

Original Research

Mapping reverse logistics for medicines in Para, Brazil: A geospatial study

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Abstract

Background: Reverse logistics is made up of attitudes, processes and means to provide the return of medicines and their packaging to the business sector for an environmentally appropriate destination. The procedure is necessary to ensure the protection of the environment and public health. **Objectives:** The objective of the study was to define the spatial analysis of the reverse logistics of medicines in pharmacies in the state of Pará. **Methods:** This is a cross-sectional study, and the research covered the medicines collected by a pharmacy chain in the period from 2020 to 2022. To obtain the data, the medicines were collected, weighed, segregated and the weight released on a dedicated waste management platform. All municipalities in the state of Pará subject to georeferencing were processed using the free software Geographic Information System. Of the 144 municipalities in the state of Pará, only 10 had records of reverse medication logistics. **Results:** A total of 3125.63 Kg of products were collected and the city of Belem was responsible for 92.5% of the collection. **Conclusion:** The findings of this study should contribute to the improvement and application of this practice and to decision-making on reverse logistics policies within the state of Pará and in Brazil.

Keywords: reverse logistic; medicines; pharmacies

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INTRODUCTION

Reverse logistics is the logistical procedure for collection, transport, storage, treatment and final disposal of solid waste and post-consumer products, as an example, we have medicines.¹ The process refers to the movement of goods, from the place of consumption to the point of origin, for the purposes of value recovery or appropriate final disposal and aims to minimize the environmental impacts caused by the improper disposal of products and materials, as well as to maximize the use of natural resources and existing products.^{2,3}

Medicines contain chemicals and can be toxic to the environment and human health.¹ This occurs when they are discarded in an irregular manner, either through direct release into the ground or by disposal in dumps and landfills without proper environmental protection. In addition, soil contamination can affect the local fauna and flora, leading to a reduction in biodiversity and compromising the quality of the ecosystem.⁴ Furthermore, these products can also cause the death of animals that feed on plants or ingest contaminated water. Therefore, it is important that reverse drug logistics (RDL) be implemented properly and efficiently, ensuring that these wastes are collected and disposed of safely and properly.⁵

In Brazil, the RDL is regulated by the National Health Surveillance Agency and in the state of Para by the State Environmental Agency.⁶ Pharmaceutical industries, distributors and retailers are responsible for implementing and maintaining RDL programs and must provide collection points at pharmacies and drugstores so that consumers can return expired or unused medications.⁷ Collected medications are sent to specialized companies that are responsible for transporting, storing and



properly disposing of waste.⁸ Thus, the development of this procedure becomes important in the state of Para to guarantee the protection of the environment and public health, avoiding soil, water and air contamination by drug residues and reducing risks to the health of the population.⁹ In addition, RDL also contributes to the circular economy, promoting the recycling and reuse of materials.

In this context, the objective of the present study was to define the spatial analysis of RDL in pharmacies in the state of Para.

METHODS

This is a cross-sectional study carried out in the state of Para (Brazil), whose total area is 1059.458 km², with an estimated population of 8.7 million inhabitants.¹⁰ The research involved medicines collected by a pharmacy chain in the period from 2020 to 2022. The pharmaceutical establishment comprises 67 stores in the state of Para and occupies the sixth position in number of establishments in Brazil and ninth place in billing, whose estimated value was R\$ 2.2 billion in revenue in 2011.¹¹

To obtain the data, the drugs were collected, weighed, segregated and the weight released on a dedicated waste management platform. The entire process followed the Health Service Waste Management Plan of each establishment. The separation was carried out by the client and deposited in a specific collector, where only the medication vials, blisters and tubes were included. The weights were calculated, and their values stored in an Excel® spreadsheet. Packaging and papers were excluded from the measurement and were placed in bins available for common waste.¹²

All municipalities subject to georeferencing were processed using the free software Geographic Information System (QGIS), version 3.22, and a georeferenced satellite image showing the urban area of cities in the state of Para. The municipality's census tracts were used as the aggregation unit.⁸

RESULTS AND DISCUSSION

Of the 144 existing municipalities in the state of Para, only ten had records of RDL during the period from 2020 to 2022. A

total of 3125.63 Kg of products were collected and the city of Belem was responsible for 92.5% of the collection. In Table 1, the values (in Kg) of the municipalities of Para are described (Table 1).

