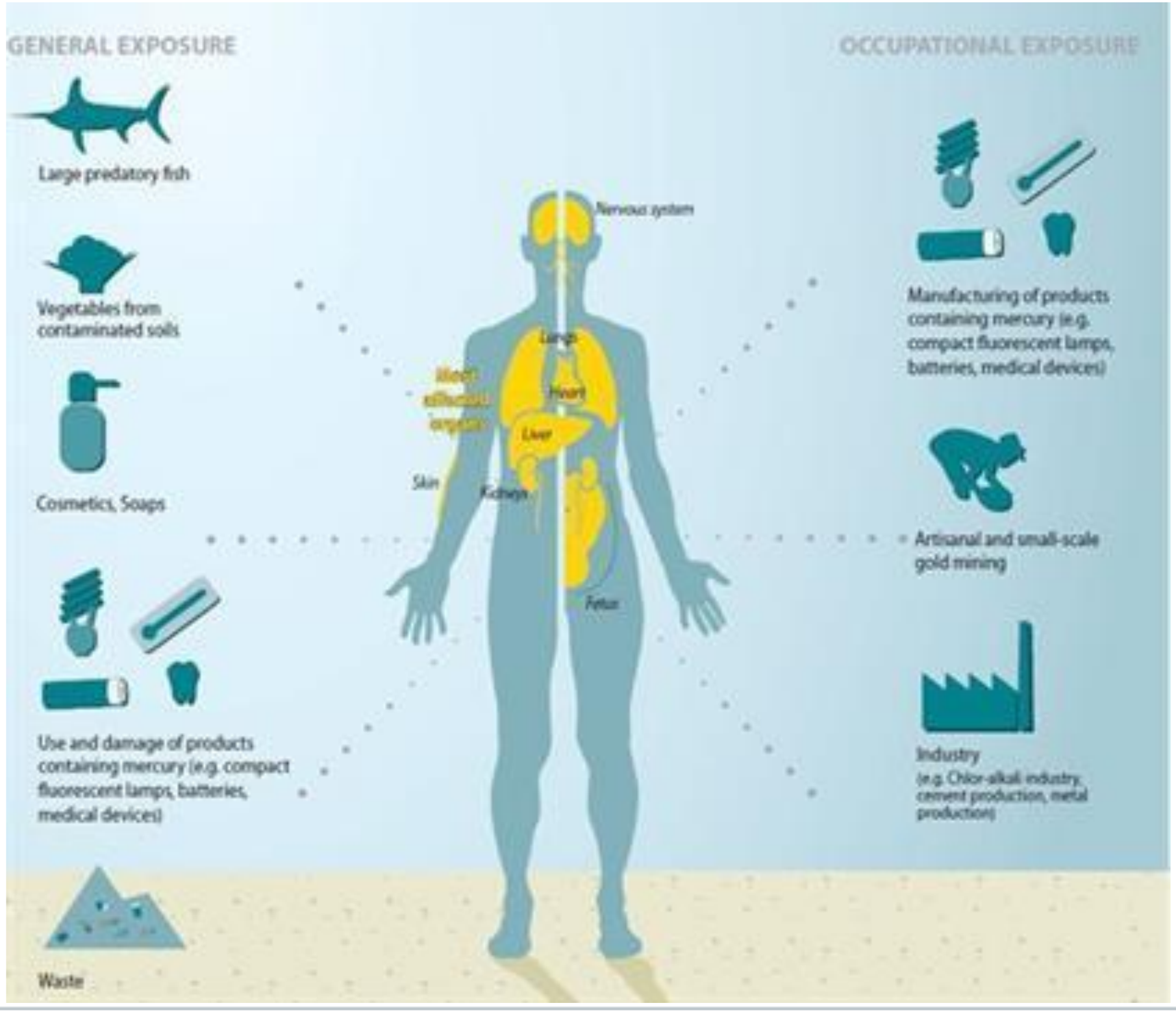
Assessment of the levels of mercury in students aged 12 to 18

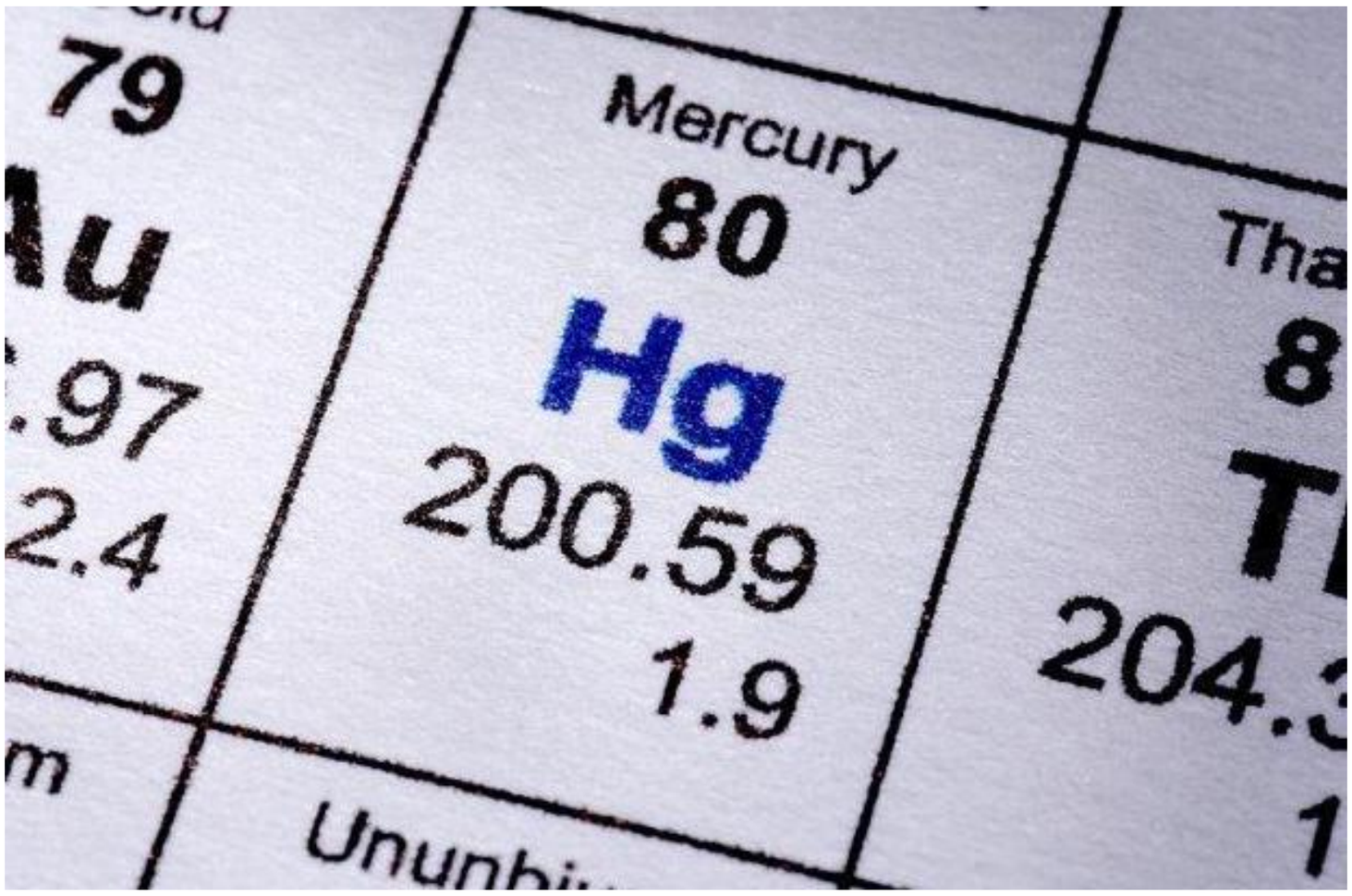
Afonso Mota, Bernardo Alves, João Leal
Portugal

Mercury exposure, an “invisible” problem



UN Environment Programme, Time to Act, 2013.

