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THE EXPOSURE TO HEXACHLOROCYCLOHEXANE IN THE HUMAN ORGANISM AND IN THE ENVIRONMENT: TRANSFORMATIVE ACTIONS

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ABSTRACT

Introduction: According to Ministry of Health reports produced between 2001 and 2002, the presence of Hexachlorocyclohexane isomers was detected in the blood serum of the population of Cidade dos Meninos. After two decades, there is still no definitive solution to the problem, about 2,000 people continue to live in the region, exposed to the toxic substances. The objective of this study is to analyze the environmental impact of contamination by Hexachlorocyclohexane, with emphasis on the health of the population of this region. **Methodology:** Literature review, carried out in a non-systematic way in the period from September 2021 to March 2022. Studies were searched in scientific databases: Portal regional da BVS, Medline, Lilacs, Scielo, Pubmed using the descriptors: HCH, Drill Dust, Hexachlorocyclohexane, Pesticide, Organochlorine Compound, Cidade dos Meninos. The data were complemented with the analysis of the list of references of the selected articles. This research was conducted according to the principles established in resolution 466/12 of the National Health Council. The study protocol was submitted and approved by the Research Ethics Committee of the Universidade Iguaçu. **Results:** The persistence of contamination by Hexachlorocyclohexane and the difficulties of access to health care of the affected population were observed.**Discussion:** The results of the various research analyzed, are decisive indicators of the need to develop agro-environmental measures to deal with the residues of Hexachlorocyclohexane in the contaminated area seeking an option to decontaminate the site. It is also necessary to provide monitoring in the area of health, in parallel with a process of awareness-raising of the residents in relation to the risks to which they are exposed. **Conclusion:** The City of Boys has been suffering the consequences of environmental and human contamination by Hexachlorocyclohexane for half a century. An interdisciplinary approach is needed in the areas of education, health and environment, strengthening efforts to reduce the impact of contamination on the environment and on the lives of this population.

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INTRODUCTION

The neighborhood Cidade dos Meninos, located in the countryside of the city of Duque de Caxias, in the fluminense lowlands, is part of the metropolitan region of the state of Rio de Janeiro, characterized by the lack of urban infrastructure and concentration of poverty (Camaz, 2015; Herculano, 2002; Gollo, 2009). In this place of around 20 hectares of Union property, orphaned and needy boys were sheltered in a boarding school regime in the period after World War 2.

However, in the first years of the 1950's, a Hexachlorocyclohexane (HCH) fabric was inaugurated and it began in the place the manipulation of other organochlorine compounds, like the dichlorodiphenylchloroethane (DDT) (Figure 1: Malaria Village) (Gollo, 2009; Porto, 2009; Porto, 2013). The HCH is an organic compound from the group of hydrocarbons of high relevance in the environmental impact for being highly toxic. This product was the most produced organochlorine pesticide in the world being used in multiple countries between 1950 and 1980 as the main form of combat to the drill, insect that attacks coffee grains. Because of that,

the pesticide became popularly known as “drill’s powder” (Porto, 2009; Peixoto Manéo, 2015; Kohli, 2016). The HCH, as other halogenated organic derivatives, isn't easily metabolized by living organisms, for this reason, it accumulates in the environment for decades after its use. Due to the handling of these pesticides, the waters and the soil get contaminated, consequently affecting the local biota, being able to directly affect the health of humans and animals (Porto, 2009; Vijgen, 2018; Adithya, 2021). In this context, despite having been useful against vectors of important diseases or parasitic arthropods, the fact that this product is bioaccumulated in living tissues (blood, adipose tissue, nervous tissue) generates a contamination in the food chain for cultivated plants, which by in turn, they contaminate animals that supply eggs, milk and meat for slaughter, ultimately affecting human health in all age groups (Vijgen, 2018). At the time of the installation of the factory in Cidade dos Meninos, it was more advantageous to produce the product in the country than to import it. However, as time went by, the situation changed, and in 1956 the factory was deactivated with large quantities of the pesticide abandoned on the site (Gollo, 2009). The population, largely rural, unaware of the risks, continued to live in the same place with the negligently abandoned products. Products which, as they were available in large quantities, started to be sold at fairs, used to make landfills, tow houses, pave streets, among others. With the dissemination through the air and rainwater, such products also became a source of contamination of local vegetation and animals (Oliveira, 2008).

