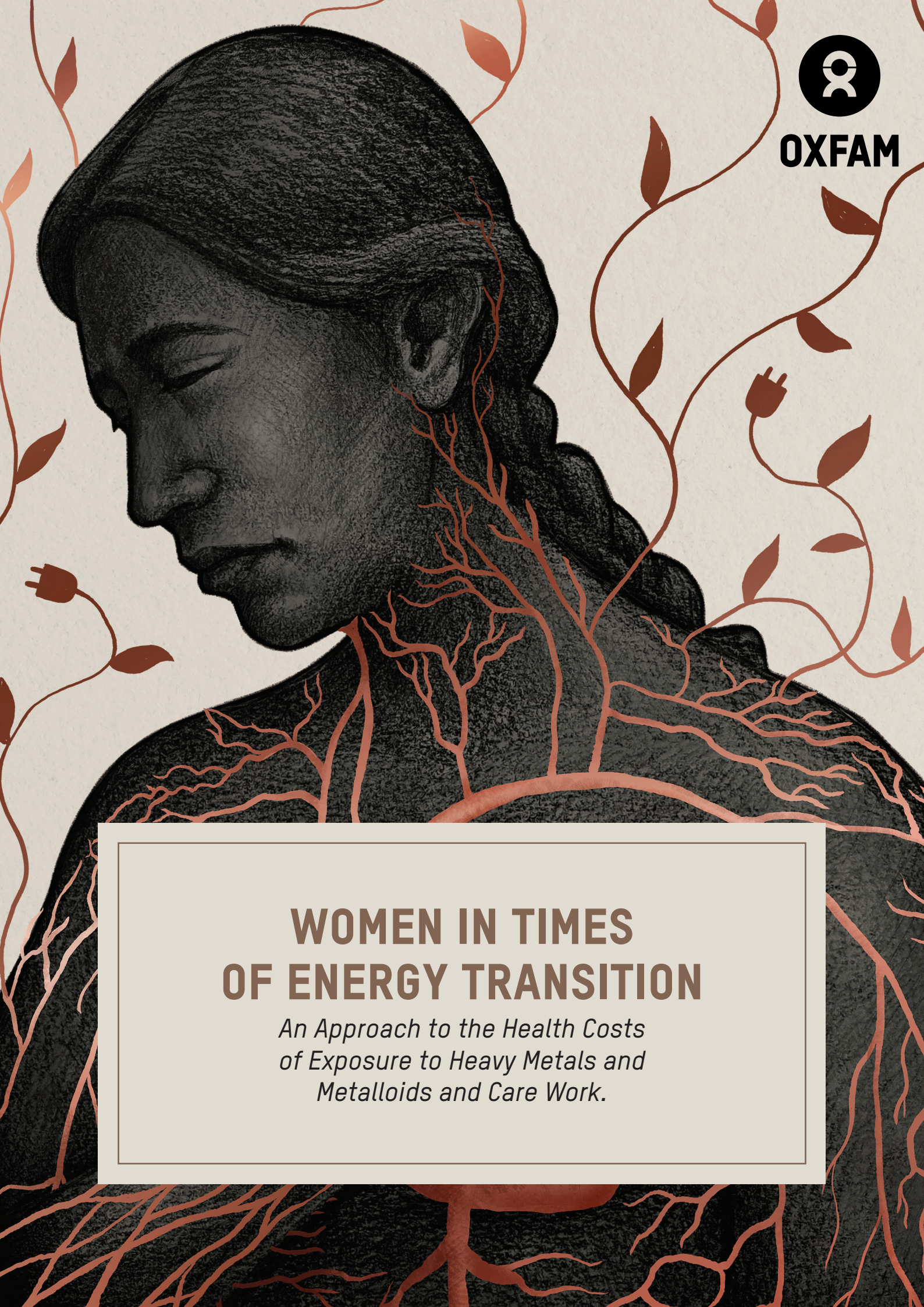

OXFAM

WOMEN IN TIMES OF ENERGY TRANSITION

An Approach to the Health Costs of Exposure to Heavy Metals and Metalloids and Care Work.

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WOMEN IN TIMES OF ENERGY TRANSITION: An Approach to the Health Costs of Exposure to Heavy Metals and Metalloids and Care Work.

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ACRONYMS AND INITIALISMS

DGIESP	General Directorate of Strategic Interventions in Public Health
ENADES	National Survey on Perception of Inequalities
ENAHO	National Household Survey
ENUT	National Time Use Survey
ET	Energy Transition
GBCP	Out-of-pocket expenditure by ability to pay
GDP	Gross domestic product
HM&OTS	Heavy metals and other toxic substances
HPO	Healthcare Provider Organizations
IEP	Institute of Peruvian Studies
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
INEI	National Institute of Statistics and Informatics
LAC	Latin America and the Caribbean
MIMP	Ministry of Women and Vulnerable Populations
MINCUL	Ministry of Culture
MINEM	Ministry of Energy and Mines
MINSA	Ministry of Health
MTSASH	Technical Roundtable on Environmental Health and Human Health
NCDs	Non-communicable diseases
OEFA	Environmental Assessment and Oversight Agency
OOP	Out-of-pocket expenditure
PAHO	Pan American Health Organization
PLANAMETOX	National Platform for People Affected by Metals, Metalloids and Other Toxic Chemical Substances
PP	Budget Program
SIS	Comprehensive Health Insurance
SRC	Referral and Counter-Referral System
UN	United Nations
WB	World Bank
WHO	World Health Organization

INTRODUCTION

Energy transition is the new climate goal to reduce global warming; it consists in producing technologies that generate renewable energy, which require a set of minerals and metals such as copper for energy transmission and storage, known as "transition minerals." Consequently, a number of private and public interests are looking in the direction of the territories and resources of Latin America and the Caribbean and, in particular, Peru, the second largest copper producer in the world (Minem, 2022).

According to the World Bank (2020), more than three billion tons of minerals and metals are necessary for global energy transition. In Peru, between 2020 and 2023, the value of mining exports almost doubled, with a progressive increase in production since 2016. As a result of this extractive race, more than ten million people in Peru are exposed to heavy metals, metalloids and other chemical substances such as mercury, lead, and arsenic (Minsa, 2020), which may have critical health effects that imply significant costs for families and women.

This study, Women in Times of Energy Transition: An Approach to the Health Costs of Exposure to Heavy Metals and Metalloids and Care Work, aims to identify the costs generated by exposure to heavy metals between 2015 and 2023. It analyzes health-related costs in the form of out-of-pocket expenditure and the opportunity costs incurred by women in the form of forgone wages due to the time dedicated to care work. It uses official databases such as the National Household Survey (ENAHO) and the National Time Use Survey (ENUT).

The first chapter introduces the context of energy transition, the importance of minerals for energy transition, and the production of minerals in Peru and the socio-environmental issues associated. The second chapter addresses the relationship between mining, exposure to heavy metals, and health. The third chapter explores literature on cost valuation. The methodology is explained in the fourth chapter. The fifth chapter presents the results of the analysis, while the conclusions are stated in the sixth chapter. Finally, the seventh chapter discusses proposed public policies linked to the study's findings.

Despite the methodological limitations met by this research, the findings provide an insight into the problems faced by households with members suffering from chronic illnesses and women who dedicate up to three times more hours to caregiving than men. This highlights the urgent need to address the reality confronted by families exposed to heavy metals, especially women. We require public policies and services that respond to the different needs of the population, including the generation of up-to-date and relevant information. Energy transition advances in parallel with inequality within territories when States fail to take joint responsibility for the effects of this increased demand for minerals.

EXTRACTIVE INDUSTRIES IN THE CONTEXT OF ENERGY TRANSITION

To limit global warming to 1.5 °C, 198 countries have committed to transitioning away from fossil fuels in their energy systems[1] given their relationship with global warming and climate change[2] and thus advance towards what has been called "energy transition" (ET). Transition toward a shift in the energy mix involves increasing the use of certain minerals for the production of renewable energy technologies, energy transmission or energy storage.

MINING FOR ENERGY TRANSITION

According to the World Bank (2020), "the more ambitious climate targets, the more minerals needed for a clean energy transition". The organization estimated that more than 3 billion tons of minerals and metals would be necessary for the implementation of wind, solar and geothermal energy, as well as for energy storage[3].

As shown in Chart 1, the minerals required for ET include copper, lithium, nickel, manganese, cobalt, graphite, chromium, molybdenum, zinc, tin, are earths, and silicon (IGF, n.d.). A growing international demand for these minerals translates into an increase in their extraction in producing countries. Between 50 % and 80 % of them are found in the territories of indigenous peoples (Oxfam, 2023). In 2017, 38 % of extractive projects in Peru were located in the territories of indigenous peoples and peasant communities[4].

1 Outcome of the negotiations that took place during the COP 28, in 2023. See: https://unfccc.int/sites/default/files/resource/sb2023_09S.pdf

2 The burning of fossil fuels—oil, gas and coal—accounts for nearly 90% of all carbon dioxide emissions and 75 % of global greenhouse gas emissions. See: https://www.un.org/en/climate-change/science/causes-effects-climate-change

3 For more information, go to: https://www.bancomundial.org/es/news/press-release/2020/05/11/mineral-production-to-soar-as-demand-for-clean-energy-increases

4 See: https://ojo-publico.com/3278/el-impacto-la-mineria-las-aguas-altoandinas

CHART 1
WHAT ARE SOME OF THE CRITICAL MINERALS AND METALS USED FOR?

MINERALS AND METALS IN ELECTRIC VEHICLES BY WEIGHT (IN KG) AND MAIN PRODUCING COUNTRIES

27 Co 58.933194 Cobalt
COBALT 13.3 KG
Australia, Canada, Democratic Republic of the Congo, Madagascar, Philippines, Russia

3 Li 6.94 Lithium
LITHIUM 8.9 KG
Argentina, Australia, Chile, China, Zimbabwe

28 Ni 58.6934 Nickel
NICKEL 39.9 KG
Australia, Brazil, Canada, Indonesia, New Caledonia, Philippines, Russia

25 Mn 54.938044 Manganese
MANGANESE 24.5 KG
Australia, Brazil, Ivory Coast, India, Gabon, Ghana, Georgia, South Africa

Countries in bold are members of the IGF.

6 C 12.011 Carbon
GRAPHITE 66.3 KG
Brazil, Canada, China, India, Madagascar, Mozambique

26 Fe 55.845 Iron
IRON AND STEEL
China, Brazil, India, Germany, Japan, South Korea, United States

TR
RARE EARTHS 0.5 KG
China, Myanmar, Madagascar, United States

29 Cu 63.546 Copper
COPPER 53.2 KG
Australia, Canada, Chile, Democratic Republic of China, Kazakhstan, Mexico, Peru, United Statis, Zambia

MINERALS AND METALS IN THE HEALTHCARE SUPPLY CHAIN

78 Pt 195.084 Platinum
PLATINUM-GROUP METALS
(Ruthenium, rhodium, palladium, osmium, iridium, and platinum)
Corrosion resistance, cancer treatment, chemotherapy, radiotherapy, implants, cardiovascular technology

4 Be 9.0121831 Beryllium
BERYLLIUM
Eye surgery, heat-resistant properties that reduce radiation levels, improved efficiency in X-rays, MRI, mammography.

29 Cu 63.546 Copper
COBRE
EPA-registered antimicrobial surface, MRI equipment, recyclable malleable, high-tech computers

MINERALS AND METALS IN MOBILE AND DIGITAL DEVICES AND INFORMATION TECHNOLOGIES

3 Li 6.94 Lithium **LITHIUM**
28 Ni 58.6934 Nickel **NICKEL**
31 Ga 69.723 Gallium **GALLIUM**
TR **RARE EARTHS**
27 Co 58.933194 Cobalt **COBALT**
29 Cu 63.546 Copper **COPPER**
52 Te 127.60 Tellurium **TELLURIUM**
73 Ta 180.94788 Tantalum **TANTALUM**

MINERALES Y METALES EN LAS ENERGÍAS RENOVABLES

24 Cr 51.9961 Chromium **CHROMIUM**
42 Mo 95.95 Molybdenum **MOLYBDENUM**
31 Ga 69.723 Gallium **GALLIUM**
52 Te 127.60 Tellurium **TELLURIUM**
25 Mn 54.938044 Manganese **MANGANESE**
29 Cu 63.546 Copper **COPPER**
32 Ge 72.630 Germanium **GERMANIUM**
28 Ni 58.6934 Nickel **NICKEL**
27 Co 58.933194 Cobalt **COBALT**
30 Zn 65.38 Zinc **ZINC**
50 Sn 118.710 Tin **TIN**
TR **TIERRAS RARAS**

Sources: AIE, ENGE (Monitor, National Mining Association, NRCan

Fuente: IGF (S.f.)

In 2022, Peru was the second largest producer of copper and zinc worldwide and the third country with the largest reserves of copper and molybdenum (Minem, 2022), placing the country in a strategic position in the global supply chain (IGF, n.d.). The increased demand for minerals in the country drove up prices and led to a "new supercycle": between 2020 and 2023, the value of mining exports almost doubled. According to Chart 2, extraordinary income exceeded $42 billion, and the variation in the value of exports due to prices was 42.4 % for molybdenum, 38.5 % for tin, 31.4 % for copper, 30.3 % for iron, and 18.8 % for zinc (Yauri, 2024).[5]

CHART 2
ESTIMATED EXTRAORDINARY INCOME FROM MINING EXPORTS, APRIL 2020 – DECEMBER 2023 (US$ MILLIONS)

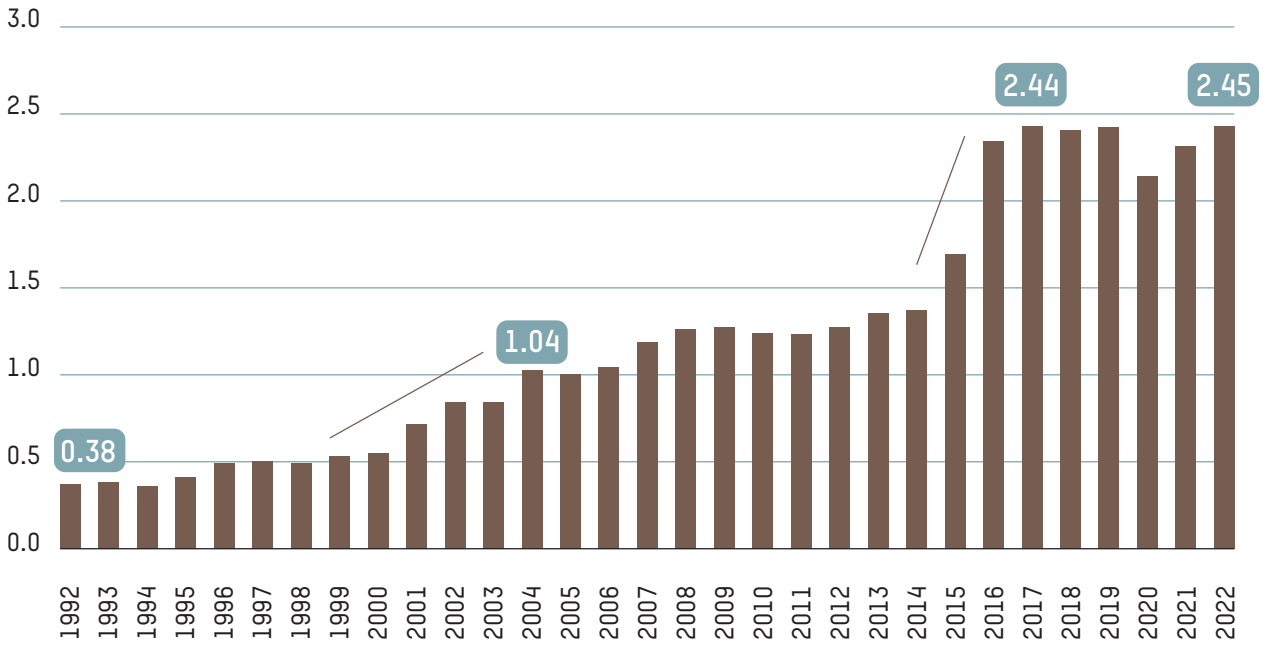
MINERAL	MINING EXPORTS AT CURRENT PRICES	MINING EXPORTS AT PRE-BOOM PRICES	DIFFERENCE	VARIATION % IN VALUE OF EXPORTS DUE TO PRICES
COPPER	73,982	50,745	23,237	31.4 %
TIN	2,588	1,593	995	38.5 %
IRON	6,595	4,597	1,997	30.3 %
GOLD	37,075	25,228	11,846	32.0 %
SILVER	382	286	96	25.2 %
LEAD	6,809	5,604	1,205	17.7 %
ZINC	8,935	7,259	1,676	18.8 %
MOLYBDENUM	4,224	2,431	1,792	42.4 %
TOTAL	**140,590**	**97,745**	**42,845**	**30.5 %**

Source: CooperAcción (2024).