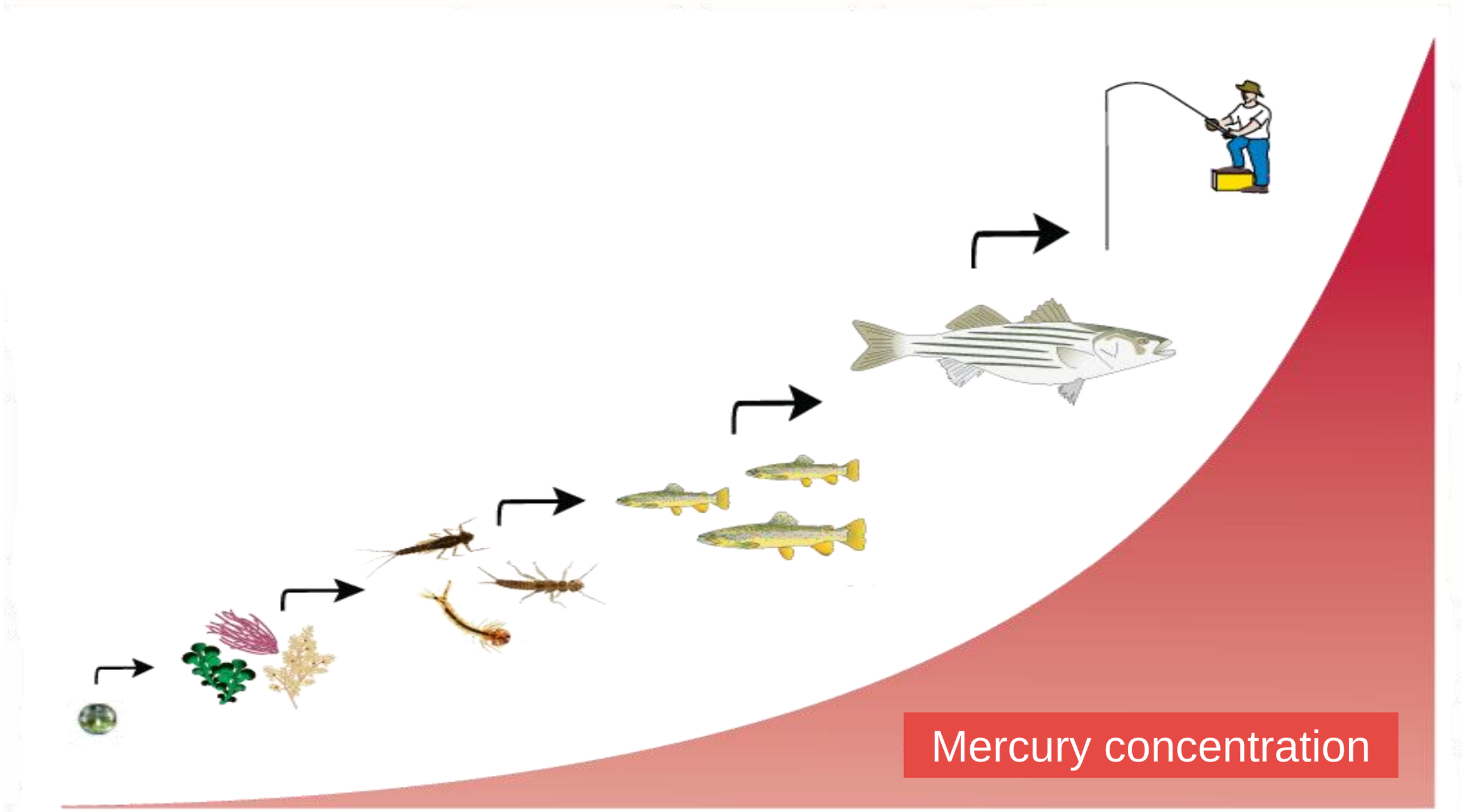
Mercury exposure



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

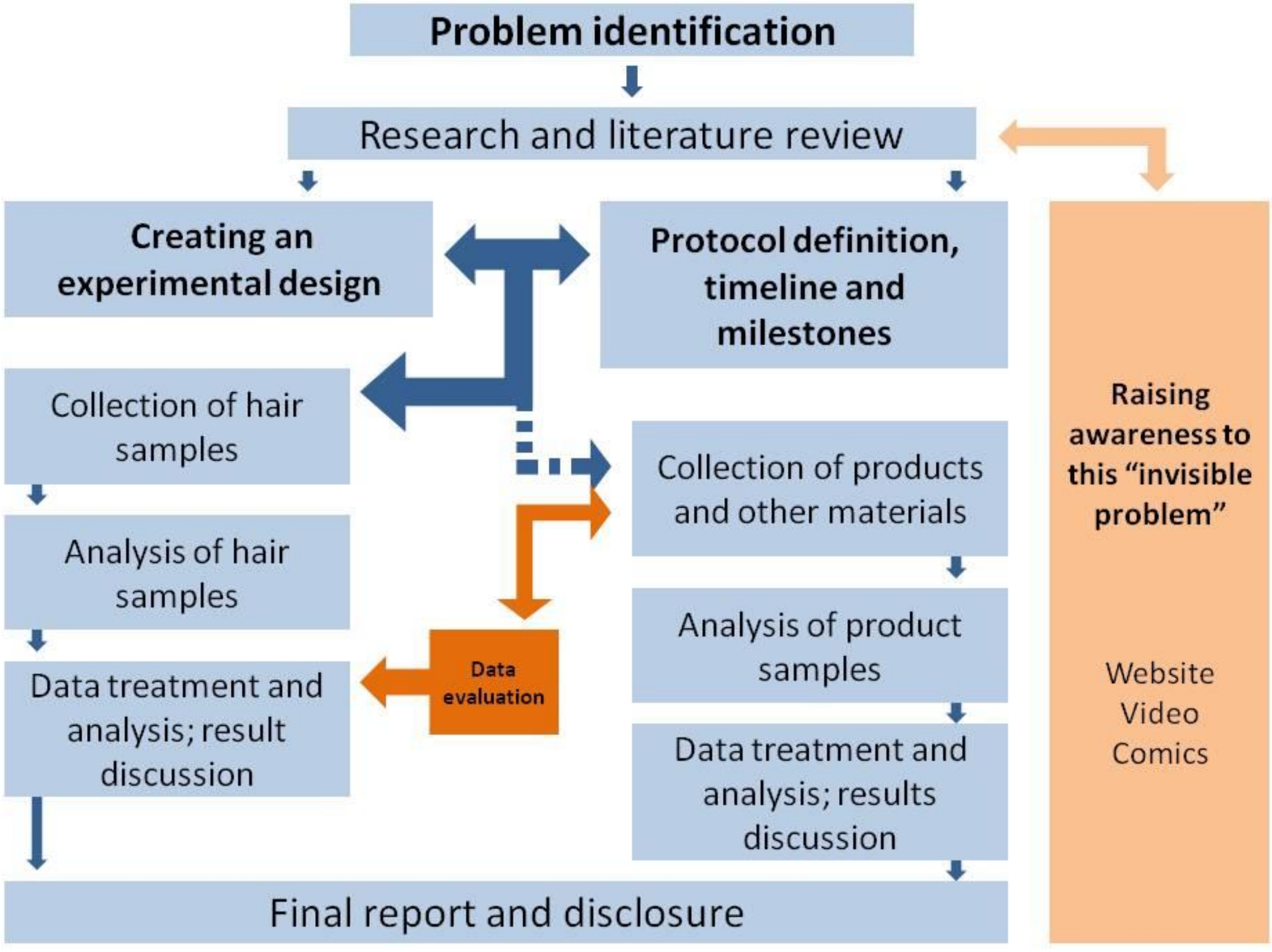
Source: Clarkson & Magos (2006).

COLÉGIO VALSASSINA



Source: http://www.publicnewsservice.org/

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.**

COLÉGIO VALSASSINA

Declaração

Para os devidos efeitos informamos que, em reunião da Direção Pedagógica do Colégio Valsassina, realizada no dia nove de janeiro de 2017, foi analisado o projeto de investigação intitulado "Avaliação dos níveis de mercúrio nos alunos do Colégio Valsassina", desenvolvido no âmbito da disciplina de Biologia, do Curso de Ciências e Tecnologias.

Pela sua importância, quer a nível científico, quer a nível académico e pedagógico para os alunos envolvidos, a Direção Pedagógica do Colégio Valsassina, aprovou por unanimidade o desenvolvimento do referido estudo.

Por ser verdade, se passa a presente declaração, que vai autenticada com o carimbo em uso no Colégio Valsassina.

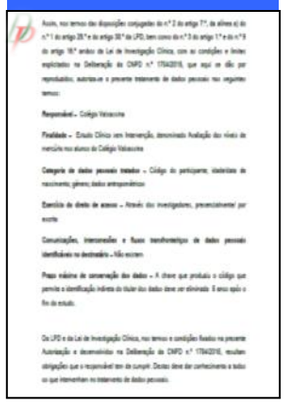
Colégio Valsassina, Lisboa, 9 de janeiro de 2017

O Diretor Pedagógico

João Valsassina Heitor

Methodology

Defining the target sample



Sample collection + Questionnaire

Projecto de investigação: Avaliação dos níveis de mercúrio nos alunos do Colégio Valsassina