According to a survey conducted by Antunes (2005), 95% of workers and residents closest to the old factory have HCH contamination in their blood tests. However, contamination tends to decrease when people are removed from the source of the problem (Antunes, 2005). In order to protect human and animal health and the environment from the effects of the pesticides, Ordinance No. 329 was approved in 1985, prohibiting the marketing, use and distribution of organochlorine pesticides for agriculture throughout the country (Brasil, 1985). It should be noted that, although efforts have been made to minimize or ban the use of certain Persistent Organic Pollutants (POPs), the difficulty of removing them from the environment and degrading them safely to avoid environmental damage is a major environmental and economic challenge to be solved. That’s because there is no ideal HCH removal technique and the selection of the removal method depends on several factors such as: temperature and soil types (Figure 2: Camboabas Road) (Adithya, 2021; Oliveira, 2008). In 1995, a company was hired to decontaminate the Cidade dos Meninos area, and the solution found was to apply quicklime on the soil. However, this action expanded the area of contamination, originating by-products that are even more harmful to health (Oliveira, 2008; Oliveira, 2003). After this ineffective attempt, the government at the time did not provide any guidance for the definitive resolution of the problem. The only measures taken were the installation of a fence surrounding the main area of the source of contamination; the installation of signs warning about the presence of contaminants; the provisional transfer of a few residents and the demolition of houses located closer to the focus area, which was not plausible nor sufficient (Oliveira, 2008; Oliveira, 2003).

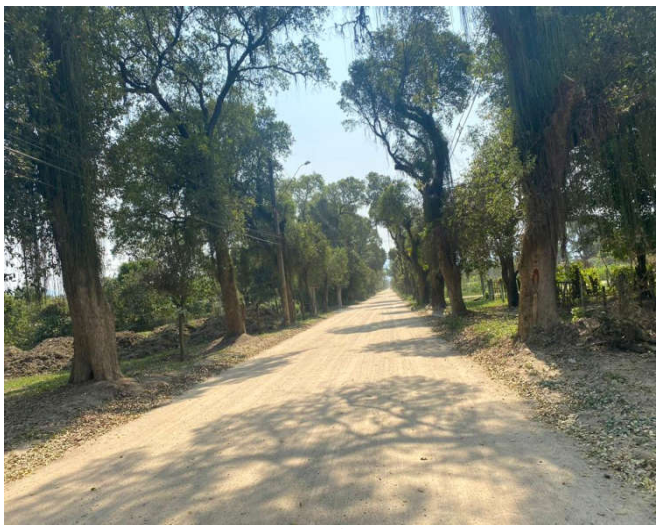
According to Ministry of Health reports produced between 2001 and 2002, the presence of HCH isomers was detected in the blood serum of the population of Cidade dos Meninos. According to the exposure and risk criteria, some selected families were transferred to housing areas outside the region and their houses were demolished. At the time, the region was home to almost 400 families and still had in place: vegetable production; cattle raising; pigs; chickens and other animals for milk and meat production. All the food production there was contaminated (Oliveira, 2008; Oliveira, 2003). However, two decades after the first report by the Ministry of Health was written, there is still no definitive solution to the problem. Today 2,000 people continue to live in the region being exposed to the toxic substances (Oliveira, 2008; Oliveira, 2003). In view of the data from the studies presented, the evaluation of the effects of the contamination caused to humans and to the environment in Cidade dos Meninos becomes essential, since there is scientific evidence that this product not only affects the environment but also has great toxicological relevance in humans. In these circumstances, another relevant point to note is the importance of providing health, education, and environmental support for the affected population. The objective of this study is the analysis of the environmental impact with emphasis on the health of the population in this region of the outskirts of Rio de Janeiro contaminated by the organochlorine compound Hexachlorocyclohexane, contributing to the construction of knowledge in several areas.