5 Minerals such as zinc, tin, molybdenum and copper are used in renewable energy production; copper is also used in the healthcare supply chain and the manufacture of mobile devices, digital devices, information technology, and electric vehicles; iron is also used in the latter (IGF, n.d.).

Global copper demand for renewable energy technologies is estimated to reach 1.35 million tons by 2030. Over the last decade, copper production in Peru has grown by 1.2 million tons (CooperAcción, 2024). In 2022, domestic copper production totaled 2.45 million tons, making up 11 % of global production (Minem, 2022) (see Chart 3); in 2023, it reached 2.7 million tons, accounting for a 12.7 % increase over the previous year's production. Between 2022 and 2023, Peru's production of other minerals linked to energy transition, such as zinc (7.2 %), iron (8.8 %) and molybdenum (6 %), also increased. In 2023, cumulative zinc production was 1.4 million tons, iron, 14 million tons, and molybdenum, more than 33,000 tons (Minem, 2023).

CHART 3
PERU: COPPER PRODUCTION VOLUME, 1992-2022
(IN MILLIONS OF FINE METRIC TONS)



Source: CooperAcción and Oxfam (2024).

Although the production of transition minerals is concentrated in at least 16 departments of Peru[6], ET urges us to discuss key national mining activity elements in light of the potential increase in the exploration or exploitation phase to meet current international demand. To this end, a historical perspective on the economic, environmental and social outcomes of such activity in the country is essential.

Economic growth, in the context of the previous mineral price[7] supercycle, played an important role in reducing monetary poverty nationwide; however, its contribution in reducing poverty among the most excluded groups, such as the rural highland population or rural indigenous population (Trivelli and Urrutia, 2018), located precisely in extractive areas, declined between 2004 and 2016. In Peru's current supercycle, despite the sector's extraordinary income, it accounted for only 9.7 % of total taxes collected in 2023, that is, it contributed less than other sectors such as commerce and manufacturing (CooperAcción, 2024). These taxes are essential for financing state action in reducing social gaps. As of 2025, monetary poverty affects 29 % of the population nationwide, 39.8 % in rural areas, and 43.1 % in rural highlands[8].

In environmental terms, almost 40 % of social conflicts in Peru in 2024 were linked to socio-environmental disputes over mining activity[9]. One of the main reasons for protest by communities in the area of influence of mining projects is the pollution of water, air and ecosystems. Although to date no official studies have been carried out to systematically establish the cause of contamination in different mining extractive areas[10], a recent document by CooperAcción, Derechos Humanos Sin Fronteras [Human Rights Without Frontiers] and Instituto de Defensa Legal [Institute for Legal Defense] (2024) summarizes the findings of the Environmental Assessment and Oversight Agency (OEFA) on the causality of pollution in Espinar, located within the area of a mining unit in Cusco[11], based on the analysis of water, air, soil, flora, fauna and other environmental components. Among the results, it was identified that leaks from the mining tailings deposit contaminate the groundwater that reaches the Tintaya and Salado rivers.

6 The southern Andes represent 57.4% of national production: Arequipa, 19%; Apurímac, 10.5%; Cusco, 9.9%; Moquegua, 9.8%; Tacna, 8.1%; and Puno, 0.1% (CooperAcción, 2024).

7 In the period between 2003 and 2012 (Yauri, 2024).

8 For more information, see Peru: Monetary Poverty Assessment 2014-2023. Technical Report (INEI, 2024).

9 See Perú: https://www.defensoria.gob.pe/defensoria-del-pueblo-cifra-de-conflictos-socioambientales-vinculados-a-actividad-minera-en-febrero-disminuyen-respecto-al-mes-anterior/

10 Except for La Oroya. See IACHR (2023).

11 In 2022, Cusco produced more than 240,000 tons of copper.

According to a Minsa report (2020), "the main risk agents generated by mining are toxic substances such as lead, cadmium, mercury, cyanide, arsenic, silica and sulfur dioxide, which can remain in the environment for years because they are not biodegradable." These substances are released into the environment by mining activities and result in the degradation and death of vegetation, animals and rivers and the potential harm to people, and "the danger of metals is greater as they are not chemically or biologically degradable (Censopas, 2010)." Mining-related pollution impacts local populations, working conditions and the environment, by contaminating air, soil, and water pollution, which subsequently causes food contamination.

Water pollution, for example, is generated, among other causes, from its use in mining production. In this process, water is combined with chemical reagents cyanide, arsenic, foaming reagents, among others to separate the metal from the rock and obtain mineral with commercial value. As a result, mining tailings are formed, which reach different water sources rivers, lakes, lagoons located in areas surrounding mining operations (Herrera and Millones, 2012). Chávez (2013) conducted an analysis on the impact of a mining unit's operations on the environment and found that its tailings had altered the flow of the Tintaya River, consequently affecting water quality.

IMPACT OF MINING POLLUTION ON PEOPLE

Food and water sources in areas affected by mining activities may become a source of contamination, posing serious health issues to nearby residents. One study found a statistically significant relationship between people's place of residence and the lead levels found in a population located in a mining extraction area (Portocarrero, 2018).

Exposure of a physical space to emissions from mining activities can have a major impact on the crops grown in the area, and this toxicity may cause genetic alterations that are not immediately noticeable (Gupta and Gupta, 2011). A study conducted on vegetable fields in China, near areas of mining and industrial contamination, found the highest average levels of heavy metals in soil samples. Although levels varied by crop type, the concentrations found represented a risk to human health in all cases due to their potential to enter and spoil the food chain (Liu, 2013). Another study conducted in the department of Madre de Dios, Peru[12], identified high levels of heavy metals such as arsenic, cadmium and lead in the soil and the agricultural products of an abandoned mining area (Soto-Benavente et al., 2020).

Bautista (2012) points out that mining activities not only generate solid waste, but also toxic gases, which are inhaled by workers in their occupational environment. In a study conducted in the province of El Oro, Ecuador, López Bravo et al. (2016) examined the impact of the mining activity on the health of a group of 42 miners from the El Osorio neighborhood and found that (i) 80 % presented musculoskeletal issues, with lower back pain being the most frequent; (ii) 62 % suffered from moderate to severe respiratory problems; and (iii) 50 % exhibited some degree of psychological disturbance attributed to the effect of chemicals on their nervous system.

In the case of the population living within the area of influence of a mining company in La Oroya, Pasco, Peru, the Ministry of Health demonstrated that "environmental pollution caused blood lead levels that exceeded three times the limit established by the World Health Organization (WHO)", and evidenced that it was a result of the mining activity (Inter-American Court of Human Rights, 2023). In Apurímac, a study used blood and urine samples from 310 residents to measure heavy metal concentration levels in the population of the area affected by a mining project; compared to results of tests taken 5 years earlier, a significant increase in cadmium and mercury levels were found (Astete et al., 2014). In Cusco, toxic metals and substances were detected

12 It produces 11% of Peruvian gold (INGEMMET, 2021).

Credit: Jacob Balzani Lööv

above reference levels in 78 % of the individuals sampled from indigenous communities settled near mining operations (Amnesty International, 2021).

Mining pollution is one of the main sources of risk of exposure to heavy metals and metalloids such as mercury, lead, cadmium and arsenic, as they are typically released by such activities (Censopas, 2010)[13]. Natural sources also represent a risk of exposure to these metals. In the case of mercury, a global assessment identified that "mining operations are responsible for approximately 37.5 % of atmospheric mercury emissions" and, globally, South America is responsible for 18.4 % of atmospheric mercury emissions (Wu et al., 2024). Identifying the source of exposure to heavy metals (causality) is one of the main reasons why civil society advocates for the State to establish accountability for the impact of these metals on health.

According to information from Minsa (2020), 10,162,380 people (31.15 % of the national population[14]) are at risk of exposure to metals, metalloids and other chemical substances, such as aluminum, arsenic, barium, boron, cadmium, iron, mercury, magnesium, sodium, and lead. Chart 4 shows the number of individuals exposed to heavy metals, metalloids, and other chemicals nationwide and the percentage of the total population by department that they represent. According to this chart, heavy metals are not isolated elements found only in three departments; they are also present in varying concentrations throughout the rest of the country, affecting the population unequally depending on the predominant economic activity, geographic location, and environmental characteristics of each region.

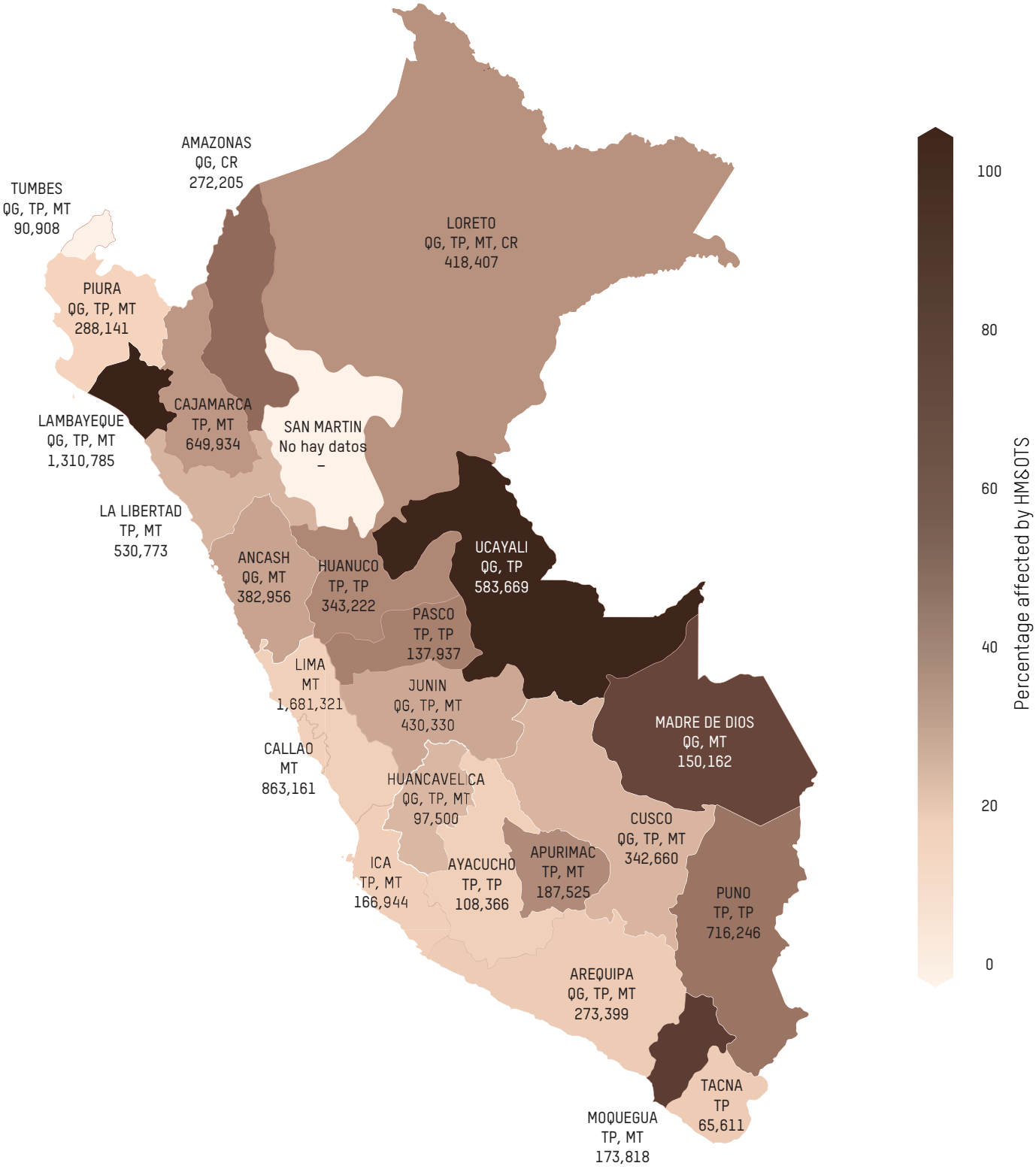
13 Also the oil activity, the scope of which is not addressed in this study.

14 Estimated population in 2020, according to the INEI.

For example, arsenic is found in significant quantities in regions such as Cajamarca, Puno and Huánuco, where mining activity is prevalent. Cadmium and mercury, meanwhile, are especially relevant in gold-mining areas, such as Madre de Dios, where mercury use has contaminated water bodies and affected riverside communities and local biodiversity. Crude oil, identified in regions such as Loreto, Lambayeque and Amazonas, creates an additional problem, affecting not only soil and water quality but also the populations that depend on these resources for their agricultural activities and daily consumption. The simultaneous presence of multiple contaminants aggravates the situation, generating what is known as "mixed exposure," where health effects can be cumulative and synergistic; that is, the combination of two or more toxic elements can have a greater impact than that caused by each one individually. This poses a challenge for mitigation and comprehensive public healthcare policies, which must consider not only specific contaminants but also their interaction in the affected populations.

Credit: Jacob Balzani Loov.

CHART 4
MAP OF PERU'S POPULATION EXPOSED TO HEAVY METALS, METALLOIDS AND OTHER CHEMICALS



QC: General chemicals, CR: Crude oil, MT: Metals, TP: Hazardous toxic e lements

Source: Report N060-2020-JAMC DENOT DGISEP/MINSA

Credit: Jacob Balzani Loov

IMPACT OF EXPOSURE TO HEAVY METALS AND METALLOIDS

HEALTH CONSEQUENCES OF EXPOSURE TO HEAVY METALS AND METALLOIDS[15]

The impact of exposure to heavy metals and metalloids on health depends on several factors, including the "individual's vulnerability, the concentration of the contaminant, the intensity, persistence and difficulty in detecting clinical symptoms, prolonged subclinical periods, and the extent, scope and duration of exposure over time" (Minsa, 2020). Once in the human body, most of these substances may cause carcinogenic, mutagenic and teratogenic processes in the short or long term (Minsa, 2020).

The effects of lead and mercury have been warned about by the PAHO (2024) and the WHO (2014), respectively. The PAHO (2024) and the WHO (2014) have warned about the effects of lead and mercury, respectively. Exposure to lead may have implications for the digestive, renal, cardiovascular, neurological and hematological systems. Mercury, in turn, can affect the digestive, renal, respiratory, neurological, dermatological and ophthalmological systems. Various studies have established a direct relationship between exposure to heavy metals and metalloids and health issues.

A study by Mamtani et al. (2011) analyzes the health effects of exposure to arsenic, lead and mercury based on a review of specialized literature. The effects of arsenic include kidney or liver damage, heart disease, increased risk of skin, liver, lung or bladder cancer, diabetes, hypertension, among others. The health consequences of lead include cardiovascular disease and immune system diseases. Possible effects of mercury include brain or kidney damage.

Mohod and Dhote (2013) reviewed literature on heavy metal contamination in drinking water and its effects on the health of population in various countries. They generally concluded that the consumption of water contaminated with heavy metals is linked to chronic diseases. This conclusion is supported by a broad body of literature describing the potential health effects of various heavy metals, such as increased risk of cardiovascular disease and related mortality. Evidence also revealed the adverse effects on the function of organs such as the kidneys and the liver, which, in the event of prolonged exposure to heavy metals, may result in physical, muscular and neurological degenerative conditions, including Alzheimer, Parkinson, dystrophy and multiple sclerosis.