CÓDIGO DA AMOSTRA: _____

QUESTIONÁRIO

1. Caracterização do indivíduo:

Sexo (M/F): _____

Peso (Kg): _____

Data de Nascimento: _____

Altura (m): _____

2. Localização geográfica da área de residência:

Localização: _____

Urbana ☐

Rural ☐

Industrial ☐

Outra: _____

3. Características do cabelo:

Liso ☐

Ondulado ☐

Encaracolado ☐

Outro _____

Natural ☐

Pintado ☐

Madeixas ☐

Comprimento do cabelo (cm): _____

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

Study sample

Hair sample analysis

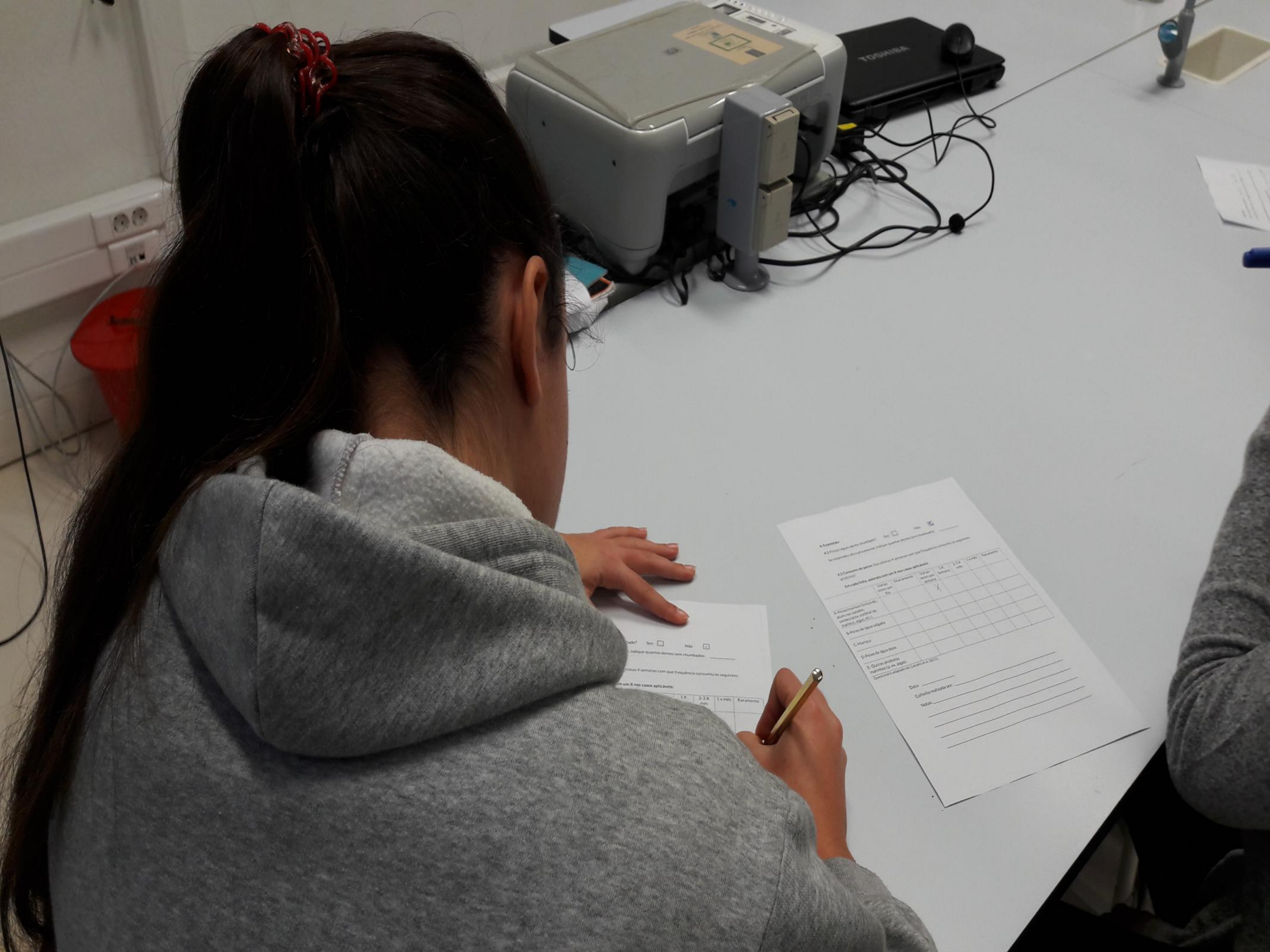
Education level	Number of students available to participate	Samples collected	Total per age group
7º	**9**	9	**32**
8º	**9**	9	
9º	**24**	14	
10º	**36**	17	**43**
11º	**25**	18	
12º	**13**	8	
Total	**116**	**Total (sample)**	**75**

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

Product sample analysis

Education level	Female	Male	Total
7º	1	1	2
8º	1	1	2
9º	1	1	2
10º	1	1	2
11º	1	1	2
12º	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**


TOSHIBA

NIC-MA-3000 (Nippon Instruments Corporation).


NIC
MA-3000
MERCURY ANALYZER

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

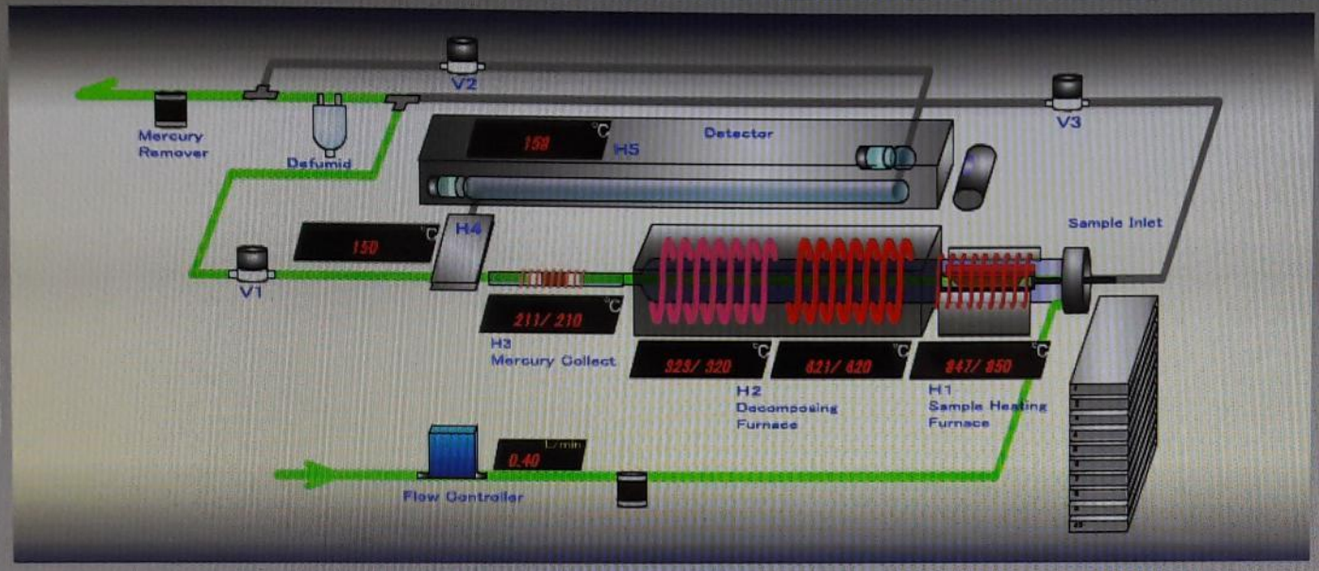
MA3Win-C:\Users\Mercurio\Desktop\Colegio Valsassina.MA3

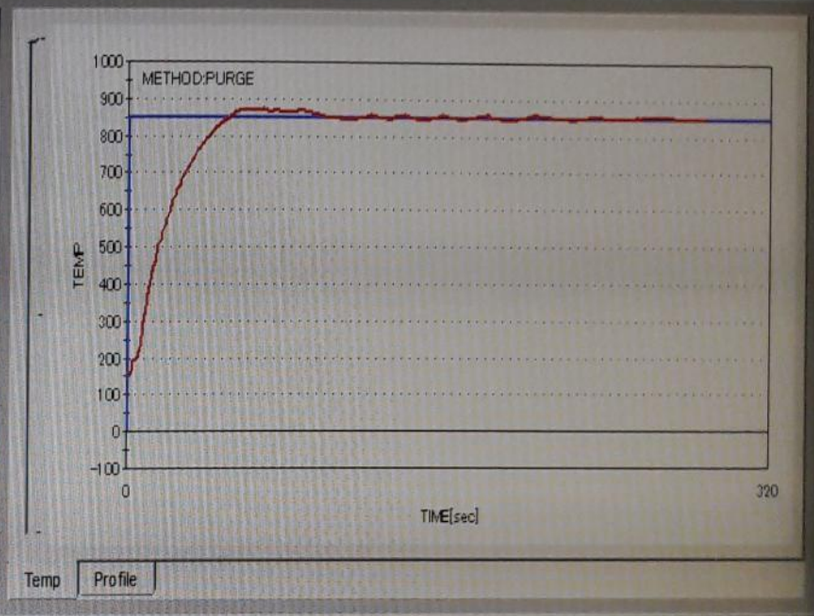
File Edit Run Table System Window Help

START STOP EMG STOP C.V PEAK AREA PEAK OFF ON DRIFT

Control

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





Temp Profile

Table

No.	MEAS	SAMPLE No.	METHOD	NAME	SVOL [mg]	ADD.STD [ng]	AREA[ON] LOW	AREA[ON] HIGH	MEAS [ng]	CONC [ppb]	ECOVER [%]	OX	RANGE	DATE	REMARKS
13	☐	10	ORGANISM(SOL	32A	10.200		9.08591	0.04764	11.492	1126.66667	-	o	HIGH	4/11 15:14	
14	☐	0	PURGE	BLANK CHECK			0.01786	0.00049	0.017		-	o	LOW	4/11 15:23	
15	☐	11	ORGANISM(SOL	32A-DUP	10.200		9.36688	0.05076	12.447	1220.29412	-	o	HIGH	4/11 15:31	
16	☐	0	PURGE	BLANK CHECK			0.02014	0.00079	0.020		-	o	LOW	4/11 15:40	
17	☐	12	ORGANISM(SOL	32B	10.000		9.71081	0.05406	13.458	1345.80000	-	o	HIGH	4/11 15:48	
18	☐	0	PURGE	BLANK CHECK			0.01132	0.00038	0.006		-	o	LOW	4/11 15:57	
19	☐	13	ORGANISM(SOL	33A	10.000		5.02569	0.02679	8.132	813.20000	-	o	LOW	4/11 16:04	
20	☐	14	ORGANISM(SOL	33B	10.500		7.68450	0.04215	9.810	934.28571	-	o	HIGH	4/11 16:12	
21	☐	15	ORGANISM(SOL	34	9.300		7.77226	0.04031	9.247	994.30108	-	o	HIGH	4/11 16:20	
22	☐	16	ORGANISM(SOL	35	3.900		3.42093	0.01847	5.532	1418.46154	-	o	LOW	4/11 16:27	
23	☐	17	ORGANISM(SOL	36	11.000		11.75973	0.06247	16.034	1457.63636	-	o	HIGH	4/11 16:35	
24	☑	0	PURGE	BLANK CHECK											
25	☑	18	ORGANISM(SOL	37A	10.700										
26	☑	19	ORGANISM(SOL	37B	9.600										