Figure 1 shows the spatial distribution of RDL cases in the municipal urban census tracts. It is possible to notice a difference between the areas of RDL concentrations, that is, municipalities in the state that carried out collections in the period from 2020 to 2022.

The state of Para is divided into six mesoregions, which in turn comprise 22 microregions. The mesoregions, the metropolitan region of Belem and the northeast of Para, were the locations that most concentrated the RDL and the five municipalities, Belem; Ananindeua; Bragança; Capanema and Vigia, were responsible for 2,981.77 Kg (95.4%) of collected medicines.

The mesoregion of Southeast Para (Maraba and Novo Repartimento), Southwest (Itaituba) and Baixo Amazonas (Santarem), together, represented 4.6% (143.86 Kg) of the RDL in the state.

This investigation identified a low rate of RDL in the study location, where only ten, out of a total of 144 municipalities, carried out this action in pharmacies in the region. In fact, it was observed that, in the state of Para, there is an effective need for RDL, corroborating with other studies carried out in the country,^{5,13} which also demonstrated the low activity of this practice in Brazil. These studies certify that there is still a lack of clarification and correct guidance for the population regarding the management and disposal of medicines. Such actions are important to ensure the protection of the environment and public health, in addition to being a legal requirement, provided for in the National Policy on Solid Waste.¹⁴

In addition, there are ongoing initiatives in the state aimed at implementing the RDL, such as the selective collection of expired or unused medications in pharmacies and drugstores, which send these materials to an appropriate destination. In this way, other Brazilian municipalities also have collection points for the return of unused medicines, as a model to avoid the inappropriate disposal of these products.¹⁵

Table 1. Description of values (Kg) of the LR of medicines in the State of Pará

Municipalities/PA	Year 2020	Year 2021	Year 2022	Total
Ananindeua	14.95	11.05	15.65	41.65
Belem	911.9	964	1016.37	2892.27
Bragança	17.2	13.95	12.3	43.45
Capanema	-		2.6	2.6
Itaituba	-	1.95	-	1.95
Maraba	-	2.6	-	2.6
Novo Repartimento	-	19.13	-	19.13
Santarem	50	54.03	16.15	120.18
Vigia	-	1.8	0	1.8
Total	994.05	1068.51	1063.07	3125.63

