of this substance present in the participants' hair.

We also studied samples of ordinary products (food, hygiene products and cosmetics, office supplies).

The maximum safe level of Hg in human hair is, according to the US EPA, 1000 ng g⁻¹. 46% of the studied population (32 individuals) presented [Hg] higher than this value. Furthermore, a recent European study suggests that the reference value should be 0.58 µg g⁻¹ (Kirk, 2016). 83% of the volunteers exhibited a mercury concentration superior to this value.

This substance accumulates in body tissue and can't be excreted by the human body, which is why it is alarming to discover so many young people with extremely high levels of mercury in their organism.

Mercury, an invisible problem

Alonso Mota
Bernardo Alves
Júlio Leal

Year 12 Student in Science and Technology
Portugal

Mercury, an invisible problem

Mercury is a metal, liquid at ambient temperature and pressure. This element is present in the environment in several states, such as elemental mercury, and inorganic or organic species, like methylmercury. Mercury is present in nature due to natural processes like rock erosion and volcanic activity. However, most Hg existent derives from human activity. This compound is bioamplified through the food chain.

Mercury increases up the food chain

Mercury's bioamplification process in the food chain

Mercury and human health

Mercury is a toxic element, and its presence in the human organism can lead to damage in the nervous, neurological and cardiovascular systems, for example. This compound can be extremely dangerous due to the human body's incapacity to filter/excrete it. As such, absorbed mercury will remain and accumulate indefinitely in our bodies.

The dangers associated with mercury contamination led to the Minamata Convention, which attempts to safeguard human and environmental health against this element's debilitating effects.

One of the main sources of mercury exposure to humans is our diet, particularly fish consumption. However, medicine, cosmetics, garbage, and vegetables which come from contaminated soil can also be sources of exposure.

MAKE THE RIGHT DECISIONS!

- Highest in Mercury: Bluefin tuna, Walleye, Marlin, King mackerel
- Large Proportion: Blue Fish, Shark, Swordfish, Wild sturgeon, Opah, Bigeye tuna
- Lowest Levels of Mercury: Salmon, Tilapia, Shrimp, Tuna (canned light), Cod, Catfish

Mercury concentration in some common fish

Adapted from <https://www.epa.gov/mercury/food-and-water-mercury>

SIMPLE CALCULATOR

PROFILE:

Boys (10-19 y) ▼

CHOOSE YOUR WEEKLY INTAKE OF FISH

TUNA



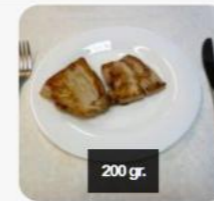
100 gr.

0 ▼



150 gr.

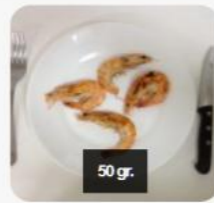
0 ▼



200 gr.

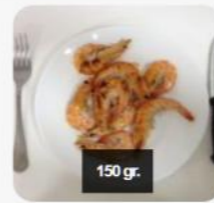
0 ▼

SHRIMP AND PRAWNS



50 gr.

0 ▼



150 gr.

0 ▼



300 gr.

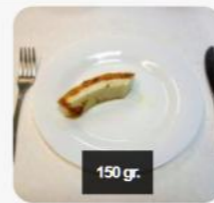
0 ▼

SQUID



100 gr.

0 ▼



150 gr.

0 ▼



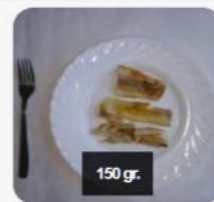
200 gr.

0 ▼

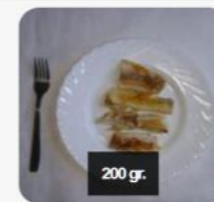
ALASKA POLLOCK



100 gr.