STD SMP

ROM: 2.1.0

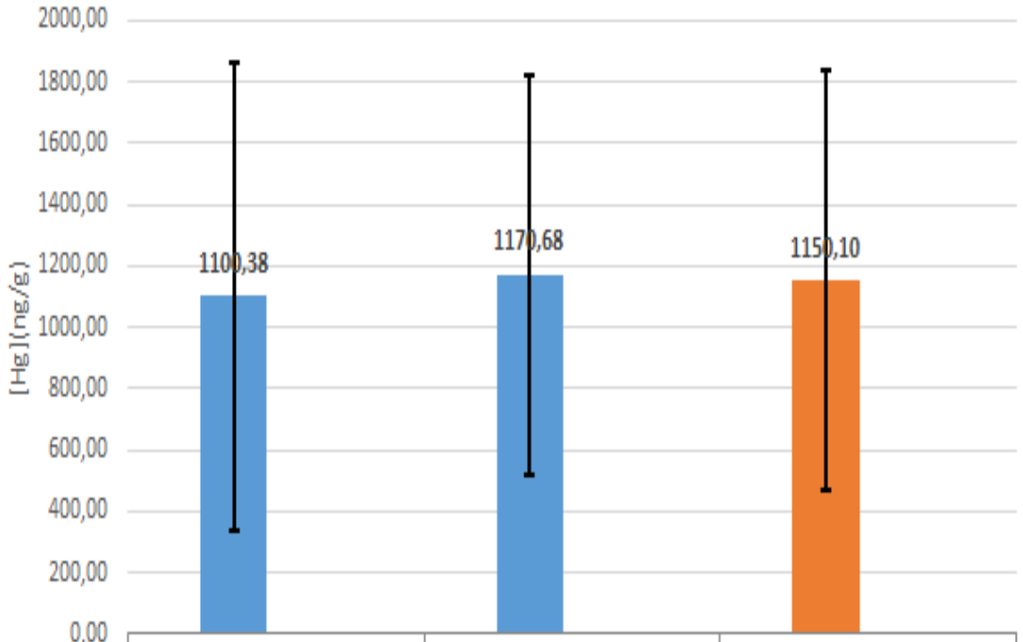
ATOMIZE-3 00:32 / 02:34

POR 16:42 11-Apr-17

Results (hair samples)

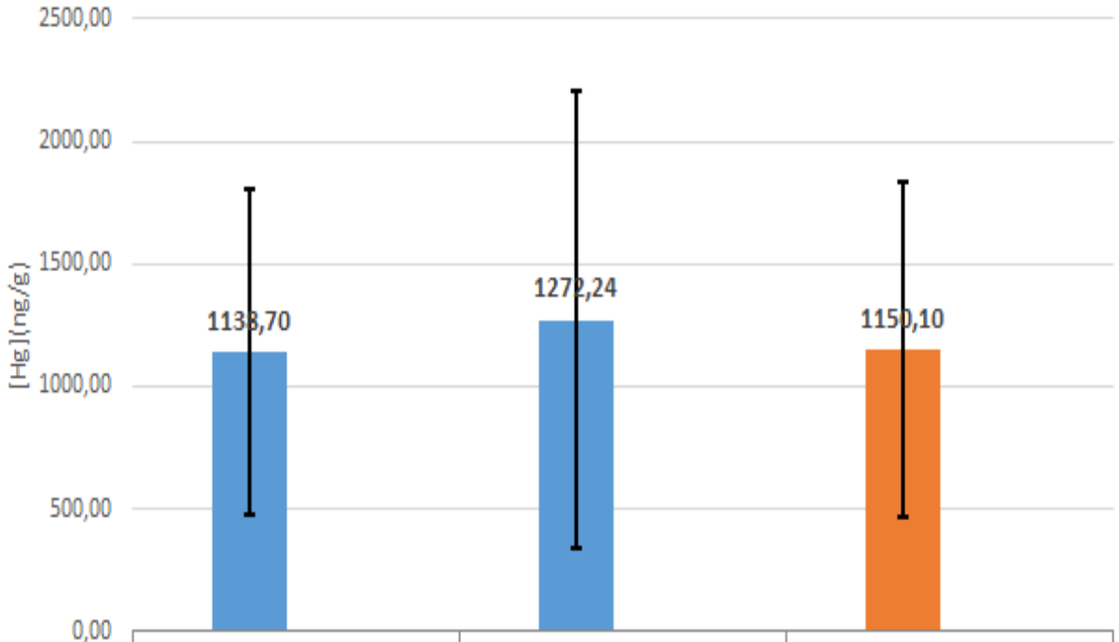
	Hair length(cm)	Age (years)	Body mass index (BMI)	[Hg] (ng g^{-1})
Average	29,19	14,85	20,19	**1148,48**
Standard deviation	17,66	1,69	2,40	**688,57**
Minimum	2,00	12,00	15,06	**12,6**
Maximum	70,00	18,00	26,96	**3314,74**
N (total)	70	70	70	**82**

[Hg] Average by age



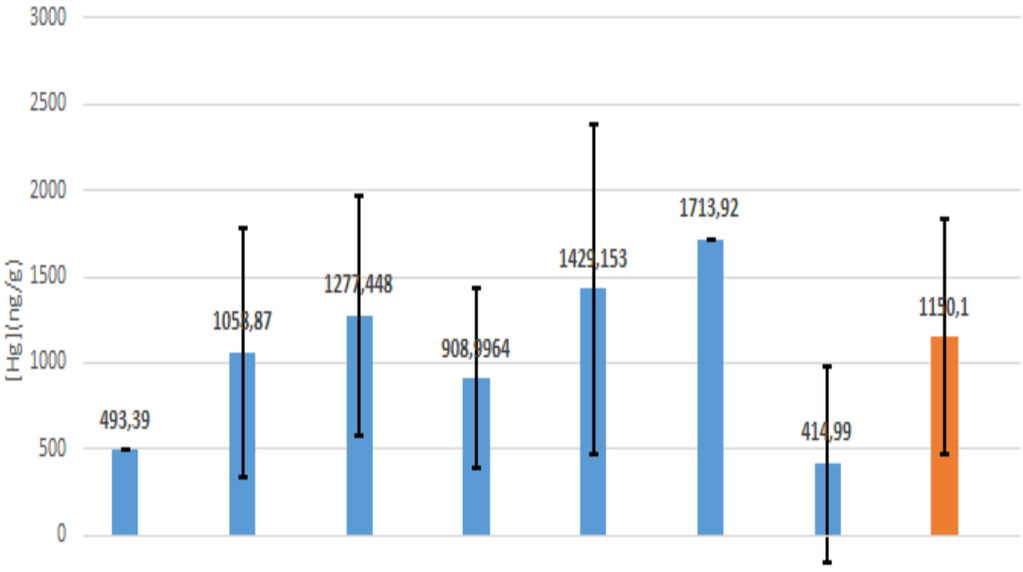
	Male	Female	General
[Hg]	1100,38	1170,68	1150,10
n	24	58	82

[Hg] Average per area of residence



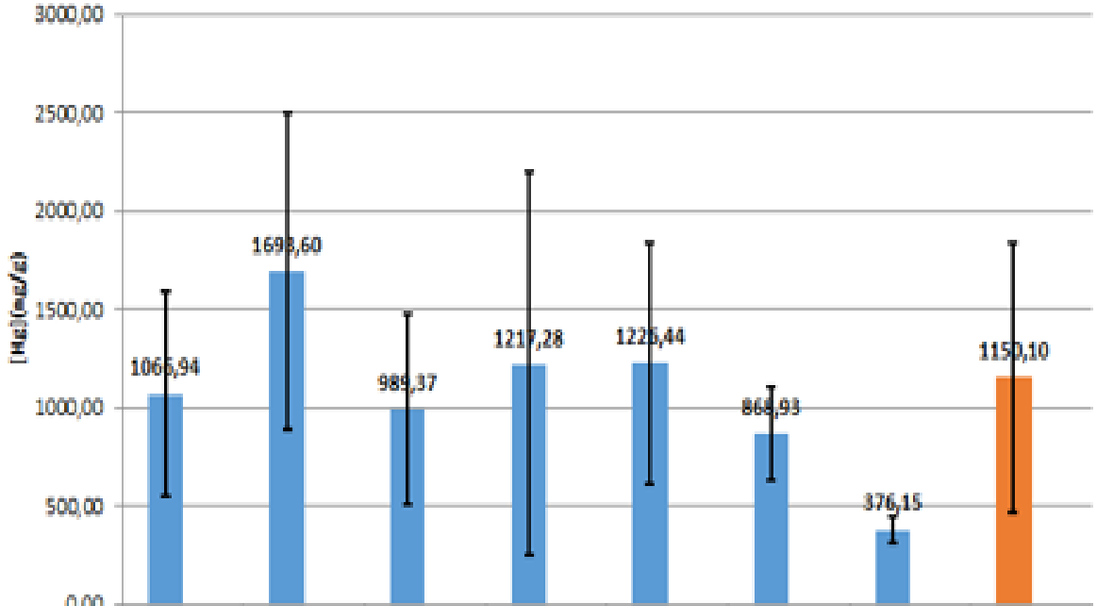
	Urban	Rural	General
[Hg]	1138,70	1272,24	1150,10
n	75,00	7,00	82,00