15 For the sake of simplicity, the term "heavy metals" will hereafter refer to both heavy metals and metalloids.

Neuberger et al. (1990) conducted a study in Galena, USA, where a zinc and lead mining waste site was located, and compared the health of the population with that of two other towns used as a control group. The analysis found a significant positive relationship between exposure to heavy metals and an increase in stroke, chronic kidney disease, hypertension, cardiovascular disease, skin cancer and anemia cases. A positive association was also observed with increased mortality from hypertension, ischemic heart disease and stroke.

In China, He et al. (2020) explored the impact of heavy metal contamination in agricultural soils on the health of the population residing nearby the Basin River, where more than 70 mining companies were located on both sides of the river. The authors found that the prevalence of chronic diseases was significantly higher than the national average for rural communities due to both the exposure to heavy metals by mining workers and the consumption of food grown in contaminated soil. Another research in the same country revealed that children with high blood lead levels showed greater social withdrawal, depression and atypical body movements (Hou et al., 2013).

In Latin America and the Caribbean (LAC), genotoxic effects and their relationship with heavy metal concentrations were assessed in a group of 112 individuals,61 in exposed areas and 51 as a control group, in the municipalities of Guaranda, Sucre, Majagual and San Marcos, in Colombia. This study revealed a significant association between the presence of mercury and cadmium and DNA damage (Calao and Marrugo, 2015). In Nicaragua, the concentration of metals such as mercury, lead, aluminum, manganese, and arsenic was found to affect the hearing of people in the Bonanza mining community as a result of the relationship between exposure and neurological problems (Saunders, 2013).

VULNERABLE POPULATIONS

Exposure to heavy metals among women tend to be more serious, as they absorb higher levels of mercury, which is especially dangerous for fetal development, causing miscarriages and unsafe births[16]. Cadmium absorption is greater among individuals with low iron stores (ONU, 2024), and, in this sense, women are one of the most vulnerable sectors. In Peru, anemia affects 22.7 % of women of childbearing age and 43.1 % of children aged 6 to 35 months are, with the prevalence increasing to 50.3 % in rural areas (INEI, 2024). On the other hand, exposure to lead during pregnancy can have serious neurological consequences for children (ONU, 2024), including mental health issues. In Espinar, Cusco, Peru, 75 % of women exposed to heavy metals experience depression, concerns about survival, illness, and economic hardship (Derechos Humanos Sin Fronteras, 2019).

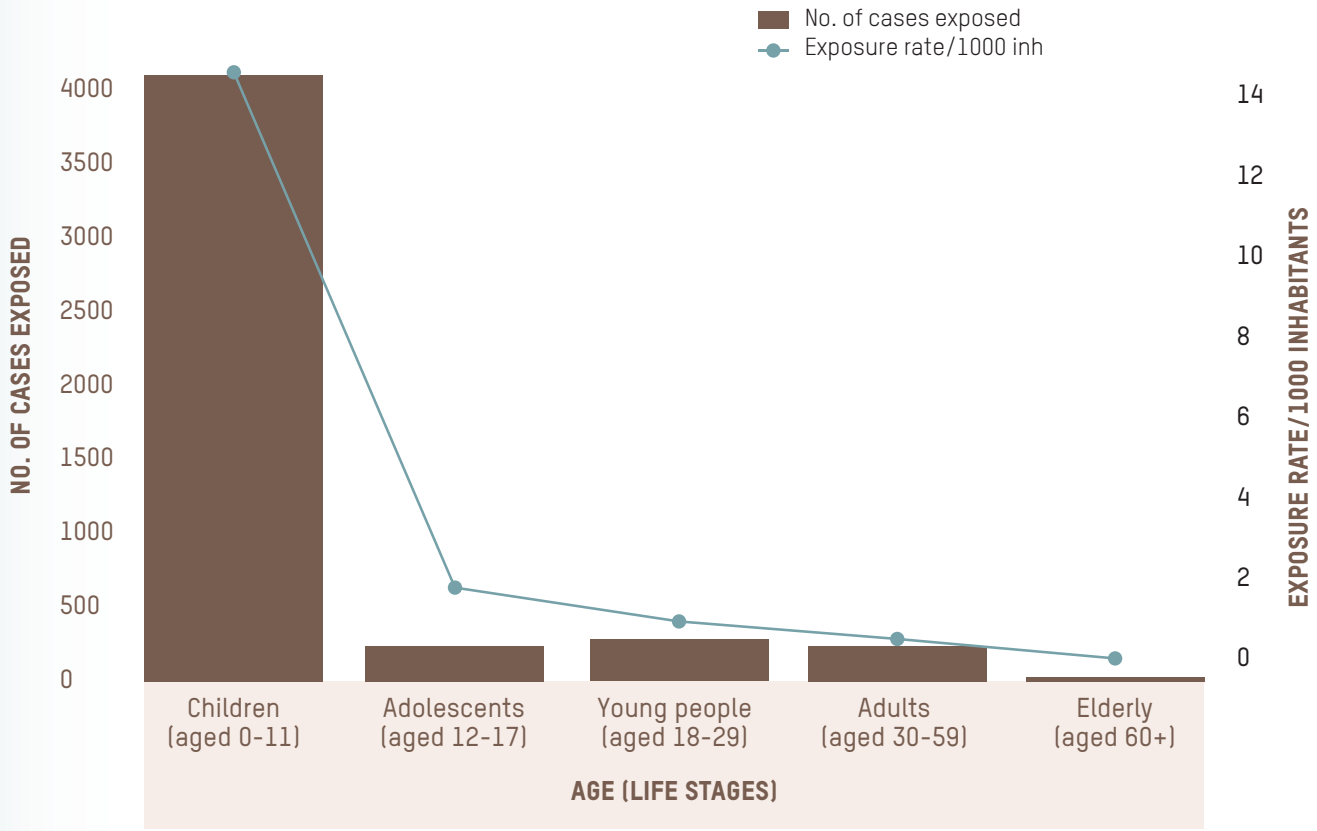
Likewise, children are the most vulnerable to lead and mercury poisoning, according to information from PAHO (2024) and WHO (2014), respectively. A study by Astete et al. (2005) examined the relationship between blood lead levels and epidemiological characteristics in 236 children and 13 pregnant women from the communities of Quiulacocha and Champamarca, in Pasco, Peru; the results revealed an association between high blood lead levels and both anemia and malnutrition in children. Also in Pasco, a study identified lower IQ levels in school-aged children exposed to heavy metals[17]. A study on exposure to heavy metals in the environment and the prevalence of communicable and mental health conditions carried out in the area of influence of a mining project in Apurímac, Peru, found heavy metals levels exceeding permitted limits, mainly lead (24.3 %) and cadmium (43.9 %). Among children, about 12.5 % showed psychomotor development issues, 34.3 % experienced anxiety, and 17.5 % suffered from depression (Astete et al., 2010).

16 These differentiated impacts were presented by the National Platform for People Affected by Metals, Metalloids and Other Toxic Chemical Substances (PLANAMETOX) and the Technical Roundtable on Environmental Health and Human Health (MTSASH) to the Committee on the Elimination of Discrimination against Women (CEDAW), available here: https://shorturl.at/29MlV . Among the effects cited in the document are: i) There are associations between exposure to cadmium and the development of hormone-dependent cancers, such as breast and uterine cancer. Cadmium is harmful to people with low iron stores, and women are more likely to lose iron with each menstrual period. ii) Exposure to arsenic more severely affects malnourished people, a condition more common among women. Malnutrition leads to an increase in the proportion and likelihood of abortions and stillbirths. iii) Exposure to asbestos is responsible for an increase in ovarian cancers. iv) Exposure to lead severely affects nursing and pregnant women in particular and is related to an increase in abortions and premature births.

17 See https://uploads-ssl.webflow.com/5d9bafe75f6edb09b82b5aaf/621c9a55ad176d-5fc4171084_Copia%20di%20pasco%20short%20ENG.pdf.

According to available information, as shown in **Chart 5, children aged 0-11** are the most affected by heavy metal contamination, both in terms of absolute number of cases and exposure rate. With over **4000 documented cases** and an incidence rate of over **14 cases per 1,000 inhabitants**, this age group demonstrates a particularly high level of vulnerability. In contrast, the rates decrease significantly in other age groups, such as adolescents and adults.

CHART 5
DISTRIBUTION OF CASES AND RATES OF HEAVY METAL EXPOSURE BY AGE GROUP IN PERU, 2021



Source: Defensoría del Pueblo [Ombudsman's Office], Deputy Report No. 19-2021-DP/AMASPPI

The above suggests that children are at greater risk due to their **biological susceptibility** and **prolonged exposure** to contaminated environments during their formative years. In fact, according to the Ministry of Health (MINSA)[18], intellectual disability is a result of prenatal exposure to certain xenobiotics[19] such as heavy metals. Children, due to their rapid metabolism during their first three years of life, can absorb xenobiotics to a greater extent than adults.

The information presented so far underscore the severity of heavy metal contamination in the country, with particular emphasis on the most affected regions and the most vulnerable population groups: children, women, and rural communities exposed to environmental risk. In this context, various studies conducted in Peru have analyzed the relationship between mining contamination and heavy metal exposure on health, identifying significant impacts on child development, the incidence of chronic or non-communicable diseases (NCDs), and the quality of life of exposed populations.

It should be noted that, according to PAHO, chronic diseases or NCDs, including cancer and chronic respiratory diseases, "tend to be long-term and result from a combination of genetic, physiological, environmental and behavioral factors." Nearly three-quarters of NCD deaths worldwide occur in low- and middle-income countries, such as Peru[20].

The Peruvian State currently implements Budget Program [21]0018: Non-communicable Diseases, which consists of four components: eye health, oral health, non-communicable diseases, and heavy metal exposure. Actions to address the latter are executed through the 3043997. Screening and Treatment of Patients Affected by Heavy Metals program[22], which aims to provide a comprehensive care package to people exposed to heavy metals at all stages of life, with priority given to children and pregnant women who reside in areas

18 According to the Minsa document published in OAS (2022), Social Inequalities in Health. Baseline for a Transformative Recovery with Social Inclusion and Environmental Sustainability in the Countries of the Andean Region. https://cdn.www.gob.pe/uploads/document/file/374690/version-preliminar-de-la-politica-nacional-multisectorial-de-salud.pdf

19 Toxic pollutants of anthropogenic origin

20 For further information, go to Noncommunicable Diseases - PAHO/WHO | Pan American Health Organization

21 Budget Programs are programming action units by public entities—organized by territory—aimed at providing goods or services to the population in order to achieve specific results. They are important because the State allocates resources to produce goods and services through them, and this allows for the evaluation of public spending in terms of state performance in providing these services at the three levels of government (national, regional and local). See https://www.mef.gob.pe/es/?option=com_content&language=es-ES&Itemid=101530&lang=es-ES&-view=article&id=5337

22 It is a service within Budget Programs specifically aimed at the population affected by heavy metals, for which the State allocates public resources at the national, regional and local levels.

considered at risk for environmental contamination[23]. However, a limited annual budget is allocated. With the 2023 budget, the State managed to serve 1.5 million people, representing 10 % of the total number of people exposed to heavy metals, and only 43.3 % of pregnant women and children under 12 exposed to heavy metals a priority population underwent a comprehensive evaluation (Minsa, 2024). The public budget for 2025, S/ 20,400,029, is equivalent to approximately S/ 2 (US$ 0.6) per person exposed to heavy metals.

Faced with this scenario, the responsibility for caring for those affected by heavy metals falls primarily on families and within families, primarily on women. That is, environmental pollution exacerbates the unequal allocation of care work (Inter-American Court of Human Rights, 2023), as social norms impose on women the burden of protecting the fetus, their children, and other family members from toxic substances (ONU, 2024).

23 According to the technical document available at https://cdn.www.gob.pe/uploads/document/file/2387955/Documento%20T%C3%A9cnico%20.pdf

CARE WORK

Defining care as work, a need, and a right[24] allows us to establish its economic, social, and political relevance. Understanding care as work places this activity at the heart of how societies function and calls for its symbolic and economic value. Although paid care work exists[25], household care and care for dependent family members are unpaid activities, mainly confined to the private sphere and rendered invisible, despite playing a fundamental role in the economic structure of society—as they support productive (paid) work—and in social well-being. Without care work, there would be no paid workforce (Rodríguez Enríquez, 2015), and care is considered work because it contributes to the production of goods and services and enables their transformation into well-being. Care work in Peru represents between 17 % and 24.4 % of the gross domestic product (GDP) [26]and falls primarily on women[27].

Care is a need because it is necessary for certain social groups, including children, adolescents, people with disabilities, older adults, among others. Care, in this case, aims to meet their basic needs in life and includes economic, moral and emotional aspects[28]. Demographic transitions increase the demand for care: the total dependency rate nationwide was 60.8 % in 2019[29]; in 2023, according to a national survey, 68 % of people in Peru live with at least one person who requires care at home[30].

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24 See https://www.cepal.org/es/notas/considerar-cuidado-como-necesidad-un-trabajo-un-derecho-contribuye-revertir-la-desigualdad

25 "Paid care work is performed by care workers in exchange for remuneration or benefits. Unpaid care work consists of the provision of care by unpaid caregivers, that is, without receiving any financial compensation in return" (ILO, 2019).

26 See Osorio, S. (2021). Agreements and Disagreements between Care and the Economy. In Leda, P., Osorio S., Vásquez, G., Lavado, T., Velazco, J., Ñopo, H. and Alayza, A. (2020), Times of Care: Inequalities, Feminist Economy and Care Work in Peru. https://peru.oxfam.org/lo-%C3%BAltimo/publicaciones/tiempos-de-cuidados-desigualdades-economia-feminista-y-trabajo-de-cuidados

27 According to the Survey of Representations on Care Work by Oxfam, CMP Flora Tristán, and IEP (2023), in 72% of households, women are primarily responsible for caregiving activities. Care work is primarily undertaken by women and girls from socially disadvantaged groups (ILO, 2019).

28 Oxfam Mexico. (2021). Dictionary of Care: A Universal and Inclusive Approach. https://oxfam-mexico.org/wp-content/uploads/2022/06/DICCIONARIO-DE-CUIDADOS_OXFAM_20junio.pdf

29 In other words, for every 100 people of working age, about 61 depended on them for their livelihood. See https://cdn.www.gob.pe/uploads/document/file/3477829/Cartilla-Virtual-Cuidados-en-igualdad.pdf

30 Oxfam, Flora Tristán CMP, and IEP. (2023). Survey of Representations on Care Work in Peru. https://peru.oxfam.org/encuesta-sobre-representaciones-del-trabajo-de-cuidado-en-el-peru

Dependent individuals are those who rely on others for their daily survival, such as children, the sick, or older adults who are unable to perform the physical tasks necessary for self-care (Esquivel et al., 2012). Within these groups, there are different types and degrees of dependency. People in need of care are those who require assistance with basic "physical or bodily survival activities," such as eating, personal hygiene, mobility, self-protection, among others (Esquivel et al., 2012). Meeting these needs requires time, economic and material resources, as well as skills and knowledge[31]. Thus, care can be classified as i) simple or everyday care (requiring specific skills, but not prior ability); ii) intense and extensive care (involving greater demands on time, labor, and effort); and iii) specialized and long-term care (in addition to being intense and extensive, it requires knowledge and specialized skills)[32].

The social organization of care establishes how the State, the market, communities, and families participate in the provision and distribution of care. In LAC, this organization is unfair because responsibilities are unequally distributed within the family and society (Rodríguez Enríquez, 2015). The current organization of care places greater responsibility for provision on families and, within these, on women (feminization of care), who dedicate more time and resources to these activities. The reason is that the sexual distribution of care is associated with gender stereotypes that attribute to women greater caregiving capacities[33]. Women perform 76 % of unpaid care work worldwide (ONU, 2024).

31 Simone de Beauvoir Leadership Institute. (n.d.). Care as a Public Issue.

32 Oxfam Mexico. (2021). Dictionary of Care: A Universal and Inclusive Approach. https://oxfam-mexico.org/wp-content/uploads/2022/06/DICCIONARIO-DE-CUIDADOS_OXFAM_20junio.pdf

33 A study carried out by Oxfam, CMP Flora Tristán and IEP (2023) found that 69% of the population strongly agrees that women are better at caring for people with disabilities than men.