METHODS

This research came to constitute a literature review of scientific data. The data collection process was carried out in a non-systematic way in the period from September 2021 to March 2022. Articles available on the subject were searched in national and international scientific databases such as the regional portal of the VHL, Medline, Lilacs, Scielo, Pubmed using the descriptors: HCH, Drill Dust, Hexachlorocyclohexane, pesticide, organochlorine compound, Cidade dos Meninos. The data were complemented with the analysis of the list of references of the selected articles. Finally, by reading the full text, the analysis of the results of the articles was carried out in order to describe the study. This research was conducted according to the principles established in resolution 466/12 of the National Health Council, which guide research and guarantee the maintenance of secrecy, confidentiality, and privacy of the research subjects' data. The study protocol was submitted to and approved by the Research Ethics Committee of the Universidade Iguaçu (CAAE: 53219121.6.0000.8044).

Source: Ministry of Health. Available at: https://images.app.goo .gl/zzQ3 kVM Fv4CS2ouU9

Figure 1. Malaria Village



Source: Author, 2022.

Figure 2. Camboabas Road

Source: Author, 2022.

Figure 3. Entrance gate of Cidade dos Meninos

RESULTS

The Effects of hch exposure on the human organism: At normal temperatures, HCH is a solid product with a crystalline appearance, with a color that can vary from brown to white. Generally, its natural state has a strong and persistent odor attributed to the presence of oxygen-containing contaminants. Its extensive use in the past and the abandoned stocks in inappropriate places continue to be a threat to man and the environment (Londres, 2009; Bhatt, 2009). The effects that direct and indirect contacts with pesticides can cause in the human body are diverse, from the mildest such as nausea and vomiting, to those that leave serious damages, even leading to death, depending on the substance to which the individual was exposed and the form of contact, and the periodicity of that contact (Oliveira, 2003). Man can be subjected to contamination by pesticides through direct contact during the manufacture of the product, through handling or use in crops. The contact will be indirect, if the same resides near a place of manufacture of the same or of a crop that uses such product or even through the ingestion of contaminated food (Londres, 2009; Londres, 2011). According to the World Health Organization (WHO), even when they are absorbed in small amounts, if exposure to HCH isomers is prolonged, adverse health effects can be observed, such as damage to the central nervous system where it acts as a stimulant (World Health Organization, 1991). Evidence has been reported in several studies that exposure to HCH is suspected of causing congenital malformations and miscarriage, and is still a risk factor for some types of cancer. According to data from the National Cancer Institute (2018), 80% of cancer cases are related to exposure to chemical agents present in the environment by human action. Thus, work environments and their surroundings areas were identified as the places where the highest concentrations of carcinogens agents (Gollo, 2009; Oliveira, 2008; INCA, 2018). Furthermore, the study by Nigam et al. (1993), demonstrated evidence of neurological symptoms and ECG abnormalities related to the intensity of recent exposure to HCH and increase in β-globulins in 365 cases of exposed individuals in a manufacturing industry, compared to 146 unexposed controls (Nigam *et al*., 1993). WHO data suggest that Pops, including HCH among those, are associated with reduced serum thyroid hormone levels in humans. It was also noticed that severe thyroid hormone deficiency is a risk factor for the early onset of neurological diseases and brain damage (World Health Organization, 2012). Growing evidence also links exposure to Pops to a drop in pregnancy rates and difficulties in pre-implantation of embryos in humans and animals (Milesi, 2017; Milesi, 2018; Milesi, 2020).

The Effects of HCH on the Environment: Halogenated pesticides such as Hexachlorocyclohexane are stable chemicals that can be easily absorbed by the soil, contaminating groundwater and are also easily dispersed in the air and when heated they decompose, emitting toxic fumes of hydrochloric acid and other chlorine, carbon monoxide and dioxide of carbon (Peixoto Manéo, 2015; Brasil, 1985; Flores, 2004). This substance is part of the list of 21 Pollutants of the Stockholm Convention. In this treaty ratified by several countries in 2004, a ban on the production and use of various persistent organic pollutants, known as POPs, was established due to their high persistence in the environment and their bioaccumulation capacity, volatility and toxicity to human health and the environment. It is noteworthy that experts explain that medicines and pesticides such as HCH are among the most persistent in the environment (Herculano, 2002; Gollo, 2009; Peixoto Manéo, 2015; Londres, 2011). In Brazil, the use of HCH was restricted in 1985, however despite being banned, it is still responsible for serious toxicological problems. Lack of knowledge and disregard for the toxic potential of these compounds, with the disposal of production residues without any proper control or care, led to serious environmental contamination (Peixoto Manéo, 2015). In addition to the problem directly caused to the health of the residents of Cidade dos Meninos, this contamination also compromises the entire local flora and fauna. Unquestionably, the losses caused by HCH contamination can mean bankruptcy or severe restrictions on family income, as evidenced in some studies carried out in the last decade, proven in the absorption of HCH in the production of foods unfit for consumption (Herculano, 2002; Gollo, 2009; Porto, 2009). After the prohibition of the production of HCH, the deactivated industries did not know the destination they should give to the products and many abandoned them inside, which were looted and misused. Some residues were buried and others incinerated, leading to the generation of more toxic compounds such as dioxins and furans (Porto, 2013; Peixoto Manéo, 2015; Bhatt, 2009). Existing treatment options for environmental decontamination include incineration, coagulation and flocculation, reduction, chemical oxidation, microwave oxidation, electrochemical oxidation, among others (Adithya, 2021). In this context, we can see the importance of providing health care and an economically viable housing alternative for the population of Cidade dos Meninos, with the government held responsible for the additional costs generated in relation to health, housing and loss of income of the local residents.