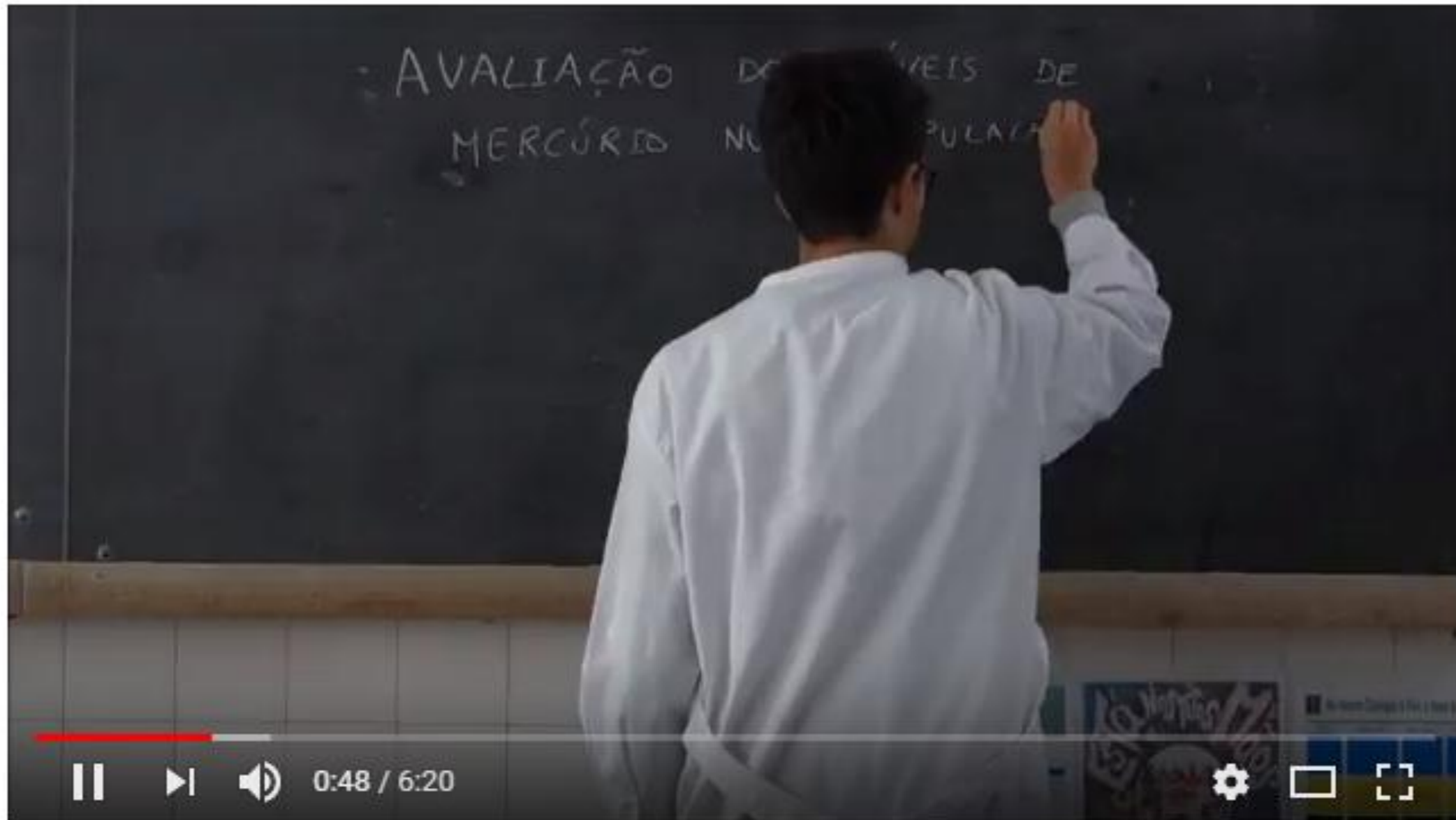


150 gr.



200 gr.

Video



Available in:

<https://www.youtube.com/watch?v=UCnD5IOBPao&t=46s>

Website

<http://escola.cvalsassina.pt/mercury>



Mercury

PROBLEM

MERCURY CYCLE

EXPOSURE

STUDY

PREVENTION

KEY FACTS

TEAM

VIDEO



Mercury, an invisible problem

Mercury is a metal, liquid at ambient temperature and pressure. This element is present in the environment in several states, such as elemental mercury, and inorganic or organic species, like methylmercury. Mercury is present in nature due to natural processes like rock erosion and volcanic activity. However, most Hg existent derives from human activity. This compound is bioamplified through the food chain.

Mercury is a toxic element, and its presence in the human organism can lead to damage in the nervous and cardiovascular systems, for example. This compound can be extremely dangerous due to the human body's incapacity to filter/excrete it. As such, absorbed mercury will accumulate in our bodies.

The dangers associated with mercury contamination led to the Minamata Convention, which attempts to safeguard human and environmental health against this element's debilitating effects.