By 2019, for example, the Peruvian State had managed to care for only 1 % of all children under 4 years old through its daycare service[34], and in 2022, women spent twice as many hours as men on care work[35]. This form of family and social organization reinforces the inequalities that women currently face, as a greater burden of care work limits their time education or paid employment, which deepens economic dependence and becomes a risk factor for gender-based violence (Puente-Martínez et al., 2016). Likewise, it restricts their participation in public spaces and, thus, their exercise of civil and political rights.

In this sense, acknowledging care as a right—understood as the "right to care, to be cared for, and to self-care" (Pautassi, 2007)—establishes the need to recognize its universality and, with it, the State's obligation to guarantee it. This obligation entails providing the means to provide care, ensuring that care is provided under conditions of equality (Pautassi, 2007), and ensuring public policies and services aimed at guaranteeing the quality, coverage, and relevance of care for those entitled to it. This expanded and equitable distribution of responsibilities can promote the development of societies that organize care more fairly.

Care time for family members affected by heavy metals is organized throughout the life cycle on an ongoing basis, and is articulated with the medical care cycle[36], where available. At the household level, it involves managing healthy nutrition, intensive and extended care in cases where people lose mobility, and palliative care when there is no possibility of recovery[37]. And caregivers do this while simultaneously taking care of the home, caring for other family members, and ensuring the sustainability of their livelihoods.

At the external level, care for people affected by heavy metals is conditioned by the State's capacity to respond to their needs. When health infrastructure is unavailable, care time is associated with seeking dosing tests to confirm

34 See Lavado, T. (2021). Mothers' Care Work and Women's Economic Autonomy. In Leda, P., Osorio S., Vásquez, G., Lavado, T., Velazco, J., Ñopo, H. and Alayza, A. (2020), Times of Care: Inequalities, Feminist Economy and Care Work in Peru. https://peru.oxfam.org/lo-%C3%BAltimo/publicaciones/tiempos-de-cuidados-desigualdades-economia-feminista-y-trabajo-de-cuidados.

35 See https://peru.oxfam.org/lo-%C3%BAltimo/blogs/desigualdades-de-genero-en-las-labores-de-cuidado-no-remunerado-data-actualizada.

36 This analysis is based on the inter-learning process promoted at the School for Quechua Women Affected by Metals in the Southern Macro Region of Planametox, promoted by CooperAcción, Human Rights Without Borders (DHSF) and Oxfam. See https://cooperaccion.org.pe/mujeres-quechua-participan-en-escuela-sobre-contaminacion-con-metales-toxicos/#:~:text=Con%20el%20lema%20%E2%80%9CKawsayninchis%20Hampiq,Sustancias%20Qu%C3%ADmicas%20T%C3%B3xicas%20(PLANAMETOX) .

37 People who have been declared beyond recovery.

that the symptoms correspond to an aggravation of the presence of metals in the body, seeking treatment in health facilities, managing access to complementary tests, medications or specialized care when the referral and counter-referral (SRC) system[38] does not operate in a timely manner, and, when it does, ensuring or accompanying the transfer and care of the family member to more complex health facilities, generally in departmental capital cities or the capital of the country, Lima..

For caregivers—primarily women, as will be discussed below—, caring for family members affected by exposure often means postponing their own self-care[39] due to the demand of double or triple work shifts. It also limits the development of their political capacities and participation in public spaces, among other aspects. The effects of exposure to heavy metals exacerbate the time poverty[40] of caregivers, placing them in a situation of greater economic, political, and gender inequality.

38 The SRC is the "ordered set of healthcare and administrative procedures through which the continuity of care for the health needs of users is ensured with due opportunity, effectiveness and efficiency, transferring it from the local community or health establishment with less resolution capacity to another with greater resolution capacity". See https://cdn.www.gob.pe/uploads/document/file/417278/-317076566557805742420191106-32001-ccqwcq.pdf?v=1573077096

39 Self-care is the set of actions aimed at meeting one's own care needs, (Oxfam México, 2021), including physical and emotional health.

40 See Beltrán, A., Lavado, P. & Teruya, B. (2019). Characterizing Time Poverty in Peru: Are Women the Poorest? In Hernández, W. (Ed.), Gender in Peru: New Approaches, Interdisciplinary Perspectives. Consorcio de Investigación Económica y Social, Universidad de Lima.

CURRENT STATE OF LITERATURE ON COST VALUATION

The negative impact of environmental pollution on human health entails costs for families; however, accurately estimating these costs can be challenging for a cost-benefit analysis of the activities that generate them as anthropogenic sources. In fact, as previously explained, the effects of exposure to heavy metals on people's health are incalculable in economic terms, because they nullify the life plans of the affected population[41].

The cost of treating diseases caused by exposure to heavy metals is undoubtedly one of the most analyzed; however, this negative impact is often underestimated, largely because assessments tend to focus only on the immediate health consequences, overlooking the long-term effects. Furthermore, there is a large gap between actual and estimated costs. Nonetheless, estimation methods are being updated, introducing new concepts into economic analysis, one of which is care work.

Credit: Jacob Balzani Loov.

41 "Some people and communities will be less likely to reproduce and give birth to healthy newborns" (ONU, 2024).

HEALTHCARE COSTS

Ripari et al. (2012) describe, based on a review of literature on the subject, methods for estimating the costs of disease. They state that studies that calculate these costs identify, quantify and value all associated economic resources, classifying them as direct, indirect, and intangible costs. Based on these authors' analysis, costs of disease can be classified as follows:

TABLE 1
CLASSIFICATION OF COSTS GENERATED BY A DISEASE

COST CLASSIFICATION		DEFINITION
Direct costs	Healthcare	Consumption of goods and services during diagnosis and treatment (outpatient care, rehabilitation, and palliative care), which can be provided in healthcare facilities, nursing homes, or at home.
	Non-healthcare	Consumption of goods and services associated with seeking healthcare: transportation costs, travel time, and waiting time, or other expenses such as adapting the home to the patient's needs, and unpaid care [42].
	Future	Consumption or saving of future health resources incurred as a result of an intervention or fatal event.
Indirect costs	Typical of the disease	Related to the loss of production resulting from the patient's temporary absence from work: opportunity costs.
	Morbidity and mortality	Those associated with lost income in the long term.
Intangible Costs		Those associated with the loss of quality of life of the patient and their family environment.

Source: Prepared by the authors based on Ripari et al. (2012).

42 In the document, the authors call this "informal care" based on the definition proposed by Van den Berg et al. (2004): care work performed by "one or more people in the sick individual's circle without any established financial compensation." For the purposes of this study, this will be referred to as "unpaid care" or "unpaid care work."

In the same document, Ripari et al. analyze different methods for calculating the different types of costs, as summarized below:

» **Direct healthcare costs:** These are estimated by multiplying the quantities of goods or services consumed by their respective prices. All inputs used during the care process and their market prices must be considered.

» **Direct non-healthcare costs:**
- Transportation, renovation, moving and additional service costs: the same methodology used for direct healthcare costs.
- Investment in promotion, prevention and research programs: a specific cost allocation method is required.
- Unpaid care costs: There are two approaches: revealed preference and stated preference.

  – Revealed preference approach method:
    › Opportunity cost: Valuation of the benefit lost as a result of the time dedicated to this activity based on the market salary of an unpaid caregiver.
    › Proxy good: Valuation of a good considered a close substitute for unpaid care based on market prices.

  – Stated preference approach method:
    › Contingent valuation: An estimate of how much money a caregiver would be willing to accept to provide a certain number of care hours.
    › Joint analysis: Valuation of time by analyzing the preferences of individuals considering a set of given alternatives.

- Travel, waiting, and appointment time costs: Depends on whether the time is paid or unpaid.

  – Paid time: Valuation of the reduction in production or consumption.
  – Unpaid time: The revealed preference approach is used.

» **Indirect costs:**
  - Human capital method: Loss of productivity due to morbidity and mortality based on the assessment of the reduction in working hours or production level.
  - Friction cost method: Valuation of the time invested by companies in finding and training (friction time) a worker to perform the activities of the sick employee, provided that such replacement is necessary.

» **Intangible costs:** Valuation is complex, given that there is no market where these goods are traded. However, two methods are proposed:
  - Qualitative method of variation in the patient's quality of life.
  - Quantitative method for estimating individual preferences.

On the other hand, García (2011) classifies costs as direct or indirect, tangible or intangible, according to the following categories:

TABLE 2
TYPES OF COSTS FOUND IN COST OF DISEASE STUDIES

	TANGIBLE COSTS	INTANGIBLE COSTS
DIRECT COSTS	– Salaries – Equipment – Reagents – Fuel – Water, gas – Food – Materials – Medications – Building – Electricity – Telephone – Transport – Out-of-pocket expenses of the patient and their family	– Pain – Insecurity – Fear – Dissatisfaction – Disability – Anxiety – Loss of self-esteem
INDIRECT COSTS	– Loss of productivity due to life-threatening illness – Unpaid care	

Source: García (2011).

According to the author, the decision on which costs to include depends on factors associated with the research objectives. While economic analyses have focused on costs affecting only the healthcare system, in recent years, costs associated with patients, their families, and social services related to treating the disease or dealing with its consequences have also been incorporated into the analysis.

COSTS OF CARE WORK

In relation to estimating the costs of unpaid care, McDaid (2001) notes that estimates vary widely, partly due to differences in study samples and the challenges involved in measuring caregiving time. The author highlights the need to standardize the methodology for estimating these costs. He also points out that a limitation in establishing caregiving time is the difficulty in identifying it, as caregivers are often responsible for other household activities: "joint time," which is time spent simultaneously on caregiving and other activities. According to the author, several measurement instruments consist of collecting detailed information from the caregiver about the activities carried out on a "typical day," which allow estimating how much of this time was dedicated to caregiving. Another method used is to compare the distribution of time in "normal" households with that of households with one caregiver. With regard to valuing caregiving time, McDaid proposes five methods, some of which were developed by Ripari et al. (2012):

- **Opportunity cost approach:** It estimates the best alternative use of the caregiver's time.
- **Friction cost approach:** It estimates the costs of the temporary absence from work plus the costs of the replacement.
- **Replacement cost approach:** It estimates the potential cost of replacing unpaid care with professional assistance.
- **Payment of state benefits:** Such payments are considered remuneration for the work of the caregiver.
- **Travel time method:** Used in transport cost analysis to value time based on the willingness to pay for reduced travel time to be able to carry out other activities.

An analysis of the importance of including unpaid care in economic or cost of disease analyses is found in a study by Krol et al. (2015). According to their research, unpaid care contributes to societal well-being, but it entails a significant cost on caregivers in terms of time, health, and personal well-being, costs that are usually excluded from economic evaluations in healthcare interventions. In this context, the study analyzes 100 economic evaluations of interventions linked to Alzheimer's disease, metastatic colorectal cancer, Parkinson's disease and rheumatoid arthritis, and finds that only 23 include unpaid care, and among them, most consider only the time costs, with very few addressing the impact on caregivers' health and well-being. The study concludes that the inclusion of unpaid care significantly increases costs and, therefore, should be taken into account in economic evaluations.

Carrillo et al. (2014) characterized caregivers of people with chronic illnesses in the Colombian Pacific region and identified the level of burden generated. Villarreal et al. (2007) explored the concept of 'hidden human cost' as the intangible cost faced by Alzheimer's patients, their family as caregivers, and the community.

METHODOLOGY

In this study, two research questions have been raised:

- What is the monetary cost associated with exposure to heavy metals and metalloids in terms of health impact?
- What is the cost of care work associated with exposure to heavy metals and metalloids?

WHAT IS THE MONETARY COST ASSOCIATED WITH EXPOSURE TO HEAVY METALS AND METALLOIDS IN TERMS OF HEALTH IMPACT?

Exposure to heavy metals and other toxic substances causes a number of health problems to the Peruvian population, which in turn result in costs for affected families. However, one of the main limitations of the study is the lack of detailed data about those who are directly affected[43], the associated health problems, and the treatments received. For this reason, households with members suffering from chronic diseases represent a valid proxy for analyzing the economic costs associated with exposure to heavy metals. This assumption is based on evidence indicating a high probability of developing chronic diseases in populations exposed to heavy metals and metalloids.

Chronic diseases have a significant impact on household spending. According to the PAHO, the risk of out-of-pocket healthcare expenses is higher in households with NCDs than in those without[44]. García and Rojas (2021) analyzed the out-of-pocket healthcare expenses in Peru and found that the most important determinant of out-of-pocket expenditure (OOP) by ability to pay[45] is the number of individuals with chronic diseases in the household; that is, the more people with these diseases, the higher the out-of-pocket expenses.

In this study, the National Household Survey (ENAHO) is used to compare the out-of-pocket expenditure of households from across the country with and without members with a chronic illness between 2015 and 2023. Out-of-

43 Despite Act No. 31189, Act to Strengthen the Prevention, Mitigation and Care of People's Health Affected by Contamination with Heavy Metals and Other Chemical Substances, published in 2021, which establishes, in its article 5, the obligation to implement and update the National Registry of People Affected by Contamination with Heavy Metals and Other Chemical Substances: https://busquedas.elperuano.pe/dispositivo/NL/1949664-1

44 See https://www.paho.org/en/topics/economics-ncds

45 This type of expenditure is defined in the study as "the share of household income remaining after food expenditure that is allocated to healthcare costs."

pocket healthcare expenses are defined as all monetary expenditure made by the household on medical care, medicines, medical supplies, hospitalization, etc.

WHAT IS THE CARE WORK COST ASSOCIATED WITH THE EXPOSURE TO HEAVY METALS AND METALLOIDS?

Other costs associated with the care provided to a dependent household member with a chronic illness are the time dedicated to caregiving and the opportunity costs. Unpaid care work prevents the person providing from engaging in activities for which they could receive income. Ripari et al. (2012) and McDaid (2001) proposed the opportunity cost or replacement cost methodology, which consists of valuing the benefit lost as a consequence of the time dedicated to care, based on the caregiver's market salary.

To estimate the time spent on care work, this study uses the National Time Use Survey (ENUT), which was conducted in 2010. This survey includes questions about caregiving for household members with physical or mental difficulties or chronic illnesses, or those who are fully dependent due to advanced age. Because chronic illnesses generate total or partial dependency[46] (Achury et al., 2011), the information provided by the ENUT is relevant to the analysis. In addition to the question that considers the time dedicated to taking care of fully dependent family members, the time dedicated to household chores is also taken into account; as McDaid (2001) pointed out, estimating the time dedicated exclusively to caregiving is often challenging, as it tends to overlap with the time dedicated to other household chores, making it difficult to accurately determine when one activity ends and another begins.

The ENAHO's Employment module is also used to estimate an average hourly wage and assess the time spent on household chores for both types of households (with or without fully dependent members). Additionally, wages are calculated by gender and area of residence to be employed as appropriate in assessing time spent on caregiving.

46 In the first case, there is a complete loss of autonomy, and the care of a caregiver is essential; in the second case, the person is capable of self-care but requires support and guidance throughout the illness and in accessing health services.

LIMITATIONS

Due to the lack of detailed information on the populations directly affected, we have used proxies based on data from households with members suffering from chronic diseases (ENAHO) and households with dependent members (ENUT) to estimate the costs generated by exposure to heavy metals. Therefore, the study has faced significant limitations.

Firstly, there are no specific data on the population exposed to heavy metals and metalloids in Peru, nor are there in-depth studies on the type of health effects and associated direct costs. For this reason, estimates are based on reasonable assumptions derived from the literature and the use of existing surveys.

Secondly, the ENUT, the source used to analyze how much time is allocated to caregiving, is a survey conducted in 2010. Although this may limit the accuracy of the estimates, this survey remains the only tool currently available for addressing this dimension.

Finally, the analysis is limited to caregiving activities carried out within the home, as the sources used do not allow for the study of the contribution of community actors or external support networks. This exclusion, although relevant, again reflects the limitations of the available data.