DISCUSSION

Education, Health and the Environment: Transforming Actions: The results of the various surveys evaluated in this study are decisive indicators of the need for a process of awareness-raising of the residents in relation to the risks they are exposed to in the locality of Cidade dos Meninos, and also the need for health follow-up actions and successful decontamination in the contaminated area, in order to preserve the environment and the population in general. With regard to the different strategies for reducing the impact of environmental contamination on the living conditions of the population of Cidade dos Meninos, there is a need for intersectoral articulation considering the magnitude of the damage to health caused by exposure to HCH and the deprivations of access to health services, education, housing, and income faced by the population. In this context, aiming at studies in the health area and technical support for the implementation of extension and research projects, the University of Iguaçu (UNIG) signed an agreement with the NGO Ecocidade da Cidade dos Meninos, for the implementation of sustainable solutions and Environmental education (Figure 3: Entrance to Cidade dos Meninos). It is also important to point out that the Federal Executive Branch, in its Article 41, authorizes the institution of ecologically sustainable development promotion, the so-called ecosystem services, through support and incentive programs for environmental conservation and reduction of environmental impacts through the adoption of technologies and good practices that can reconcile agricultural and forest productivity[27]. In Law 14.119, in its 2nd article it also says that ecosystem services can be used for maintenance, recovery or improvement of environmental conditions. Considering the data presented and the general objectives of UNIG's social actions in Cidade dos Meninos, we can state that they are directly related to the ecosystem services described in the federal law presented (Farias). The projects that have been implemented by Iguaçu University in the Boys' Town cover the following lines of action: In the area of education; the creation of a community library and training courses for volunteer residents in order to act as monitors in the mentioned space. In the area of health, in search of strategies for intervention and

disease control, studies are being carried out on the epidemiological profile and evaluation of the prevalence, monitoring and follow-up of five main groups of diseases: cancer; cardiovascular diseases; respiratory diseases; diseases of endocrinological origin and neurological diseases, along with analysis of the degree of soil contamination and the distance from their dwelling to the main point of contamination and its effect on living conditions and environmental factors. The data collected from the evaluation of the epidemiological profile of the population will provide the basis for further research that can deepen the social and economic issues related to the risk factors to which the residents of the City of Boys are exposed in their home environment and the planning of social actions that can be applied based on the information gathered, such as prevention campaigns, lectures, and quality of life workshops. It is known that the conditions in which people live can influence different levels of risk and contribute directly to their illness. In this context, in relation to the environment, feasibility studies are being carried out on the renovation of historical buildings and the implementation of an environmental and creative economy reference center to find sustainable solutions for reforestation of the area. It is also worth adding in the environmental area, that studies will be carried out to analyze the contamination of soil samples and characterize the degree of toxicity for a living organism, in relation to the distance from the main point of contamination and experimental study with the use of products in soil samples for decontamination.

CONCLUSION

It is concluded that Cidade dos Meninos is a place that has suffered the consequences of environmental and human contamination by HCH for half a century. Research results indicate the need to carry out an interdisciplinary approach in ecosystemic services in the community, thus significantly contributing to social solidarity actions in the areas of education, health and the environment, which collaborate to potentialize efforts to reduce the impact of HCH contamination on the lives of this population.

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