[Hg] Average per fish consumption



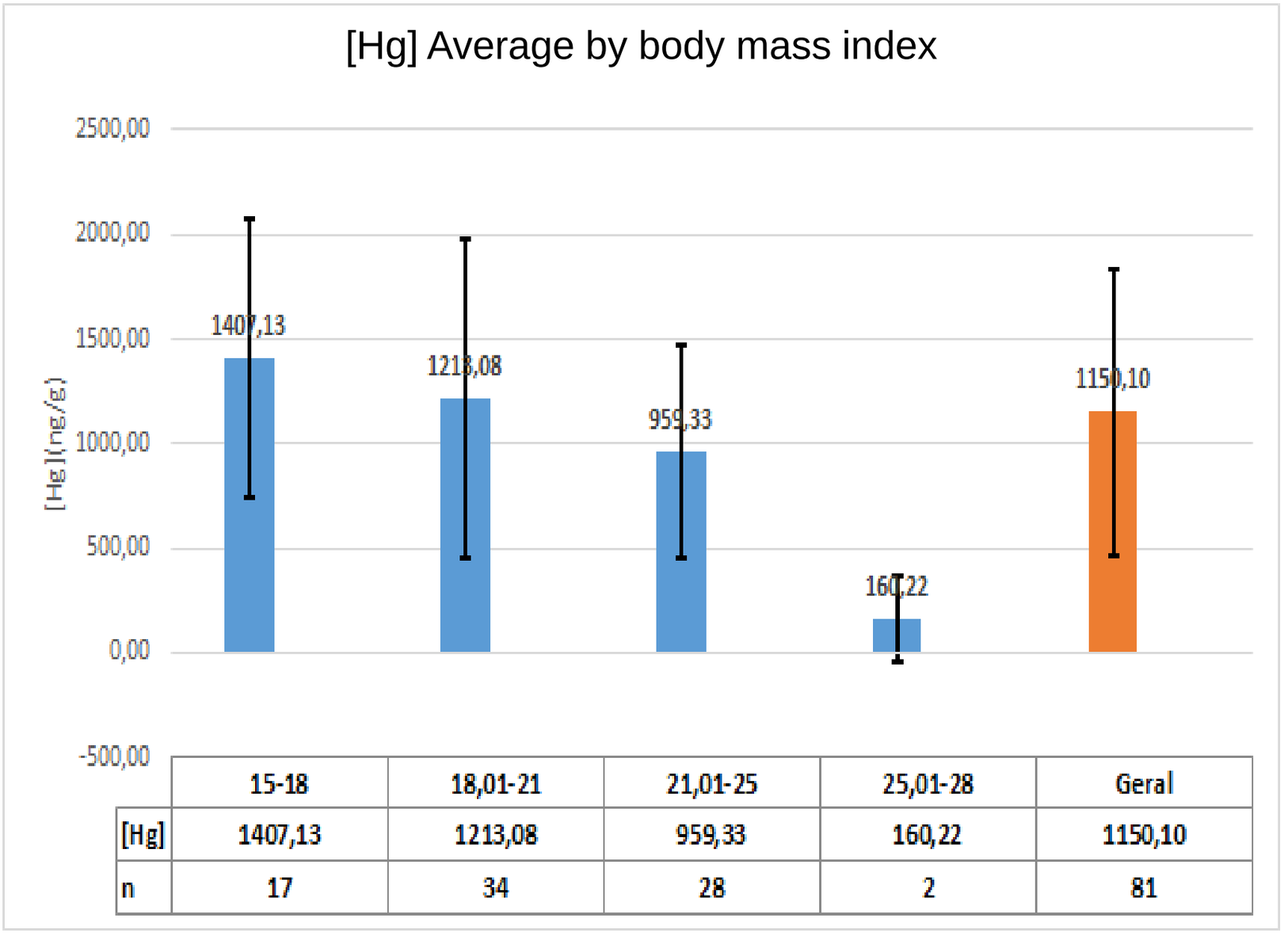
	Several times a day	Daily	Several times a week	1 x week	2-3 x month	1 x month	Rarely	General
[Hg]	493,39	1058,87	1277,448	908,9964	1429,153	1713,92	414,99	1150,1
n	1	2	46	24	6	1	2	82

[Hg] Average for age



	12	13	14	15	16	17	18	Geral
[Hg]	1066,94	1693,60	989,37	1217,28	1226,44	868,93	376,15	1150,10
n	10	10	13	14	22	10	3	82

Age at the time of collection



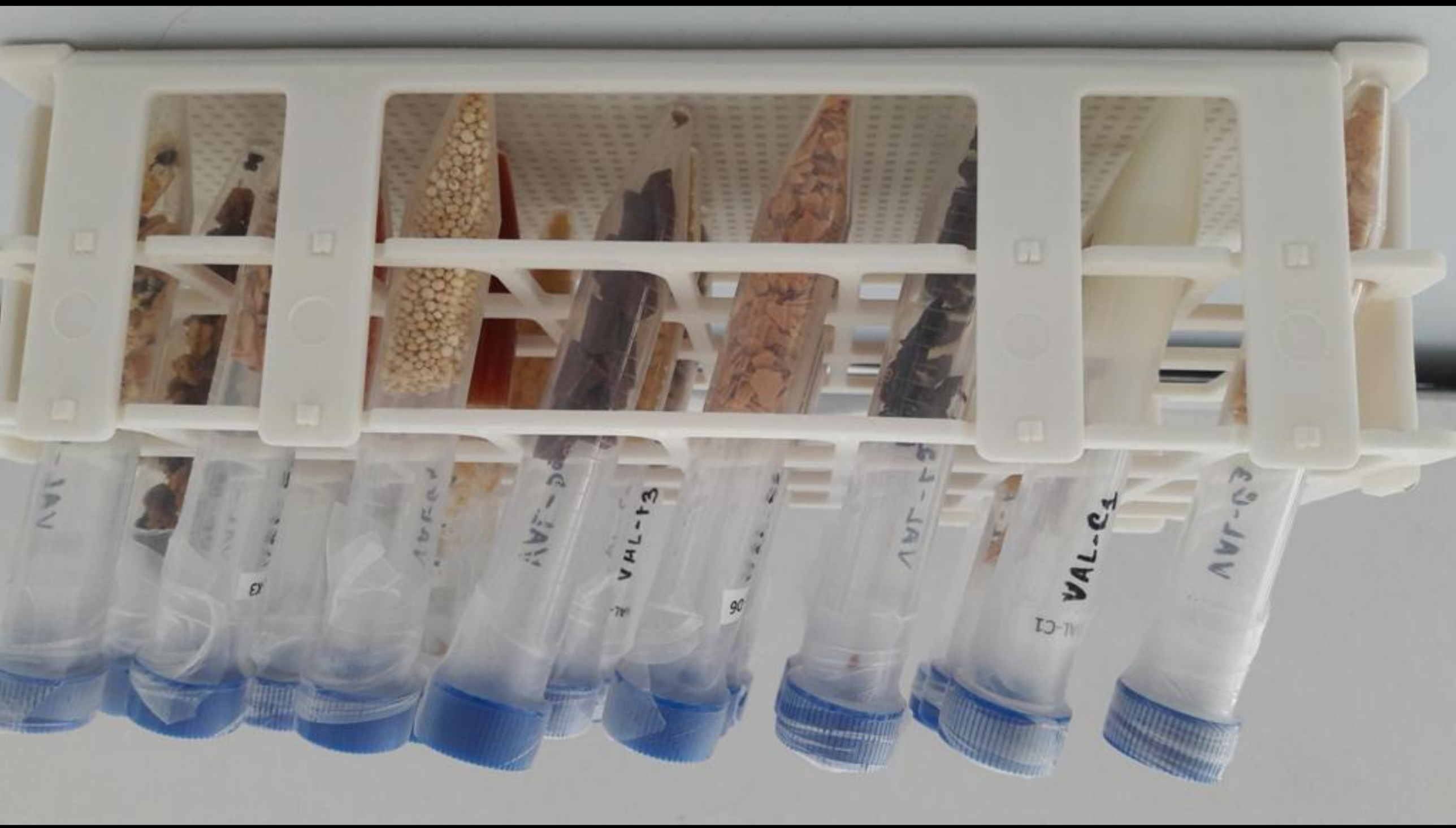
	15-18	18,01-21	21,01-25	25,01-28	Geral
[Hg]	1407,13	1213,08	959,33	160,22	1150,10
n	17	34	28	2	81