These methodological restrictions highlight the urgency of having better statistical information systems in the country for the adequate monitoring of the exposed population, their health conditions, and the associated direct costs. This would not only enable more accurate estimates but would also lay the groundwork for implementing effective public policies to mitigate the impacts of heavy metal contamination.

These methodological considerations and limitations provide the framework within which this study has been conducted. The results obtained are presented below; they answer the questions posed above and allow us to estimate the costs generated by exposure to heavy metals in Peru, which is especially relevant in the context of energy transition and the resulting increase in demand for transition minerals.

Credit: Jacob Balzani Lööv

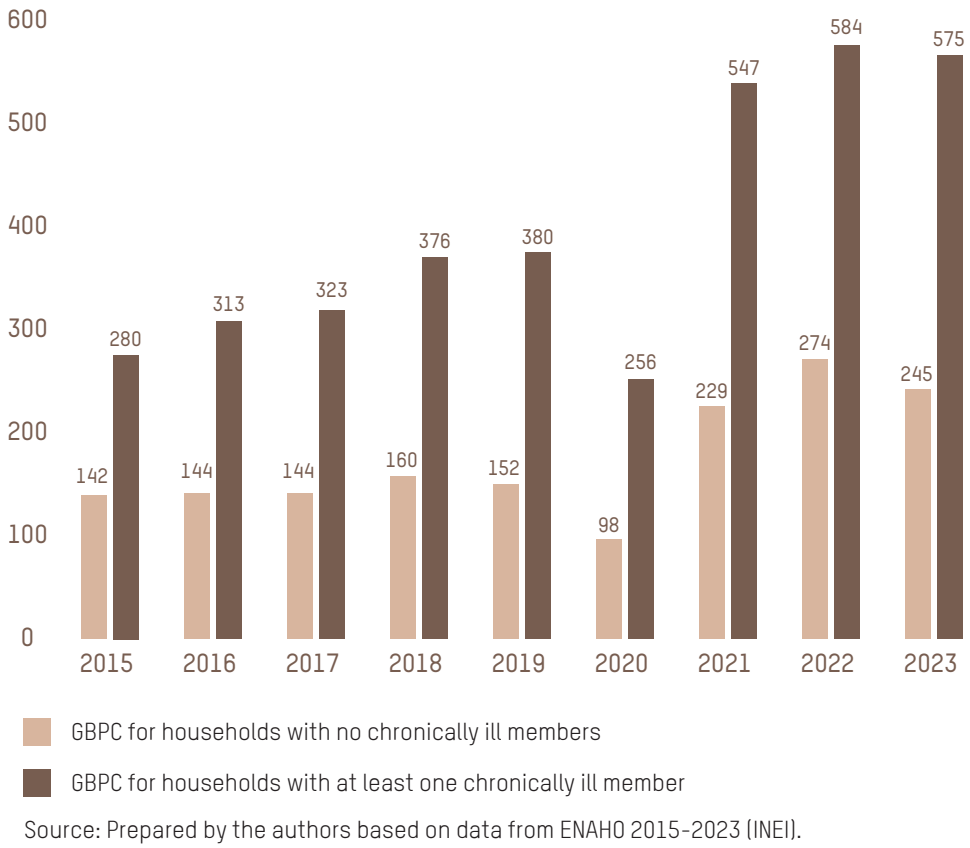
RESULTS

HEALTHCARE COSTS

INCREASE IN HOUSEHOLD HEALTH EXPENDITURE AS A RESULT OF A MEMBER HAVING A CHRONIC ILLNESS

Chart 6 illustrates the difference in per capita out-of-pocket expenditure between households without chronically ill members and those with at least one chronically ill member. The difference is statistically significant in all years[47]. On average, between 2015 and 2023, **households with at least one chronically ill member spent S/ 227 more per person per year** (in 2021 prices) **than those without**. This corresponds to an average annual expenditure of S/ 404 per person (in 2021 prices) in households with chronically ill members compared to S/ 176 per person in households without.

CHART 6
PER CAPITA OUT-OF-POCKET EXPENDITURE IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS, 2015–2023 (IN 2021 CONSTANT S/)

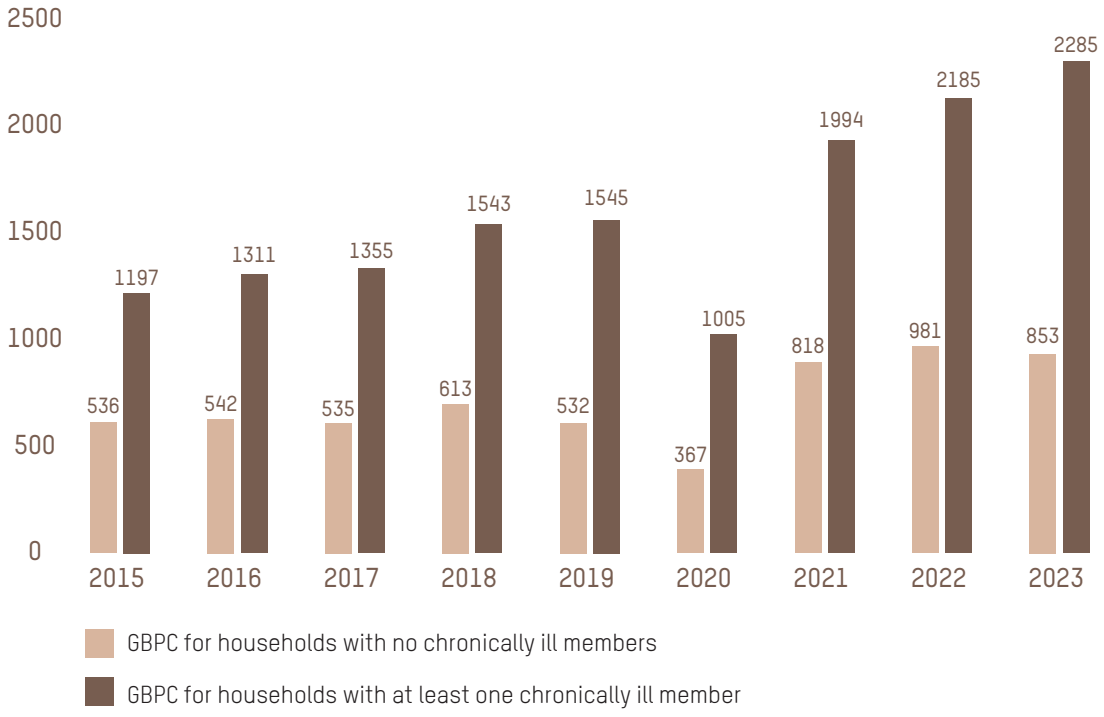


Source: Prepared by the authors based on data from ENAHO 2015-2023 (INEI).

47 A test of means is performed in each year and a p- value equal to 0.000 is obtained in all cases.

Chart 7 presents the average total out-of-pocket expenditure (OOP) of households with and without chronically ill members from 2015 to 2023. A statistically significant difference is observed throughout the period, with an average gap of around S/ 960. **Households without chronically ill members spent an average of S/ 642 annually on health-related goods and services, while households with one or more chronically ill members spent an average of S/ 1,602.** In other words, households that bear the economic burden of supporting at least one member with a chronic illness spend 2.5 times more than those without.

CHART 7
TOTAL OUT-OF-POCKET EXPENDITURE IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS, 2015-2023 (IN 2021 CONSTANT S/)



Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

Table 3A shows the differences in total and per capita out-of-pocket expenditure, along with the averages shown in previous charts for the 2015-2023 period. The gap widens in all years except 2020 and 2023, increasing from S/ 661 in 2015 to S/ 1,432 in 2023, in real terms adjusted for inflation. This expansion represents an **increase of over 50 % in spending since the beginning of the period, reflecting a worsening financial burden for households with members affected by chronic illnesses.**

TABLE 3A
PER CAPITA AND TOTAL OUT-OF-POCKET EXPENDITURE IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS, IN S/ FOR 2021

	PER CAPITA OUT-OF-POCKET EXPENDITURE (S/ 2021)		TOTAL OUT-OF-POCKET EXPENDITURE (S/ 2021)	
Year	Households without chronically ill members	Households with at least one chronically ill member	Households without chronically ill members	Households with at least one chronically ill member
2015	141.6	280.0	535.6	1197.0
2016	143.5	313.3	542.0	1311.2
2017	143.6	323.4	535.1	1355.4
2018	159.8	376.3	613.3	1542.6
2019	152.1	380.2	532.1	1544.8
2020	98.5	255.6	366.7	1005.5
2021	228.5	546.5	817.6	1994.4
2022	274.4	583.6	981.4	2185.3
2023	245.0	574.6	852.9	2285.2
Average	176.3	403.7	641.9	1602.4

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

Table 3B presents the above figures expressed as monthly monetary expenditure and gross monthly expenditure, which includes non-monetary and in-kind spending. On average, annual out-of-pocket expenditure accounts for approximately 2.89 % of total spending for households without chronically ill members, compared to approximately 5.69 % in households with at least one chronically ill member. This reflects a gap of just over 2 percentage points. When non-monetary expenditure are included, this gap remains at around 2 percentage points.

TABLE 3B
OUT-OF-POCKET EXPENDITURE AS A PERCENTAGE OF TOTAL SPENDING IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS

	OOP AS % OF MONTHLY MONETARY SPENDING		OOP AS % OF GROSS MONTHLY SPENDING	
Year	Households without chronically ill members	Households with at least one chronically ill member	Households without chronically ill members	Households with at least one chronically ill member
2015	2.85 %	5.24 %	2.16 %	3.86 %
2016	2.81 %	5.24 %	2.11 %	3.84 %
2017	2.56 %	5.12 %	1.89 %	3.72 %
2018	2.80 %	5.53 %	2.04 %	4.04 %
2019	2.41 %	5.36 %	1.79 %	3.89 %
2020	1.79 %	3.82 %	1.30 %	2.72 %
2021	3.83 %	7.45 %	2.83 %	5.29 %
2022	3.81 %	6.94 %	2.87 %	5.05 %
2023	3.16 %	6.48 %	2.38 %	4.73 %
Average	2.89 %	5.69 %	2.15 %	4.13 %

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

DIFFERENCES IN HOUSEHOLD HEALTH EXPENDITURE BASED ON AREA OF RESIDENCE

Table 4 performs the same analysis, this time disaggregating households by area of residence and showing average values for the 2015-2023 period. As shown, **out-of-pocket health expenditure in absolute terms is significantly higher in urban areas** S/ 778.7 for households without chronically ill members and S/ 1819 for households with chronically ill members) **compared to rural areas** S/ 312.8 and S/ 676.9, respectively. A similar pattern is observed in per capita out-of-pocket expenditure.

Secondly, **income and expenditure dynamics** differ between urban and rural contexts. While higher income levels in urban households allow them to absorb higher healthcare costs, in rural areas, even lower absolute out-of-pocket expenditure can represent a substantial share of disposable income. Finally, unequal access to medications and specialized treatments between both areas may also contribute to the observed differences.

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TABLE 4
TOTAL PER CAPITA OUT-OF-POCKET HEALTH EXPENDITURE AND ITS SHARE OF HOUSEHOLD SPENDING IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS BY AREA OF RESIDENCE, 2015-2023 AVERAGE

Category	URBAN HOUSEHOLDS, 2015-2023 AVERAGE		RURAL HOUSEHOLDS, 2015-2023 AVERAGE	
	Households without chronically ill members	Households with at least one chronically ill member	Households without chronically ill members	Households with at least one chronically ill member
Total out-of-pocket expenditure (S/ for 2021)	778.7	1,819.2	312.8	676.9
Per capita out-of-pocket expenditure (S/ for 2021)	215.8	440.7	81.1	180.5
OOP as % of monthly monetary spending	2.99 %	5.82 %	2.65 %	5.10 %
OOP as % of gross monthly spending	2.33 %	4.32 %	1.73 %	3.29 %

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

DIFFERENCES IN HOUSEHOLD HEALTH EXPENDITURE BASED ON THE SEX OF THE HEAD OF HOUSEHOLD

Table 5 presents the analysis of out-of-pocket health expenditure by the sex of the head of household, including a category for single female-headed households (without a partner). It can be observed that the share of out-of-pocket health expenditure both monetary and gross expenditures, and whether or not the household includes members with chronic illnesses is statistically similar across all three household types.

TABLE 5
TOTAL PER CAPITA OUT-OF-POCKET HEALTH EXPENDITURE AND ITS SHARE OF HOUSEHOLD SPENDING IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS BY SEX OF HEAD OF HOUSEHOLD, 2015-2023 AVERAGE

Category	MALE HEAD OF HOUSEHOLD, 2015-2023 AVERAGE		FEMALE HEAD OF HOUSEHOLD, 2015-2023 AVERAGE		SINGLE FEMALE HEAD OF HOUSEHOLD, 2015-2023 AVERAGE	
	Households without chronically ill members	Households with at least one chronically ill member	Households without chronically ill members	Households with at least one chronically ill member	Households without chronically ill members	Households with at least one chronically ill member
Total out-of-pocket expenditure (S/ for 2021)	645.8	1620.6	626.3	1559.6	553.9	1487.3
Per capita out-of-pocket expenditure (S/ for 2021)	170.9	380.9	192.1	416.8	191.7	427.5
OOP as % of monthly monetary spending	2.92 %	5.68 %	2.80 %	5.71 %	2.75 %	5.75 %
OOP as % of gross monthly spending	2.18 %	4.14 %	2.09 %	4.11 %	2.00 %	4.06 %

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

DIFFERENCES IN HOUSEHOLD HEALTH EXPENDITURE BASED ON THE AREA OF RESIDENCE AND SEX OF THE HEAD OF HOUSEHOLD

Table 6 shows the difference in out-of-pocket health expenditure between households with one or more chronically ill members and those without. This difference represents the additional monthly healthcare cost associated with having one or more family members with a chronic illness. The data is disaggregated by household type, by area of residence and by sex of the head of household.

TABLE 6
DIFFERENCE IN TOTAL OUT-OF-POCKET HEALTH EXPENDITURE BETWEEN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS BY AREA OF RESIDENCE AND SEX OF THE HEAD OF HOUSEHOLD, 2015-2023 AVERAGE

HOUSEHOLD TYPE	HOUSEHOLDS WITHOUT CHRONICALLY ILL MEMBERS (S/ FOR 2021)	HOUSEHOLDS WITH AT LEAST ONE CHRONICALLY ILL MEMBER (S/ FOR 2021)	ANNUAL DIFFERENCE (S/ FOR 2021)
Total households	641.9	1602.4	960.5
Urban households	778.7	1819.2	1040.5
Rural households	312.8	676.9	364.1
Households with a male head	645.8	1620.6	974.9
Households with a female head	645.8	1620.6	974.9
Households with a single female head	553.9	1487.3	933.3

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

CHANGES IN THE DISTRIBUTION OF EXPENDITURE IN HOUSEHOLDS WITH A CHRONICALLY ILL MEMBER

Table 7 compares the average distribution of household expenditure across spending categories between households with one or more chronically ill members and those without, for the total number of households and for households by area of residence and sex of the head of household. The category "Care, health maintenance, and medical services"[48] is used to assess the impact of chronic illness on spending patterns.

For the 2015-2023 period, households with chronically ill members allocated an average of 7.5 % of their total spending to this category, compared to just 3.9 % in households without chronically ill members. The spending category that saw the greatest reduction in relative share among households with chronically ill members was "Food," which accounted for 45.3 % of total expenditures, compared to 47.3 % in households without members affected

48 Includes payments (out-of-pocket, money transfer, or other payment methods) made by a household member for consultations, hospitalization, surgery, medication purchases, and other services. See https://shorturl.at/WFb8S

by chronic illness. This may suggest that, to cover expenses associated with chronic illness, households are reallocating resources away from essential categories such as food.