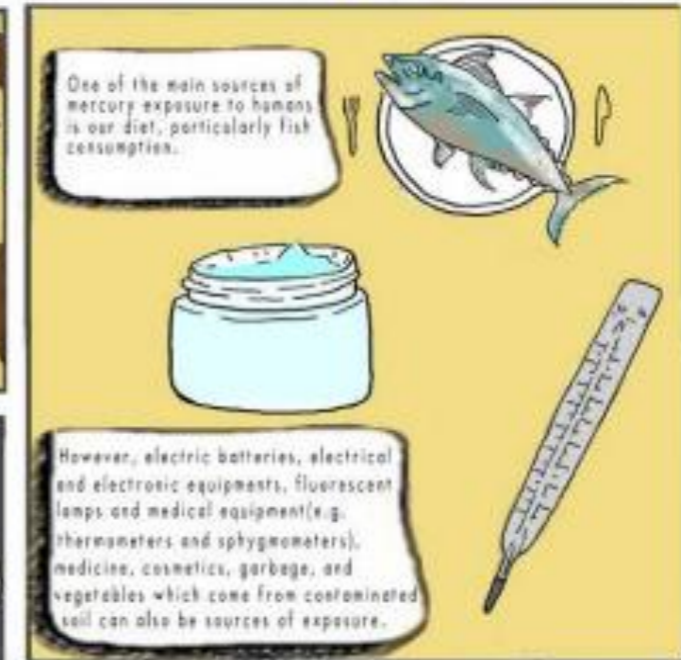
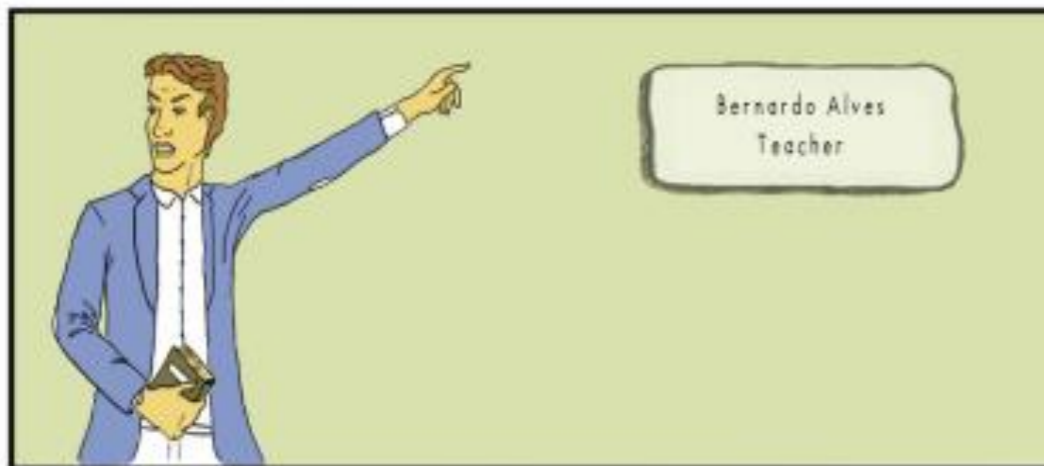
When faced with this worrying issue, we developed a study in which we looked to evaluate the mercury contamination of students in our school.

BD production to raise awareness

Mercury is a metal, liquid at ambient temperature and pressure. Mercury is present in nature due to natural processes like rock erosion and volcanic activity. However, most Hg existent derives from human activity. This compound is bioamplified through the food chain.

Mercury is a toxic element, and its presence in the human organism can lead to damage in the nervous, neurological and cardiovascular systems, for example. This compound can be extremely dangerous due to the human body's incapacity to filter/excrete it. As such, absorbed mercury will remain and accumulate indefinitely in our bodies. The dangers associated with mercury contamination led to the Minamata Convention, which attempts to safeguard human and environmental health against this element's debilitating effects.

This is a story of a family and a teacher, a fishseller and a pharmaceutical that as teenagers understood the risks of mercury and how society is unaware of this problem.



Final considerations



Some relevant points emerged from our study:

- **There's a need for more studies of this kind**
 - **How do we effectively prevent mercury exposure?**
 - **How do we educate the population to choose a healthier diet, particularly concerning fish?**
 - **Besides mercury, are we exposed to other metals or contaminants?**
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