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

Product analysis

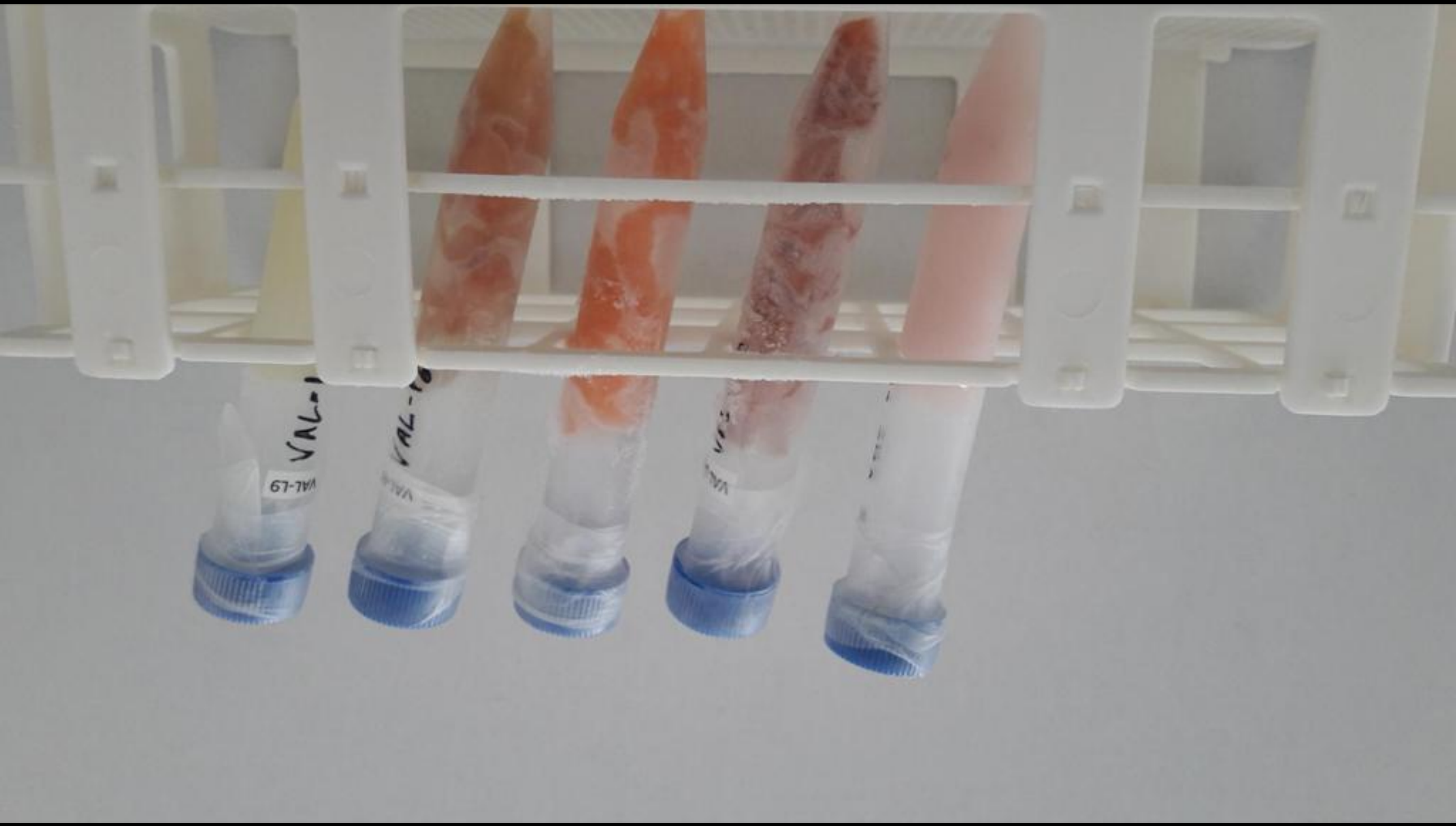
We analyzed:

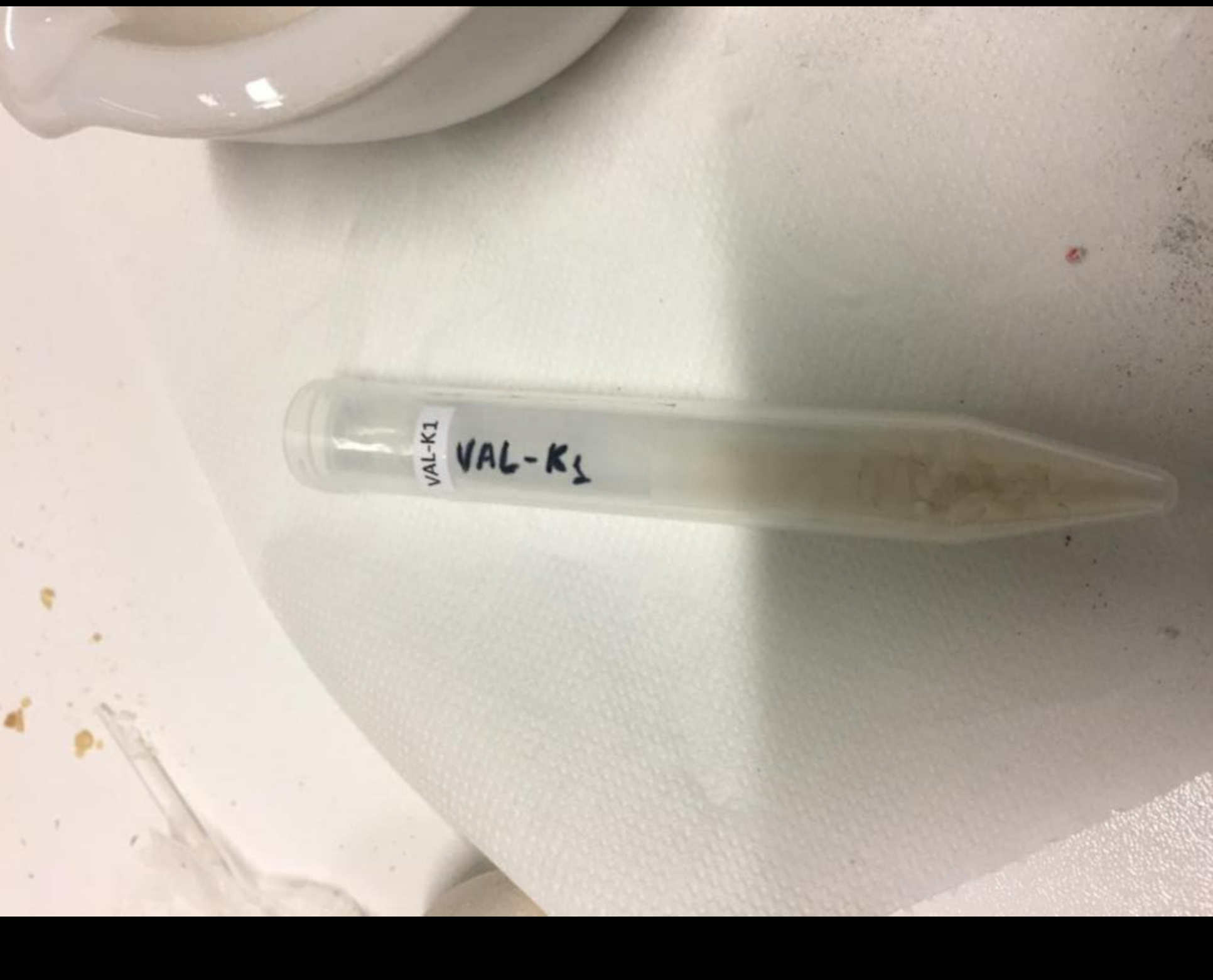
- **43** food products
- **48** cosmetics and hygiene products
- **4** office supplies

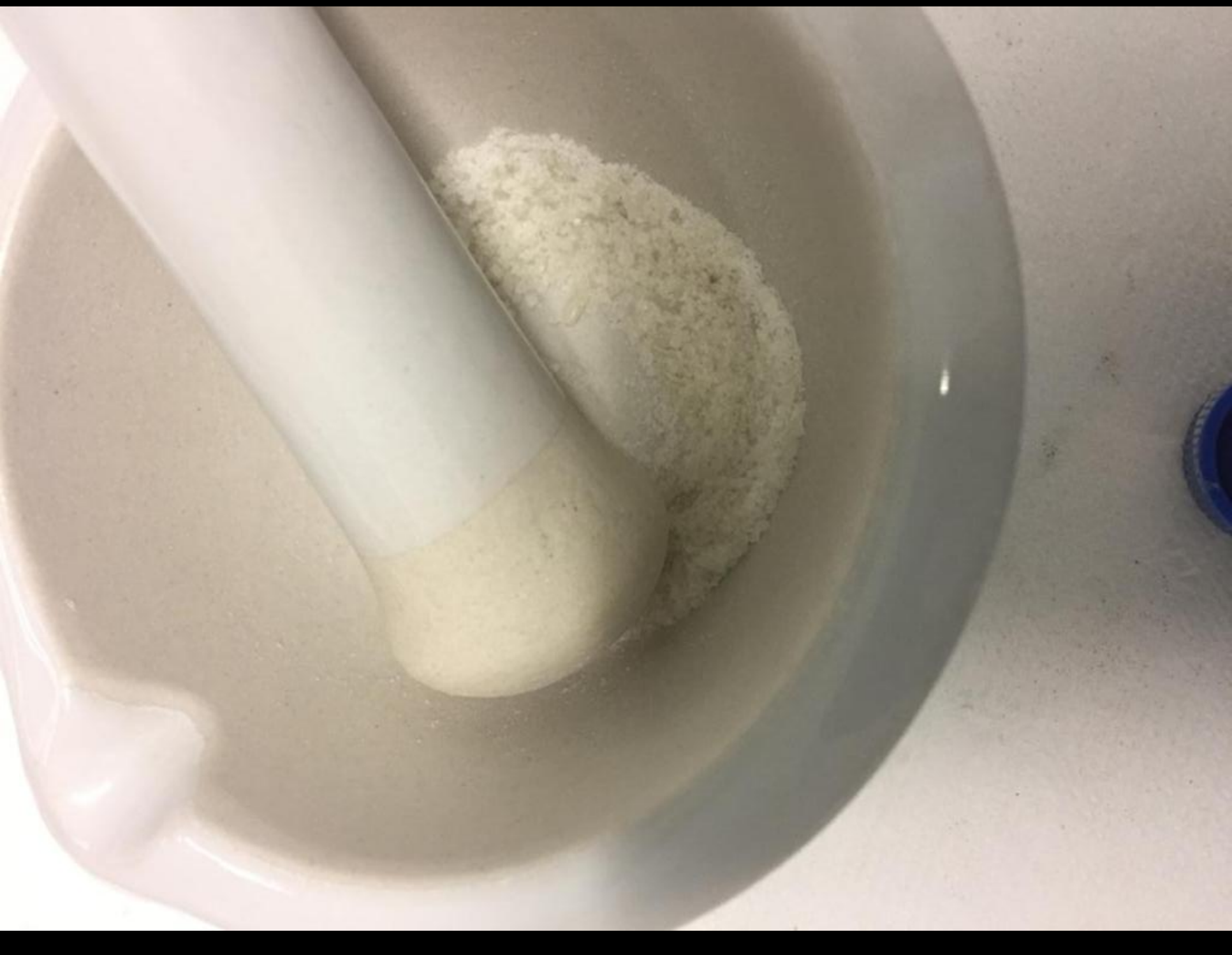

VAL-C1
VAL-C3


VAL-K10
VAL-K2
VAL-D5


VAL-L9
VAL-L9


VAL-19


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 µg.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.