TABLE 7
DISTRIBUTION OF MONTHLY HOUSEHOLD EXPENDITURE BY SPENDING CATEGORY IN HOUSEHOLDS WITH AND WITHOUT CHRONICALLY ILL MEMBERS BY AREA OF RESIDENCE, 2015-2023 AVERAGE

Spending category	TOTAL HOUSEHOLDS			URBAN HOUSEHOLDS			RURAL HOUSEHOLDS		
	Distribution of monthly household spending (%)		Difference (pp)	Distribution of monthly household spending (%)		Difference (pp)	Distribution of monthly household spending (%)		Difference (pp)
	Without chronic diseases	With chronic diseases		Without chronic diseases	With chronic diseases		Without chronic diseases	With chronic diseases	
Food	47.3	45.3	-2.0	47.2	44.9	-2.3	47.5	47.2	-0.3
Clothing and footwear	7.4	5.8	-1.6	6.1	5.1	-0.9	10.6	8.5	-2.1
Housing rental, fuel, electricity, and home maintenance	11.0	11.0	-0.1	12.9	11.9	-1.0	6.5	6.9	0.4
Furniture, fixtures and home maintenance	6.7	6.1	-0.6	5.6	5.4	-0.1	9.3	8.8	-0.5
Care, health maintenance and medical services	3.9	7.5	3.6	4.1	7.8	3.6	3.3	6.2	2.9
Transport and communications	9.5	9.8	0.2	9.2	9.5	0.3	10.3	10.8	0.5
Recreation, entertainment, cultural and educational services	7.9	8.4	0.5	8.6	9.1	0.5	6.5	5.8	-0.7
Other goods and services	6.2	6.2	0.0	6.3	6.3	-0.1	6.0	5.9	-0.2

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

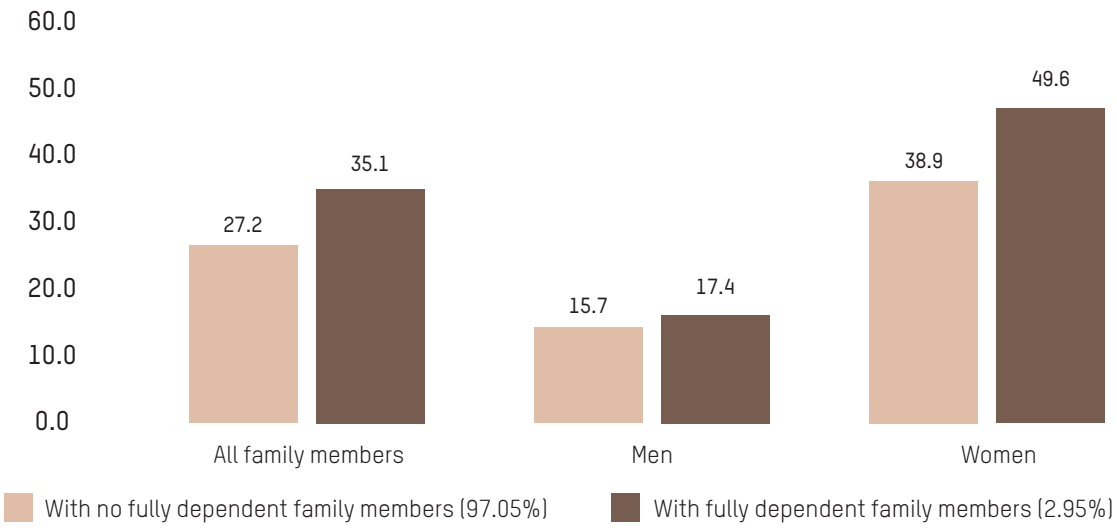
COSTS TO WOMEN FROM EXPOSURE TO HEAVY METALS

Below are the results of the estimated time spent on care work in households with and without fully dependent members requiring permanent care.

TIME SPENT ON HOME CARE WORK IN HOUSEHOLDS WITH A FULLY DEPENDENT MEMBER

Chart 8 illustrates the time spent on care work in households with and without fully dependent members. On average, **households without fully dependent members spend 27 hours per week on care work, while those with fully dependent members spend 35 hours per week** a difference of 8 hours. More specifically, men spend 15 hours per week on care work in households without fully dependent members, and 17 hours per week in those with fully dependent members, while **women spend 39 hours per week on care work in households without fully dependent members, and 50 hours per week in those with fully dependent members.** This means that, in households with dependent members, women dedicate nearly three times more hours to care work than men.

CHART 8
TIME SPENT ON CARE WORK IN HOUSEHOLDS WITH OR WITHOUT FULLY DEPENDENT MEMBERS, BY SEX OF THE HEAD OF HOUSEHOLD, 2010
(HOURS PER WEEK)

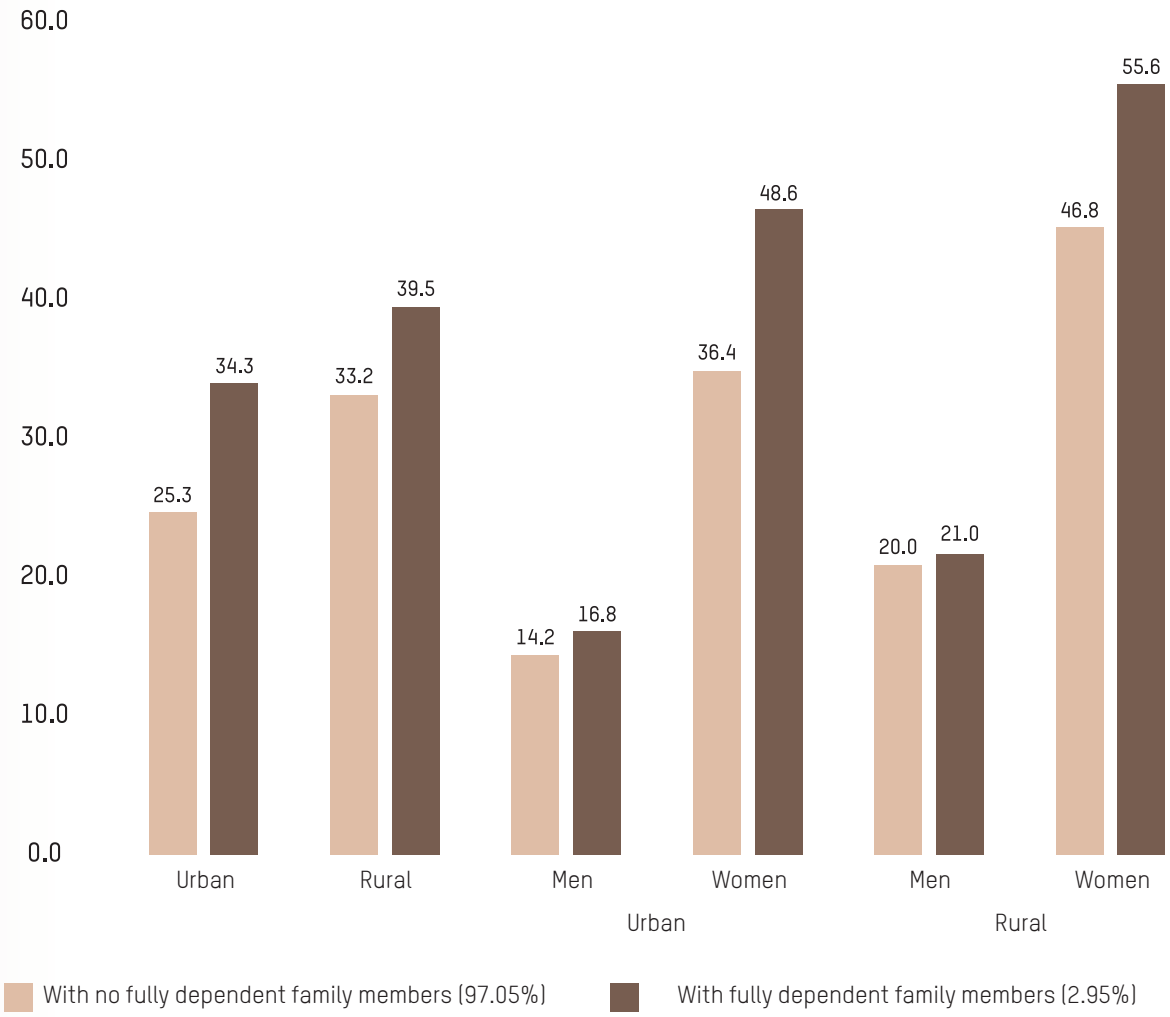


Source: Prepared by the authors based on data from ENUT (INEI, 2010).

DIFFERENCES IN TIME SPENT ON CARE WORK BASED ON AREA OF RESIDENCE

Chart 9 shows that, in rural households, the time spent on care work is generally greater. **Women in rural households with fully dependent members spend more than twice as much time on care work as men in rural households with this condition** and more than three times as much time as men in urban households with fully dependent members.

CHART 9
TIME SPENT ON CARE WORK IN HOUSEHOLDS WITH OR WITHOUT FULLY DEPENDENT HOUSEHOLD MEMBERS, BY SEX OF THE HEAD OF HOUSEHOLD AND AREA OF RESIDENCE, 2010 (HOURS PER WEEK)



Source: Prepared by the authors based on ENUT (INEI, 2010).

FORGONE WAGES FOR TIME SPENT ON HOME CARE WORK IN HOUSEHOLDS WITH A FULLY DEPENDENT MEMBER

Table 8 analyzes the time spent on home care work for both the total population and disaggregated by sex. As explained in the methodology section, an average hourly wage has been estimated for the population by geographic area using information from the National Household Survey (ENAHO) by the National Institute of Statistics and Census. This allowed us to estimate the lost labor income under each scenario. Wages have been also differentiated by sex to reflect gender-based disparities. Based on this approach, the estimated monthly cost of hours dedicated to care work in households with fully dependent members is S/ 1,353.8 (in 2021 constant S/) for the general population, S/ 758.9 for men, and S/ 1,560.4 for women.

TABLE 8
ESTIMATED VALUE OF FORGONE WAGES FOR HOURS DEDICATED TO CARE WORK IN HOUSEHOLDS WITH FULLY DEPENDENT MEMBERS, 2010

Sex	Monthly hours dedicated to care work, 2010		Average hourly wage 2023 (S/ 2021)	Monthly forgone income for hours dedicated to home care work in 2023, in 2021 S/		Difference (S/ 2021)
	Without fully dependent members	With fully dependent members		Without fully dependent members	With fully dependent members	
Men and women	108.8	140.4	S/ 9.6	S/ 1049.11	S/ 1353.82	S/ 305
Men	62.8	69.6	S/ 10.9	S/ 684.83	S/ 758.99	S/ 74
Women	155.6	198.4	S/ 7.9	S/ 1223.78	S/ 1560.40	S/ 337

Source: Prepared by the authors based on ENAHO 2015-2023 (INEI).

Women dedicate 198.4 hours per month to caring for their children in households with at least one fully dependent member, making it highly unlikely that **they can pursue other activities. As a result, they forgo an estimated monthly labor income of S/1,560.40, which currently exceeds the national minimum wage.**

DIFFERENCES IN FORGONE WAGES FOR THE TIME SPENT ON CARE WORK IN HOUSEHOLDS WITH A FULLY DEPENDENT MEMBER BASED ON AREA OF RESIDENCE AND SEX OF THE HEAD OF HOUSEHOLD

Tables 9 and 10 present the estimated time spent on household care work, broken down by sex of the head of household and area of residence. The valuation uses differentiated wage rates by sex and location, as appropriate. Rural women dedicate the highest number of hours to care work, with over 222 hours per month, which translates into a forgone monthly income of S/ 840. Notably, the estimated hourly wage for women in rural areas is about half that for men, which affects the valuation of a real opportunity cost consistent with the high number of hours they invest in the care of fully dependent people.

TABLE 9
ESTIMATED VALUE OF FORGONE WAGES FOR HOURS DEDICATED TO CARE IN HOUSEHOLDS WITH FULLY DEPENDENT MEMBERS BASED ON AREA OF RESIDENCE, 2010

Sex	Monthly hours dedicated to care work, 2010		Hourly wage, 2023 (S/ 2021)	Monthly forgone income for hours dedicated to care work in 2023, in S/ 2021		Difference (S/ 2021)
	Without fully dependent members	With fully dependent members		Without fully dependent members	With fully dependent members	
Urban						
Men and women	101.20	137.20	S/ 10.5	S/ 1066.5	S/ 1445.9	S/ 379
Men	56.80	67.20	S/ 12.1	S/ 686.2	S/ 811.8	S/ 126
Women	145.60	194.40	S/ 8.5	S/ 1241.4	S/ 1657.5	S/ 416
Rural						
Men and women	132.80	158.00	S/ 5.5	S/ 723.8	S/ 861.2	S/ 137
Men	80.00	84.00	S/ 6.3	S/ 501.5	S/ 526.6	S/ 25
Women	187.20	222.40	S/ 3.8	S/ 707.1	S/ 840.0	S/ 133

Source: Prepared by the authors based on ENAHO, 2019; ENUT, 2010 (INEI).

Table 10 shows that the highest estimated costs are incurred by women in households with female heads and single female heads. In this case, the monthly forgone income due to care work in households with fully dependent members amounts to S/ 1723.6 and S/ 1675.4, respectively.

TABLE 10
ESTIMATE VALUE OF FORGONE WAGES FOR HOURS SPENT ON CARE WORK IN HOUSEHOLDS WITH FULLY DEPENDENT MEMBERS BY SEX OF THE HEAD OF HOUSEHOLD, 2010

Sex	Monthly hours dedicated to household care work, 2010		Hourly wage, 2023 (S/ 2021)	Monthly forgone income for hours dedicated to home care work in 2023, in S/ 2021		Difference (S/ 2021)
	Without fully dependent members	With fully dependent members		Without fully dependent members	With fully dependent members	
Male head of household						
Men and women	109.2	134.4	S/ 10.0	S/ 1086.8	S/ 1337.5	S/ 250.8
Men	64.4	77.6	S/ 11.0	S/ 711.1	S/ 856.8	S/ 145.7
Women	164	190	S/ 7.6	S/ 1247.2	S/ 1444.9	S/ 197.7
Female head of household						
Men and women	107.6	152.8	S/ 9.0	S/ 972.5	S/ 1381.0	S/ 408.5
Men	54	47.6	S/ 10.4	S/ 563.8	S/ 497.0	-S/ 66.8
Women	135.6	212	S/ 8.1	S/ 1102.5	S/ 1723.6	S/ 621.1
Single female head of household						
Men and women	108.4	150.8	S/ 8.5	S/ 918.5	S/ 1277.8	S/ 359.3
Men	53.2	48.4	S/ 9.5	S/ 507.5	S/ 461.7	-S/ 45.8
Women	134	208.8	S/ 8.0	S/ 1075.2	S/ 1675.4	S/ 600.2

Source: Prepared by the authors based on ENAHO, 2019; ENUT, 2010 (INEI).

SEX OF CAREGIVERS IN HOUSEHOLDS WITH MEMBERS REQUIRING PERMANENT CARE

Table 11 shows the gender distribution of individuals who report caring for household members who require permanent care, along with the average number of hours men and women dedicate to this activity. The data reveal that **67.8 % of those who report doing care work are women**, who dedicate an average of 16.8 hours per week to household members requiring permanent care, compared to 8.9 hours reported by men.

TABLE 11
DIFFERENCE IN TIME SPENT ON CARE WORK BY MEN AND WOMEN IN HOUSEHOLDS WITH FULLY DEPENDENT MEMBERS, 2010

Sex	Sex composition of the sample dedicating time to caring for a fully dependent family member (2.95%)	Average time spent caring for fully dependent family members
Women	67.8 %	16.8
Men	32.2 %	8.9

Source: Prepared by the authors based on ENUT (INEI, 2010).

Tables 12 and 13 replicate the analysis by area of residence and sex of the head of household. **The greatest differences are found in households with female heads.**

TABLE 12
DIFFERENCE IN TIME SPENT ON CARE WORK BY MEN AND WOMEN IN HOUSEHOLDS WITH FULLY DEPENDENT MEMBERS BY AREA OF RESIDENCE. 2010

Sex	Sex composition of the sample dedicating time to caring for a fully dependent family member (2.95%)		Average time spent caring for fully dependent household members	
	Urban	Rural	Urban	Rural
Women	68.5 %	63.3 %	17.1	14.5
Men	31.5 %	36.7 %	9.3	6.8

Source: Prepared by the authors based on ENUT (INEI, 2010).