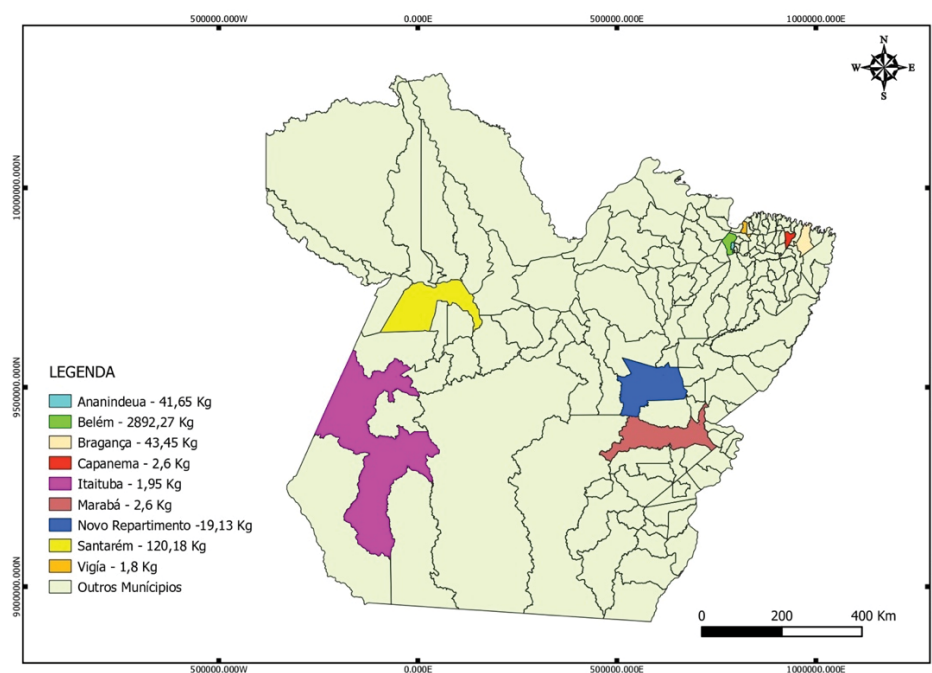


Figure 1. Spatial distribution of RDL cases in the census tracts of the state of Pará

Another initiative to encourage this practice is the participation of entities and public agencies, which work to raise awareness of the population about the importance of RDL and to monitor the proper disposal of waste generated by these products.¹⁶ Consequently, it is important to emphasize that RDL is a shared responsibility between the manufacturer, distributors, traders, and consumers, and that each of these agents has an important role to play in the proper management of waste generated by their products.⁶

The metropolitan region of Belem and the northeast of Para were the most frequent in the practice of RDL, accounting for 95.4% of the total in Kg received. These two regions have a large flow of people who seek these locations due to their local attractions and the distance of approximately 100 km from the capital Belem.¹⁷

State capitals and their surroundings are generally the main urban centers and concentrate a greater number of people, commercial establishments, and health institutions and, therefore, the practice of RDL can be performed more frequently.¹⁸ Contrary to these findings, results from other analyzes point out that carrying out this practice depends on several factors, such as population awareness, availability of collection points, inspection by the competent authorities and the existence of public policies that encourage this practice.^{19,20} However, it is important to highlight that metropolises generally have more financial resources and infrastructure available to implement RDL programs, which can facilitate the execution of these activities.²¹

The cities of Maraba, Novo Repartimento, Itaituba and Santarem were responsible for only 143.86 Kg (4.6%) of

collected medicines. Other studies.^{22,23} also show this reality in municipalities that are far from the capital. This is justified by the fact that municipalities far from the capital possibly have more difficulties in implementing the RDL due to the lack of adequate infrastructure, the scarcity of financial resources and the lower availability of specialized services.²⁴ Furthermore, according to Ritchie et al.²⁵, the lack of investments in transport and storage infrastructure can make it difficult to move medicines to their destination.

However, it is important to emphasize that the implementation of the RDL is a legal obligation for drug manufacturers and importers throughout the country, regardless of the geographic location of the cities.⁶ Thus, it is up to the regulatory authorities and competent bodies to monitor compliance with the legislation and ensure that the responsible companies are carrying out the RDL properly in all regions of the country, including cities far from the capital.²⁶

The findings referring to the spatial analysis are in line with the Brazilian scenario, which revealed that the RDL process has a greater concentration in large urban centers and their surroundings.^{5,8} On the other hand, studies claim that the RDL process in Brazil is decentralized and can be found both in large urban centers and in smaller cities in the countryside.^{27,28} However, smaller cities in the interior have structural difficulties, access, and lack of population awareness and this favors that the practice of RDL is reduced.²⁷ Therefore, it is important that pharmaceutical companies and drug sales outlets work together with local authorities and the community to implement efficient reverse logistics systems and ensure that drugs are used and disposed of properly and safely.^{28,29}

CONCLUSION

The study defined the spatial analysis of RDL in the state of Para and indicated the low activity of this branch in this locality and demonstrating that the highest prevalence occurred in central regions and with a large population flow. The findings of this study should contribute to the improvement and application of the RDL and to decision-making on reverse logistics policies within the state of Para and in Brazil.

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