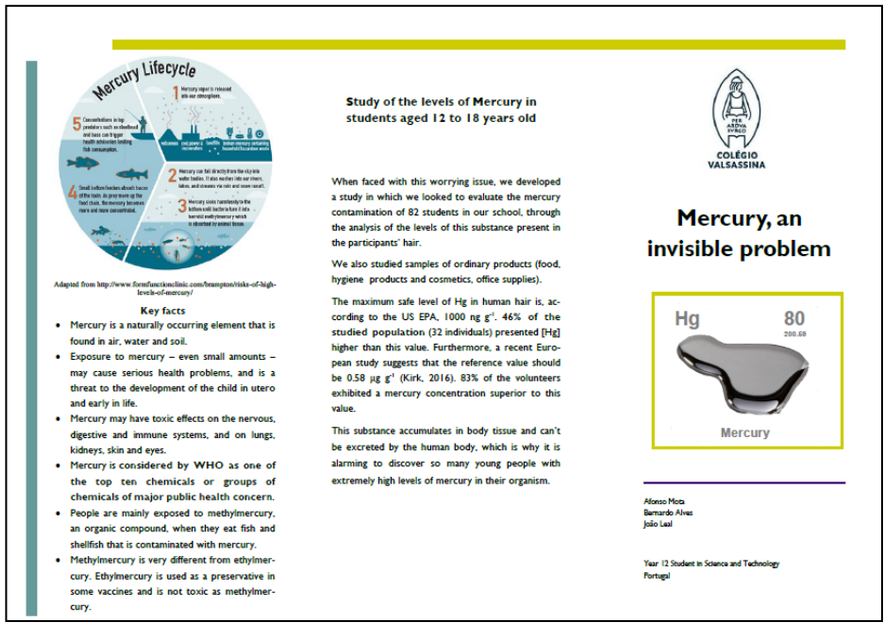
Results and discussion

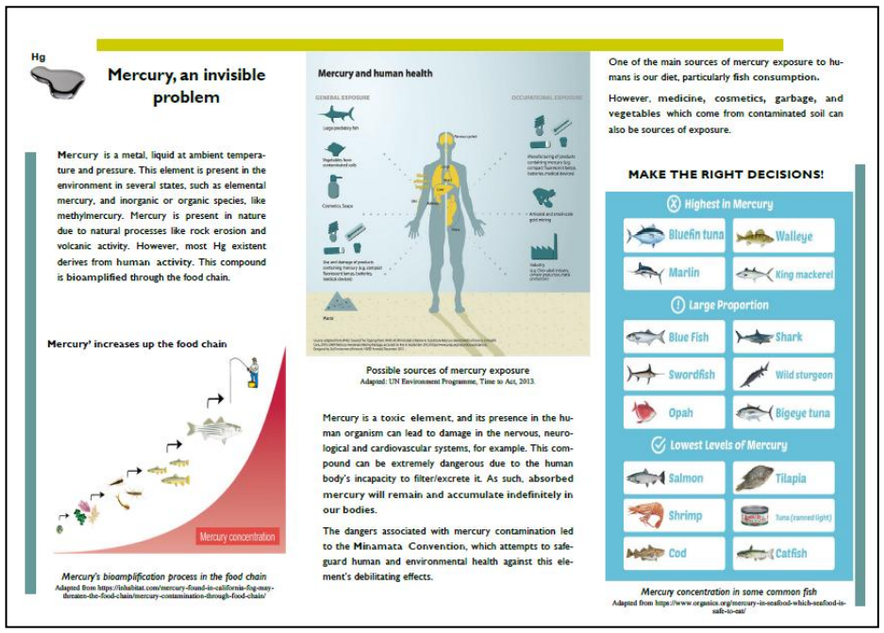
• The product samples' analysis revealed that **fish is the main source of mercury contamination**. This data is consistent with the results found in previous investigations.

• 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.

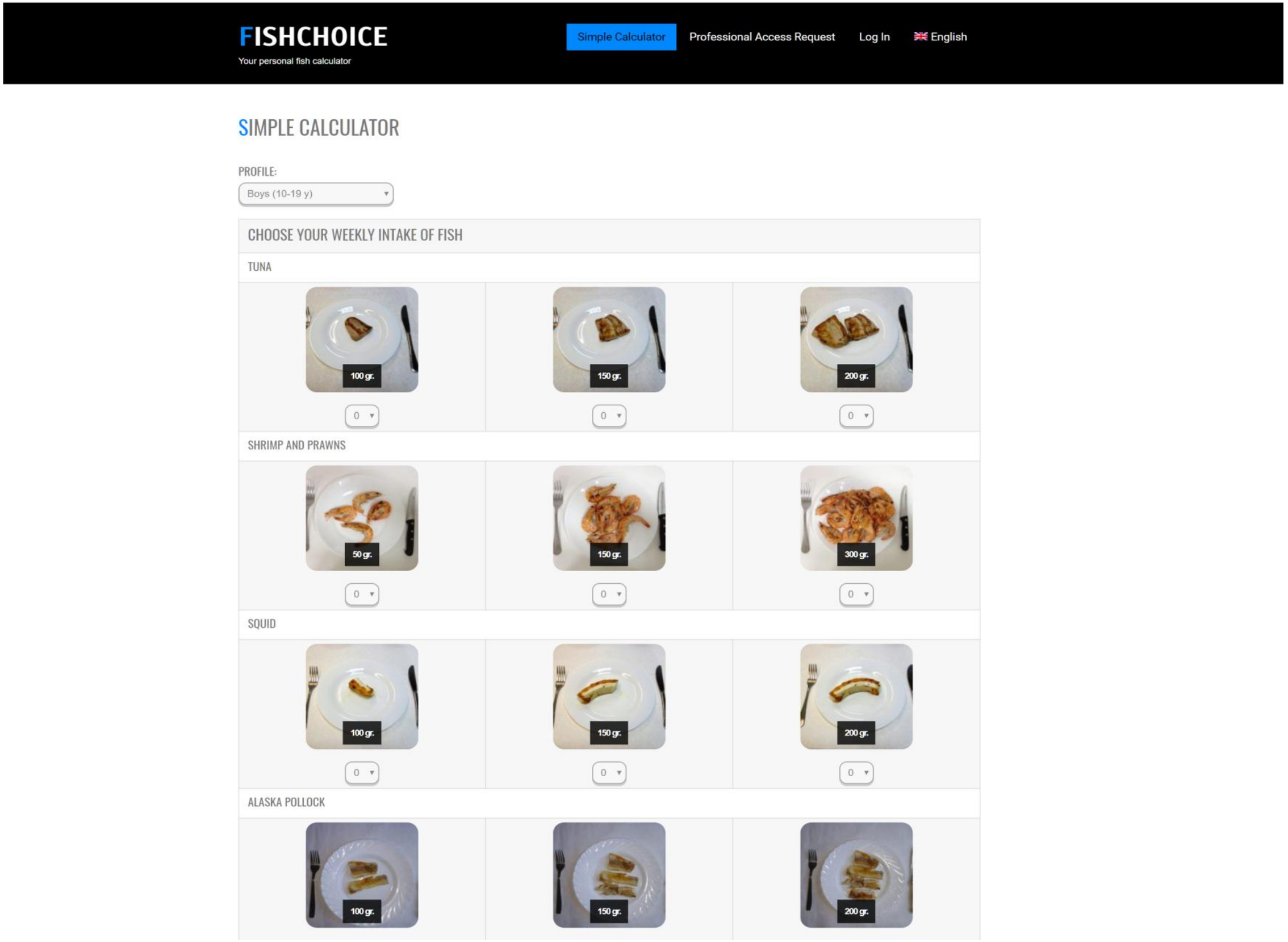
Next steps

• 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.