TABLE 13
DIFFERENCE IN TIME SPENT ON CARE WORK BY MEN AND WOMEN IN HOUSEHOLDS WITH FULLY DEPENDENT MEMBERS BY SEX OF THE HEAD OF HOUSEHOLD, 2010

Sex	Sex composition of the sample dedicating time to caring for a fully dependent family member (2.95%)			Average time spent caring for fully dependent household members		
	Male head of household	Female head of household	Single female head of household	Male head of household	Female head of household	Single female head of household
Women	59.1 %	85.3 %	84.0 %	15.9	18.1	16.4
Men	40.9 %	14.7 %	16.0 %	9.9	3.6	3.6

Source: Prepared by the authors based on ENUT (INEI, 2010).

Credit: Jacob Balzani Loov

CONCLUSIONS

- Estimating the health costs associated with the exposure to heavy metals is subject to several limitations. **There are no available data to accurately identify the affected population** or the specific health effects they have experienced. As a result, it is not possible to directly quantify the cost of these effects; instead, estimates must rely on studies on populations with health conditions similar to those related to heavy metal contamination.

- Chronic or non-communicable diseases (NCDs) are the most common health conditions among individuals exposed to heavy metals. According to the study's results, out-of-pocket **expenses rise significantly in households with at least one member suffering from a chronic illness.** Since exposure to heavy metals increases the risk of developing such conditions, households with at least one affected member are likely to face higher out-of-pocket expenses compared to those not exposed.

- Between 2015 and 2023, households with a member suffering from a chronic illness spent, on average, S/ 227 more per person per year than those without chronically ill members. Likewise, **households with chronically ill members incurred out-of-pocket expenses that were 2.5 times higher than those of households without such member; the gap between both was S/ 960.** As of 2023, spending increased by 50 % compared to 2015, reflecting a deteriorating financial situation for households affected by chronic diseases.

- **Out-of-pocket healthcare expenses are considerably higher in urban areas** S/ 778.7 in households without chronically ill members and S/ 1,819 in households with chronically ill members **compared to rural areas** S/ 312.8 and S/ 676.9, respectively. This disparity could be explained by various structural factors. For example, urban households tend to have greater access to private healthcare services, which are typically more expensive, whereas rural households primarily rely on public services that, while lower in cost, often suffer from limited coverage and poorer quality. Furthermore, urban households generally have higher income levels, allowing them to absorb greater healthcare costs, while in rural areas, out-of-pocket spending, although lower, can represent a considerable share of disposable income[49].

49 Since the analysis in this study is based on 2021 prices, we consider the average monthly income for that year, which was S/ 1,445.1 in urban areas and S/ 814.6 in rural areas. See https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1870/libro.pdf

- Chronic diseases often lead to total or partial dependency (Achury et al., 2011). In contexts of heightened health vulnerability, such as those with high risk of exposure to heavy metals, the responsibility of caring for members affected by heavy metals falls primarily on women. This study found that **women dedicate an average of 50 hours per week to household caregiving when there are fully dependent members nearly three times more than men. The figure increases to 55.6 hours per week for rural women, exceeding a full-time workday of 8 hours.** Overall, women provide care for fully dependent family members in 67.8 % of cases, spending twice as much time on this task as men. In rural areas, the gap widens even further, and for female heads of household, the time spent on fully dependent members can be up to five times greater than that spent by their male counterparts.

- The study also estimates that women lose an average of S/1,560.40 per month in wages due to the time spent caring for fully dependent members an amount that exceeds the current minimum wage. Although rural women spend more hours on caregiving, their estimated monthly wage loss is S/ 840 due to the official hourly wage by geographic area. The highest cost of exposure to heavy metals falls on women who are heads of household, whose lost monthly wages from caregiving range between S/ 1,675.40 and S/ 1,723.60.

DISCUSSION OF PUBLIC POLICIES

OUT-OF-POCKET HEALTH EXPENSES DUE TO EXPOSURE TO HEAVY METALS AND METALLOIDS

» ***Implementation of a national registry of people exposed to and affected by heavy metals, metalloids, and other toxic substances.***
The National Platform of People Affected by Metals, Metalloids, and Other Toxic Chemical Substances (Planametox) is a coalition of leaders from 13 Peruvian departments affected by exposure to heavy metals, metalloids and other toxic substances. Since 2017, these departments, organized in 4 macro-regions, have been collectively advocating for public policies that address the human and environmental health problems experienced in their territories, particularly in areas of extractive activities. As part of this advocacy process, in coordination with the Technical Roundtable on Environmental and Human Health (MTSASH)[50], Act No. 31189 was approved in 2021, whose article 5 mandates the creation and maintenance of a National Registry of People Affected in Their Health by Contamination with Heavy Metals and Other Chemical Substances (hereinafter, the National Registry).

Four years after its mandatory execution, the National Registry is implemented based on a record system containing information from people receiving medical attention, that is, those able to access health facilities and receive medical care and a diagnosis. However, 32 % of the population with health conditions do not receive medical care, with this figure rising to 36.3 % in rural areas (INEI, 2024); therefore, the State's obligation to implement the National Registry actually relies on the efforts of those affected to access health care. In Peru, access to healthcare depends heavily on the financial capacity of families: 83 % of the Peruvian population believes that access to medical care is unequal or very unequal (Oxfam e IEP, 2024).

Moreover, the National Registry must not be limited to individuals already diagnosed with poisoning. As established in the Regulations of Act No. 31189[51] and reaffirmed by the MTSASH[52], it is also essential to include those who have been exposed, since they are also at risk, and health deterioration becomes more likely as exposure becomes chronic. The MTSASH has also highlighted diagnosis challenges as a

50 Coordination space for civil society organizations that provides technical assistance to Planametox. For further information, see https://planametox.org/

51 Approved by Supreme Decree No. 007-2023-SA.

52 See https://saludconlupa.com/noticias/el-peru-tendra-un-registro-de-afectados-por-la-contaminacion-con-metales-pesados/

result of the difficulties in identifying the causality of diseases due to, among other reasons, the lack of specialized medical personnel.

It is urgent to implement **the National Registry with sufficient data, organized by geographic area, to define the incidence and prevalence of health effects caused by exposure to heavy metals. Such data are essential for assessing the various levels of health impact and enabling the organization and/or adaptation of the healthcare system.** The Act assigns responsibility to the Ministry of Health (MINSA) for maintaining and regularly updating this registry. This is especially relevant given Ministerial Resolution No. 184-2024-MINSA, which establishes "exposure of the population to heavy metals, metalloids, and other hazardous products" as the ninth of 53 national health priorities.

A major limitation of this study has been the lack of official databases on the population exposed to heavy metals. Access to reliable data is key to measuring the effectiveness of public policies. In line with the objectives of this study, a properly implemented National Registry could help identify the number of individuals—and households—incurring out-of-pocket healthcare expenses, which in effect subsidize the country's weak healthcare system. Such registry could serve as a state tool to progressively guarantee access to effective medical care and help ensure that exposed individuals and their families can live in dignified conditions. It would also help shift the financial burden away from these families, ending the implicit subsidy they currently provide and addressing the structural inequality in which they are trapped; in addition to the multiple barriers faced by the average citizen, these households must cope with the progressive health deterioration of exposed members and the resulting economic strain.

» ***Characterization of out-of-pocket expenditure of people affected by heavy metals***

Exposure to heavy metals is associated with a wide range of diseases, including severe conditions such as breast cancer, the treatment of which, when accessible, can cost over S/ 83,000[53] ,far beyond what families can afford out-of-pocket (López et al., 2019). Given the variety of illnesses caused by exposure to heavy metals, including cumulative and synergistic effects, **further analysis is needed to understand the nature of healthcare expenditure in affected households. This entails not only quantifying the difference in spending amounts but also analyzing the composition and timing of these expenses,** as it is very likely that they become long-term costs that exert a prolonged and significant negative impact on the household economy.

» ***Healthcare infrastructure that guarantees comprehensive medical care***

While it is noted that people without health insurance may spend twice as much as those with insurance[54], coverage is not always sufficient[55]. In Peru, 99 % of the population is ensured, with 75 % enrolled in the public Comprehensive Health Insurance (SIS); however, the existing gaps in service availability and quality lead many people to incur out-of-pocket expenses[56]. **Expanding insurance coverage alone is not enough; a healthcare system that meets the population's differentiated needs is required.**

According to the MINSA, comprehensive healthcare encompasses interventions related to health promotion, prevention, recovery and rehabilitation, all delivered within the context of the family and community by health personnel based on a biopsychosocial approach[57]. Budget Program 0018, under its product "3043997. Screening and Treatment of Patients Affected by Heavy Metals", established the duty of providing a comprehensive care package to people exposed to heavy metals residing in areas identified as environmentally at risk. However, the actions planned and reported under this

53 With prices corresponding to 2019, the date of publication of the study.

54 See Universidad del Pacífico's Research Center (April 12, 2024). Peruvian Families Spend an Average of S/ 1,500 a Year on Medications https://ciup.up.edu.pe/analisis/rafael-cortez-gasto-bolsillo-salud-medicamentos-familiasperu-nota-de-prensa/

55 In fact, Montañez (2018) states that "the expansion of insurance coverage through the SIS led to a greater demand for services, putting greater pressure on the weak service availability."

56 See https://www.defensoria.gob.pe/defensoria-del-pueblo-sis-debe-financiar-el-transfer-por-motivos-de-saludde-las-personas-en-situacion-de-pobreza-y-vulnerables/

57 See https://cdn.www.gob.pe/uploads/document/file/282407/254174_RM729-2003.pdf20190110-18386-1ngi05p.pdf

product focus primarily on diagnosis through screening activities.

Treatment, depending on the complexity of the health effects of exposure to heavy metals, fundamentally relies on other enabling conditions, such as the capacity of healthcare facilities to deliver specialized services that respond to the diverse needs of the population[58], This includes adequate equipment, supplies, and the availability of specialized health professionals. Currently, 97 % of healthcare provider organizations (HPOs) in Peru operate at the primary care level, while only 3 % are classified as secondary and tertiary care providers[59]. In other words, the Peruvian health system is largely composed of low-complexity facilities such as local health centers and primary care clinics that are often unequipped to manage complex conditions such as those resulting from exposure to heavy metals. If treatment for people exposed to these metals is not guaranteed as a component of comprehensive health care, neither are other components such as recovery and rehabilitation.

It is necessary to uphold the purpose of Budget Program 0018 and its product 3043997; its components must provide comprehensive healthcare for people exposed to heavy metals. Addressing a reality as complex as that faced by affected populations requires a health system that meets people's treatment, recovery and rehabilitation needs in accordance with the technical instruments approved for the care of those exposed to heavy metals.

58 Pursuant to Ministerial Resolution No. 546-2011-MINSA. https://cdn.www.gob.pe/uploads/document/file/272294/243402_RM546-2011-MINSA.pdf20190110-18386-cimfnp.pdf?v=1547161089

59 See https://www.comexperu.org.pe/upload/articles/publicaciones/situacion-actual-del-mercado-de-salud-peruano-informe.pdf

» ***Providing comprehensive healthcare with a gender perspective and cultural and community relevance***

Women and children are identified as the most vulnerable populations. Therefore, it is urgent to address aggravating factors, such as anemia, especially in rural areas. Women living in extractive zones see their life plans curtailed and live under the constant fear of heavy metal contamination in their children. **It is essential to design a targeted social program for this population, incorporating a gender perspective both in healthcare delivery and budget allocation.**

Likewise, it is critical to address the health impact of heavy metals from the perspective of their long-term effects on families and communities, as exposure undermines family livelihoods and erodes community life. Faced with the risk of exposure to heavy metals, some sectors of the community choose to migrate to lower-risk areas. It is, therefore, vital to ensure the full implementation of the Comprehensive Life Course Health Care Model for Individuals, Families, and Communities, approved in 2020[60], aimed to ensure that care is aligned with people's daily activities, social dynamics, and individual and collective needs, recognizing that health conditions are influenced by various factors, including ecological and environmental determinants.

In a country where 25 % of the population belongs to indigenous or native groups, and 4.4 million people speak an indigenous or native language, according to the 2017 National Census, the delivery of comprehensive, culturally relevant healthcare to populations exposed to heavy metals, especially in rural areas, is constrained by limited funding, weak healthcare capacity, and a predominantly monocultural approach.

It is also essential to execute Administrative Directive No. 261-MINSA/2019/DGIESP, as approved by Ministerial Resolution No. 228-2019-MINSA, which mandates the **adaptation of culturally relevant health services at the primary level of care, and the creation of culturally relevant HPOs, especially in regions with populations affected by heavy metals. Likewise, the incorporation of the ethnic variable in the medical records of individuals exposed to heavy metals must be ensured,** in accordance with the guidelines approved by Supreme Decree No. 010-2021-MC.

60 Approved by Ministerial Resolution No. 030-2020 -MINSA. See https://bvs.minsa.gob.pe/local/fi-admin/rm-220-2021-minsa.pdf

» ***Reducing sources of exposure to heavy metals and strengthening standards for extractive activities***

Preventing and mitigating exposure to heavy metals—in this case from anthropogenic sources—is closely linked to environmental health: "The presence of heavy metals in the body is the result of continuous exposure to heavy metals in the environment (Castro, 2022)." Therefore, addressing this issue requires a comprehensive approach, grounded in intersectoral coordination and complementary interventions to prevent, identify, control and remedy[61] contamination sources.

In response to sustained dialogue efforts with the State, promoted by Planametox with technical support from the MTSASH, in 2021, the Peruvian government approved the Special Multisectoral Plan (PEM) for Comprehensive Intervention for Populations Exposed to Heavy Metals, Metalloids, and Other Toxic Chemical Substances through Supreme Decree No. 037-2021-MINAM. However, key actions outlined in the plan remain unimplemented to this day, including the integrated diagnosis of environmental sources, both natural and anthropogenic, of exposure to heavy metals, metalloids and other toxic chemicals, aimed to determine affected areas. This process was scheduled for 2023 under the responsibility of MINAM, with the participation of multiple sectors[62], regional governments, and civil society. Likewise, specific intervention areas, in prioritized affected zones, have not yet been identified for environmental management or remediation, as stated in the PEM. It should be noted that, as of 2024, Peru has identified 6,001 mining environmental liabilities[63] and the estimated investment for their remediation is approximately S/ 3 billion[64].

Currently, the sectors involved in addressing heavy metal contamination meet in the Permanent Multisectoral Commission responsible for monitoring the incorporation of prevention, mitigation and healthcare measures into government plans and programs across the three levels

61 According to the Ministry of the Environment, environmental remediation is the "set of tasks carried out at a contaminated site with the aim of eliminating or reducing contaminants, in order to ensure the protection of human health and the integrity of ecosystems." See https://www.minam.gob.pe/wp-content/uploads/2014/04/GUIA-PDS-SUELO_MINAM2.pdf

62 Including the Ministry of Energy and Mines, Ministry of Production, Ministry of Housing, Construction and Sanitation, Ministry of Agriculture and Irrigation, Ministry of Health, OEFA, Ministry of Culture and the Presidency of the Council of Ministers.

63 According to the inventory approved by the Ministry of Energy and Mines through Ministerial Resolution No. 351-2024-MINEM/DM.

64 See https://iimp.org.pe/institucional/noticias/se-requiere-inversion-de-s-3000-millones-para-remediar-todos-los-pasivos-ambientales-mineros-del-peru

of government, as well as for overseeing the implementation of the PEM[65]. Although its creation was approved in 2022 by Supreme Decree No. 129-2022-PCM[66], it has not been possible to consolidate articulated actions in relation to the PEM's environmental objectives, as pointed out by Planametox[67].

Meanwhile, the 2030 National Multisectoral Health Policy[68], includes the commitment to "strengthen the environmental health surveillance system for drinking water sources" through the Epidemiological Surveillance and Research on Exposure to Heavy Metals and Health in the Most Polluted Cities. However, its measurement indicator focuses solely on compliance with a standard[69], rather than expanding service coverage to allow epidemiological surveillance to cover more contaminated cities, which would increase the system's preventive capacity for exposure to heavy metals. In this context, it is critical for the State to implement the Technical Health Standard, which establishes the public health epidemiological surveillance of risk factors related to exposure to and poisoning by heavy metals and metalloids.