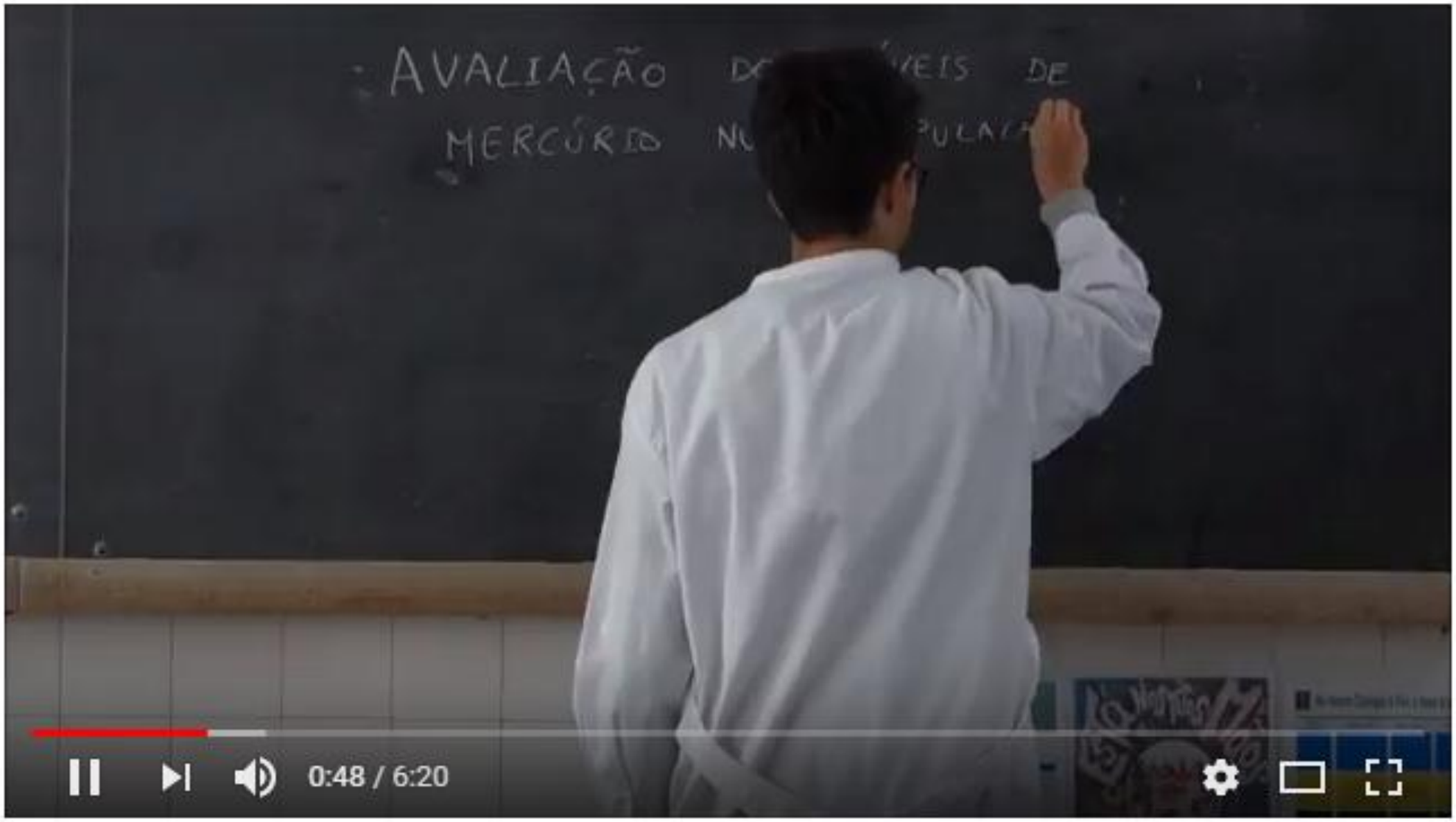




http://www.fishchoice.eu/calculator/



Video



Available in:

https://www.youtube.com/watch?v=UCnD5lOBPao&t=46s

Website

http://escola.cvalsassina.pt/mercury

COLÉGIO VALSASSINA

Mercury, an invisible problem

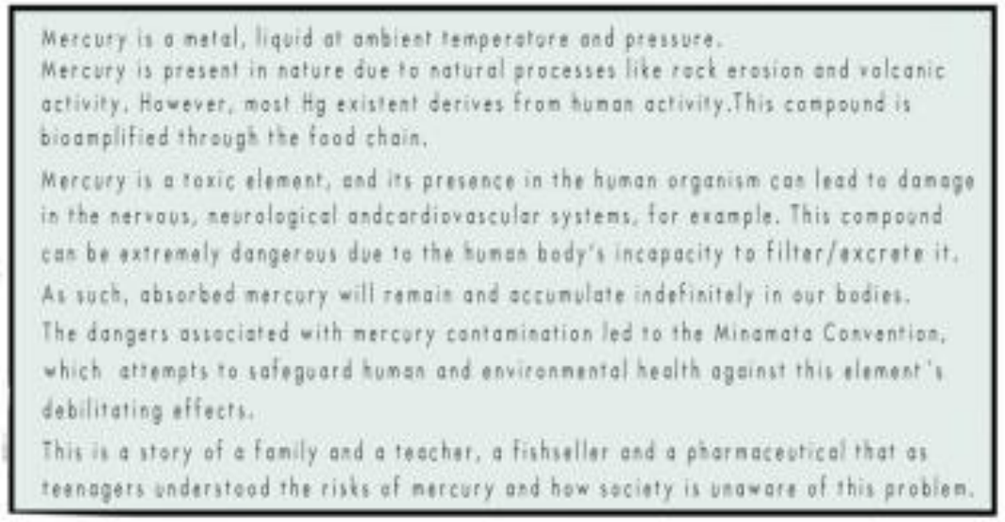
Mercury is a metal, liquid at ambient temperature and pressure. This element is present in the environment in several states, such as elemental mercury, and inorganic or organic species, like methylmercury. Mercury is present in nature due to natural processes like rock erosion and volcanic activity.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

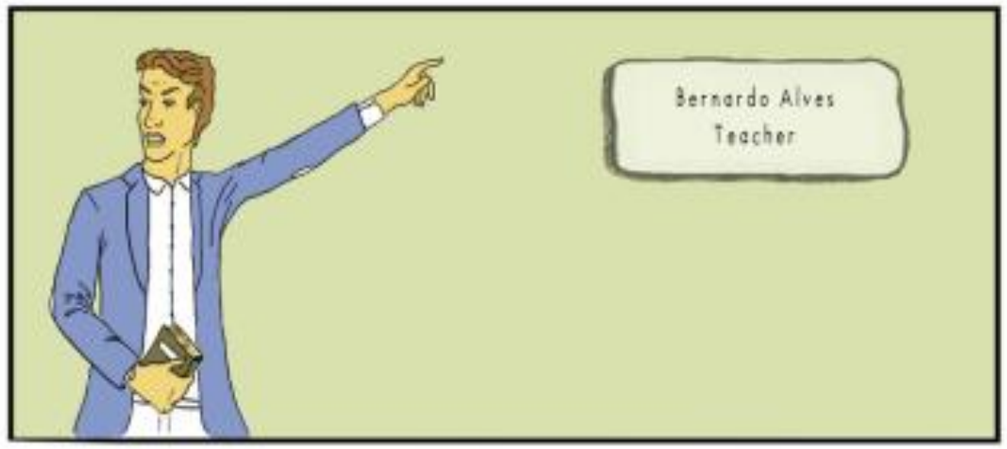
Mercury is a toxic element, and its presence in the human organism can lead to damage in the nervous and cardiovascular systems, for example. This compound can be extremely dangerous due to the human body's incapacity to filter/excrete it. As such, absorbed mercury will accumulate in our bodies.

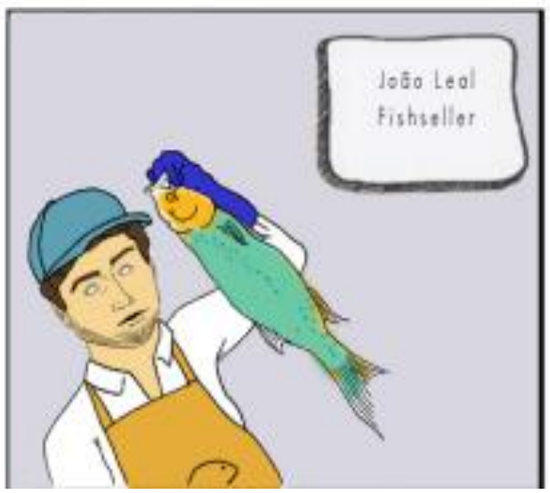
The dangers associated with mercury contamination led to the Minamata Convention, which attempts to safeguard human and environmental health against this element's debilitating effects.

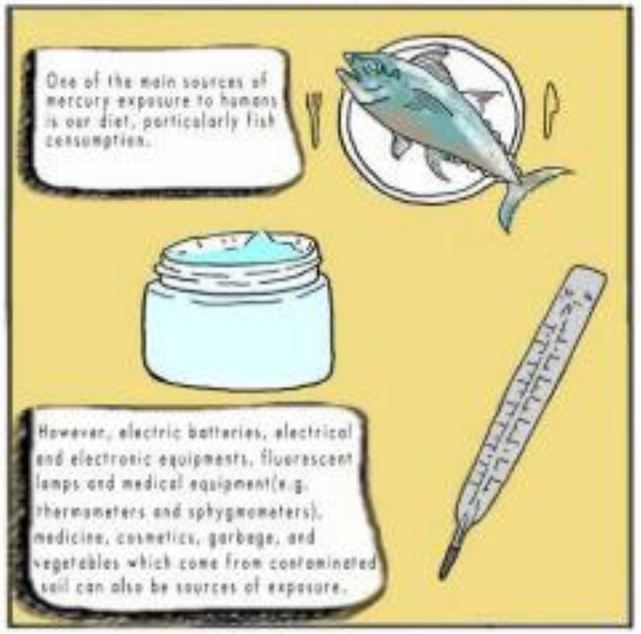
When faced with this worrying issue, we developed a study in which we looked to evaluate the mercury contamination of students in our school.

BD production to raise awareness









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?**

Acknowledgments

- Professor Ana Sousa
- Professor Ramiro Pastorinho
- University of Beira Interior
- Rafael Barros
- Professor Sofia Caranova
- Miguel Guerreiro
- Professora Liliana Moreira
- Professor Tiago Santos