Furthermore, it is necessary to raise environmental standards for extractive activities, to urge companies to implement due diligence processes to assess the real or potential human rights impacts of their operations, and to implement prevention, mitigation, and accountability mechanisms (Oxfam, 2023). Civil society has documented, through official reports, the causal relationship between mining operations and environmental pollution[70]. For its part, the State must advance in the identification of anthropogenic sources of exposure to heavy metals and assign accountability for the pollution that violates people's rights.

65 Created by Supreme Decree No. 129-2022-PCM. Its creation was also part of the dialogue process between Planametox and the State and its antecedent is the creation in 2020 of the Temporary Multisectoral Commission for the Comprehensive and Integrated Approach to the Population Exposed to Heavy Metals, dependent on the Presidency of the Council of Ministers, approved by Supreme Resolution No. 034-2020-PCM.

66 See https://busquedas.elperuano.pe/dispositivo/NL/2118613-1

67 See https://cooperaccion.org.pe/afectados-por-metales-toxicos-insisten-en-que-se-ejecute-plan-de-atencion/

68 Approved by Supreme Decree No. 026-2020-SA, available at https://cdn.www.gob.pe/uploads/document/file/1272348/Pol%C3%ADtica%20Nacional%20Multisectorial%20de%20Salud%20al%202030.pdf?v=1598736848

69 The clinical-epidemiological evaluation and notification must be carried out according to the technical standards and the Ministry of Health's annual plan.

70 See CooperAcción and Oxfam (2023).

» ***Allocating a public budget that guarantees rights***

Such a complex reality requires the government's commitment to allocate sufficient financial resources to ensure, repair and restore health conditions for the affected population and the environment in which they live. However, the 2025 public budget allocated for people exposed to heavy metals through Budget Program 0018, amounts to S/ 20,400,029, equivalent to approximately S/ 2 for each person exposed to heavy metals. As detailed in previous sections, the 2023 budget only managed to serve 10 % of all people exposed to heavy metals. As pointed out by Planametox[71], there is a significant gap between the magnitude of the impact of exposure to heavy metals on the population's health and the state's commitment to allocating sufficient resources to respond to this problem.

Between 2019 and 2023, the average execution achieved by regional governments in Budget Program 0018 exceeded 90 %[72]; however, i) more than 50 % of the execution was directed to personnel expenses between 2019 and 2021, and ii) regional comprehensive healthcare plans for populations exposed to heavy metals and other toxic substances are now unavailable or outdated. Therefore, although they report high budget execution, its quality or effectiveness in changing conditions for the population cannot be assessed, that is, we cannot tell how and to what extent the execution of these resources has had measurable and verifiable results. It is necessary to implement public investment mechanisms that ensure the traceability of their results in the population affected by heavy metals. State commitment to addressing this issue must be measured not only in terms of budget allocation, but also through its results in improving the population's living conditions.

As outlined in previous sections, the apparently new supercycle of mineral prices with extraordinary revenues has unfolded within an inertial policy framework for the sector, with no improvement in environmental and social standards, and no economic measures grounded in fiscal justice aimed at increasing the sector's tax burden to ensure higher levels of collection[73]. Resources must be guaranteed to repair the effects of negative extractive practices on the population exposed to heavy metals and to remediate the over 6,000 environmental liabilities that continue to pose risk to the population's health.

71 See https://cooperaccion.org.pe/afectados-por-metales-toxicos-insisten-en-que-se-ejecute-plan-de-atencion-2/

72 See information on the Ministry of Economy and Finance's Friendly Consultation.

73 See the Tax Justice Group's proposal: https://cooperaccion.org.pe/proponen-usar-ingresos-mineros-extraordinarios-para-alivio-social/

CARE WORK COSTS ASSOCIATED WITH THE EXPOSURE TO HEAVY METALS AND METALLOIDS

» ***Characterizing care work performed by rural and indigenous women in areas exposed to heavy metals and metalloids***

The right to care is interdependent with other rights. Limitations in access to and exercise of rights such as health and living in a healthy environment can compromise the conditions under which care is provided, thereby undermining the guarantee of its exercise. Moreover, in contexts of exposure to heavy metals, the feminization of care work can lead to the violation of other rights and, therefore, deepen the levels of inequality faced by women as primary caregivers. Therefore, addressing the right to care in these contexts requires understanding the latter in their multiple dimensions and in their relationship with the absence or presence of other public policies and services in the territory.

To this end, it is important to characterize the care work performed by women, particularly rural and indigenous women in areas exposed to heavy metals, using an intersectional approach. This approach involves assessing the conditions under which they live, their care needs, the strategies they adopt to reconcile care responsibilities with other aspects of life, and the impact of care work on their life plans and self-care, as they are also at greatest risk of exposure to heavy metals. This characterization process can substantially contribute to identifying ad hoc policies or programs that appropriately respond to this reality.

» ***Improving public infrastructure in rural areas to reduce the burden of care work***

Analyzing households with fully dependent members offers insight into the reality faced by families with members specifically affected by heavy metals. While caregiving poses challenges for the general population, caring for people affected by heavy metals in rural areas is even more complex because care work is conditioned by additional disparities or gaps, such as access to uncontaminated water sources. 21.5 % of the rural population lacks access to public water and relies primarily on river, ditch, or spring water (13 %), and even where public water is available, only 4 % meets adequate chlorination standards (INEI, 2023). **Caring for family members exposed to heavy metals requires an intersectoral and comprehensive intervention that includes investment in safe in-home water infrastructure to reduce the care work time primarily provided by women.**

A major component of care work for people affected by heavy metals is the time spent traveling to access health services due to geographical isolation and inadequate healthcare coverage, especially in rural areas. In Peru's southern highlands, it can take an average of 77 minutes for a person to reach the nearest health post and 139 minutes to reach a hospital; in the northern highlands, it takes 103 minutes to reach a health post and 242 minutes to reach a hospital[74]. Considering that 97 % of the country's health services are provided at the primary care level, and that exposure to heavy metals requires more complex interventions, female caregivers in these areas spend even more time seeking adequate treatment. In fact, lower out-of-pocket expenditure in rural areas compared to urban areas may be explained by the limited access to specialized services rather than reduced need.

The ability of people exposed to heavy metals to access healthcare is mediated by the care work performed by women. In addition to overcoming economic, geographic, cultural, gender and service availability barriers, **care work also involves community mobilization.** Access to diagnostic testing, for example, typically requires collective advocacy to pressure authorities to provide screening services, which are often deficient and require additional organizational efforts to access reliable information[75].

» ***Addressing the mental health of caregivers of people exposed to heavy metals and metalloids***

Chronic or non-communicable diseases require "diverse, extensive, and interconnected" health services (Vergara, 2023). Where these are unavailable, home care becomes intense and prolonged, demanding more time, work and effort, or even requiring certain levels of specialization for which families are unprepared. This situation carries significant implications for mental health. Evidence shows that women exposed to heavy metals experience depression, concerns about their survival, and economic constraints (Derechos Humanos Sin Fronteras, 2019). Comprehensive healthcare for people affected by heavy metals must consider mental health service components within the framework of the community mental health model. The country's budget priorities need to be reconsidered: by 2024, public investment in mental health was approximately S/ 21 per capita[76].

74 See https://www.mef.gob.pe/contenidos/pol_econ/documentos/Un_balance_de_las_politicas_sociales.pdf

75 See https://convoca.pe/investigacion/espinar-las-pruebas-medicas-que-oculto-el-gobierno

76 See https://www.gob.pe/institucion/minsa/noticias/1000859-minsa-continua-fortaleciendo-y-cerrando-brechas-de-atencion-en-salud-mental

» ***Ensuring official statistical data on time use in care work, with territorial and cultural relevancel***

Limited access to information for this study has prevented us from analyzing disaggregated data concerning how caregiving time is distributed among women in households with fully dependent members, particularly those affected by heavy metals. **It is necessary to build sufficient, up-to-date, and high-quality official data on the time women especially rural and indigenous women dedicate to care work and how other community variables intervene.**

The National Survey on Time Use (ENUT) was implemented 15 years ago, and since then, the generation of evidence on the use of care work time has been largely driven by the efforts of civil society[77]. In 2024, the State began fieldwork for a new edition of the ENUT[78]. **The results of this new survey are expected to delve deeper into variables associated with care work in rural areas, taking into account the specific conditions of this population and the barriers they face in accessing services,** This is particularly relevant because, as shown throughout this study, caregiving at the family and community levels addresses needs that public services fail to meet or compensate for harm resulting from the State's actions or inactions, such as the promotion of extractive activities with precarious standards or no timely state oversight.

» ***Determining state co-responsibility and fair social organization of care***

The unfair organization of caregiving, both within families and across society, generates inequality. Because caregiving responsibilities fall primarily on families and, within them, on women, this dynamic limits their well-being and autonomy. In families experiencing severe poverty or vulnerability, the impact of having to care for another member has a much greater impact on their well-being than in less vulnerable households. A single illness in the family can push a household back into poverty (Vergara, 2023). Moreover, for women, the overload of care work restricts their access to the labor market or their freedom to decide how to use their time, exposing them to multiple forms of violence. **The State plays a major role in mitigating these inequalities through the implementation of public policies and the provision of services that reduce and redistribute the burden of caregiving on families and women.**

77 Oxfam, CMP Flora Tristán, and IEP published the Survey on Time Use and Unpaid Domestic Work in 2022 and the Survey of Representations on Care Work in Peru in 2023.

78 See https://www.gob.pe/institucion/inei/informes-publicaciones/5920191-encuesta-nacional-de-uso-del-tiempo-enut-2024

In the current context of expanding extractive frontiers as a result of the increased demand for transition minerals, there is also a growing risk of exposure to heavy metals due to harmful extractive practices. This scenario intensifies care demands, further burdening women. **To date, the right to care is not recognized in Peru's national legal framework[79]. Achieving such recognition would contribute to protecting those who provide and receive care and compel the State to implement policies, services, and other public measures to uphold this right.** In the specific case of people exposed to heavy metals, it would also entail coordinated actions to guarantee better conditions, such as accessible, high-quality, and adequately equipped healthcare infrastructure, access to safe drinking water, quality public transportation, among others.

Guaranteeing the right to care will also entail a more equitable redistribution of care work among the State, the private sector, the community, and families. **In this effort, it is essential to recognize and support the reconciliation mechanisms implemented by families and women to ensure care in households affected by heavy metals, especially in rural areas.** The State needs to develop ad hoc programs and services that guarantee care for people whose health conditions have deteriorated and who require specialized treatment that families and primary health facilities cannot provide. It is also fundamental to acknowledge the work women do by respecting what they define as valuable based on their geographic location and needs, but, above all, **it is necessary to liberate women's time dedicated to caring for family members affected by heavy metals so that they can live as they see fit.**

Finally, it is necessary to ensure the financing of this right; and in this sense, the discussion about the role of the State in care work is also linked to its ability to raise more and better public resources through a fair, progressive, and equitable tax system.

79 Despite being a right recognized by the harmonious interpretation of the international corpus of law.

ELEMENTS FOR DISCUSSION ON A FAIR ENERGY TRANSITION

The findings of this study contribute to the conversation on justice in energy transition regarding the conditions that must be guaranteed in a scenario of increased international demand for minerals. This concerns the territories where extraction occurs, vulnerable families, and, above all, women, not only in terms of the potential effects of an increase in mining production, but also in terms of the ongoing and historical effects of this activity on people's lives. It is essential to anticipate the impacts and, equally important, to compensate the affected population. Thousands of environmental liabilities from previous mining operations remain unresolved, many of which are still sources of pollution (CooperAcción, 2024).

The new commodity boom is occurring within an inertial mining institutional framework that reinforces social, economic, environmental and gender gaps, aggravating the inequalities faced by rural families and women. A public infrastructure—in terms of state capacity—that fails to operate its legislative and regulatory framework is a State that is difficult to maintain and, even more so, difficult to trust. 31 % of the population calls for a more just State to reduce persistent inequalities[80]. A just State ensures that investment is made respecting social, environmental, economic, and gender standards; enforces due diligence and accountability with respect for human rights; implements redistributive economic policies; protects the public value of health services, and guarantees the right to care for those who provide and need care, organizing and redistributing care work and, most importantly, ensuring its financing.

80 According to ENADES 2024, prepared by Oxfam and the Institute of Peruvian Studies (2024), 31 % of the population states that "having a more just State" is one of the factors that would most help to have a more egalitarian country.

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ANNEX 1

POPULATION AT RISK OF EXPOSURE TO HEAVY METALS, METALLOIDS, AND OTHER TOXIC SUBSTANCES BY REGION IN PERU (2020)

Region	Arsenicre-lated risk	Crude oilrelated risk	Risk related to heavy metals and other chemical substances	Identified expo-sure	Estimated population 2020	% affected by arsenic	% affected by crude oil	% affected by heavy metals and other chemical substances
Amazonas	0	272205	272205	Al,Fe,Hg,Pb,Crudo de Petróleo	426806	0.00 %	63.78 %	63.78 %
Áncash	0	0	382956	Al,Fe,Mn	1180638	0.00 %	0.00 %	32.44 %
Apurímac	187,525	0	187525	As,Fe	430736	43.54 %	0.00 %	43.54 %
Arequipa	273,399	0	273399	Al,As,Fe,Mn,Pb	1497438	18.26 %	0.00%	18.26 %
Ayacucho	108,366	0	108366	As,Bo,Cd,Hg,Pb	668213	16.22 %	0.00 %	16.22 %
Cajamarca	549,934	0	549934	As,Fe,Pb	1453711	37.83 %	0.00%	37.83 %
Callao	0	0	863161	Cd,Pb	1129854	0.00 %	0.00 %	76.40 %
Cusco	342,660	0	342660	Al,As,Fe,Mn,Pb	1357075	25.25 %	0.00%	25.25 %
Huancavelica	97,500	0	97500	Al,As,Ba,Fe,Hg,Pb	365317	26.69 %	0.00 %	26.69 %
Huánuco	343,222	0	343222	As,Cd,Hg,Pb	760267	45.14 %	0.00 %	45.14 %
Ica	166,944	0	166944	As,Fe,Hg,Mn,Pb	975182	17.12 %	0.00%	17.12 %
Junín	430,330	0	430330	Al,As,Cd,Hg,Pb	1361467	31.61 %	0.00 %	31.61%
La Libertad	530,773	0	530773	As,Fe	2016771	26.32 %	0.00 %	26.32 %
Lambayeque	1,310,785	1310785	1310785	Al,As,Na,Pb,Crudo de Petróleo	1310785	100.00 %	100 %	100 %
Lima	0	0	1681321	Cd,Pb	10628470	0.00 %	0.00 %	15.82 %
Loreto	414,807	414807	418407	Al,As,Cd,Fe,H-g,Mn,Pb,Crudo de Petróleo	1027559	40.37 %	40.37 %	40.72 %
Madre de Dios	0	0	150162	Al,Fe,Mn,Hg	173811	0.00 %	0.00 %	86.39 %
Moquegua	173,818	0	173818	As,Al,Cd,Pb	192740	90.18 %	0.00%	90.18 %
Pasco	137,937	0	137937	As,Cd,Hg,Pb	271904	50.73 %	0.00 %	50.73 %
Piura	288,141	0	288141	Al,As,Fe,Mn,Pb	2047954	14.07 %	0.00 %	14.07 %

Puno	716,246	0	716246	Al,As,Ba,Bo,Pb	1237997	57.86 %	0.00 %	57.86 %
San Martín	-	-	-	-	899648	-	-	-
Tacna	65,611	0	65611	Al,As	370974	17.69 %	0.00 %	17.69 %
Tumbes	90,908	0	90908	Al,As,Fe,Mn,Pb	251521	36.14 %	0.00 %	36.14 %
Ucayali	583,669	0	583669	Al,As,Cd,Hg	589110	99.08 %	0.00 %	99.08 %
Perú	6,812,575	1,997,797	10,165,980		32625948	20.88 %	6.12 %	31.16 %

Source: Ministry of Health, 2020.