

Original Research

“Look, It’s a Dengue Mosquito”: A Qualitative Study on Living Near Open-Air Dumpsites and Vector-Borne DiseasesTara Rava Zolnikov ^{1, 2, *}, Tanya Clark ², Frances Furio ³, Sandul Yasobant ^{4, 5}, Ana Carolina Silva Martins ⁶, Vanessa Resende Nogueira Cruvinel ⁶, Marcos Takashi Obara ⁶

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Currently, almost half of the human population is at risk of acquiring dengue. Other emerging pathogens affecting human populations transmitted by *Aedes (Stegomyia) aegypti* are chikungunya and Zika viruses. People who live in poor areas are more susceptible to be infected by these diseases. The lack of selective garbage collection and inadequate water storage are important factors in the dynamics of vector-borne transmission. This study took place in Estrutural City, the poorest city in Brasilia, Brazil, which hosted the largest open dump



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in America Latina and second largest in the world for almost 60 years; many of the inhabitants are waste pickers, who live and survive by gathering and selling recyclable waste. A qualitative study used semi-structured interviews with 100 participants to understand the experiences regarding community knowledge on mosquitos, contributing and prevention measures, and water access. Previous research on waste pickers has focused on vector-borne diseases, their exposure, and mitigation strategies. This research uncovered novel experiences that confirmed the plethora of knowledge of this population regarding exposure to vectors, specifically dengue. Participants mentioned contributing factors to the disease, while identifying mosquitos that carry dengue, and how often and how specifically it was to have dengue. They also mention preventative techniques that they currently take and strategies to improve upon these. These findings and actions will provide new control alternatives for arboviruses in risk areas and contribute to continued public health policies and basic services to be provided to the vulnerable communities.

Keywords

Dengue fever; arbovirus infections; waterborne diseases; social conditions; garbage; *Ae. aegypti*

1. Introduction

Waste pickers are a marginalized group of society at a time when sustainability is crucial to survival [1]. Waste pickers earn income in low-and middle-income countries by collecting salvageable recyclable materials from mounds of discarded items, though at the same time exposing themselves to devastating vector-borne diseases such as dengue [1]. Other nearby populations may be equally exposed, despite not picking garbage. This exposure is important to understand because the mosquito *Aedes aegypti* is a potent dengue transmitter and globally, dengue fever accounts for upwards of 3.0 million disability-adjusted life years (DALYs) [2]. Dengue fever is prevalent in nearly 130 countries and accounts for at least 60 million infections each year, with the disease burden assumed to be markedly higher due to underreporting [2, 3]. In Brazil, in 2022, there were 1,450,270 probable cases of dengue (incidence rate of 679.9 cases per 100,000 inhabitants.). Compared to the previous year, there was an increase of 162.5% cases [4].

Brasilia, Brazil was home to South America's largest, and the world's second largest open-air dumpsite, which was operational for over six decades until its closure in 2018 [5]. To date, nearly 36,000 individuals continue to inhabit the location called Estrutural City, which also happens to contribute to vector-borne diseases in part due to garbage accumulation, the built environment (e.g., dirt surface and standing pools of water), and poor housing structures (e.g., slums or favelas) [5]. Estrutural City has the lowest Human Development Index in Brasília, Federal District [4, 5]. The settlement is characterized by low socioeconomics and suffers from unimproved sanitation and poor access to quality water—ideal conditions for the development of foci of *Ae. aegypti* mosquito larvae [4, 5]. Quintero et al., [6] showed that in five Latin American countries, including Brazil, the majority of water containers infested by *Ae. egypti* are found outdoors and seldom used nor covered (e.g., unused tires) as is the case with living conditions in Estrutural City.

Based on the environmental risks to which waste pickers are exposed [7], this research sought to understand the lived experiences of the population proximal to the Estrutural dumpsite with a focus on the *Ae. aegypti* mosquito, which may lead to enhanced public health through reduction of the incidence rate of vector borne diseases. Researchers used a participatory action research approach to provide participants with a voice to describe and clarify community reality. Interpretative phenomenological analysis (IPA) was employed as a means of allowing participants to focus on their lived experiences. The focus of the study was to gather the experiences of waste pickers with a focus of comprehending specific events [7] and an overall goal of understanding why waste pickers are vulnerable to vector-borne diseases, such as dengue due to poor or unimproved water sources. The research objectives used semi-structured interviews to discover how the proximal population had knowledge regarding the environment and dengue (e.g., pools of water in dirt road potholes offer breeding grounds for *Ae. Aegypti*). The thematic data that emerged was expected to provide key information for policy measures on protection and health via the surveillance and control of vector-borne diseases, specifically the use of preventative methods, the implementation of periodic basic sanitation actions, and analysis of water quality.

1.1 Research Objectives

This study aimed to understand the experiences of the population with facts in mind, like sanitation or density of *Ae. aegypti* mosquito, in order to develop solutions readily applicable in public health to reduce the incidence rate of arboviruses in a vulnerable area in Brasilia, Brazil. The first objective was to understand water sources in Estrutural City, including waste selective collection and quality of water. By understanding participant experiences on water, the study aimed to understand if the water supply can influence in the increase of mosquito vector breeding sites and subsequent disease exposure. The second objective focused on understanding participant experiences related to vector-borne diseases directly from people in at-risk areas. The following questions served as a guide for the research: What are the lived experiences of waste pickers regarding poor or unimproved water and vector borne disease rates? According to the lived experiences, what factors contribute to exposure to vector borne diseases? Based on these experiences, can solutions to prevent vector-borne diseases be created by waste pickers?

Using these objectives as a guide, a better understanding of the dynamics of occurrence and transmission of diseases related to *Ae. Aegypti* was explored through the lens of the waste pickers. Ultimately, the expectation of this research was to provide important information for the surveillance and control of vector-borne diseases through the implementation of periodic basic sanitation actions, analysis of water quality, and use of preventative tools or interventions. This information combined with health education can then be used to engage the population to improve habits to prevent disease exposure and improve health.

2. Methodology

Investigating the environmental risk factors in the transmission of vector-borne diseases, assessing the impact of waste disposal in areas with transmission of disease, and monitoring the quality of drinking water are of fundamental importance to improve the prevention and control of dengue, Zika and chikungunya. This study goal was to ultimately decrease vector-borne disease exposure and improve water and sanitation to inhabitants around an open dump, close to the city

of Brasilia. To this end, a qualitative research study was used with the population of Estrutural City to understand their needs and knowledge about vector-borne disease exposure. In the following sections, the methodology and research design used for this research project are examined, with discussion related to study objectives and research design, the study site and participants, data collection/analysis, and ethical considerations.

2.1 Study Site and Participants

This study was conducted from March 2022 to March of 2023 in Estrutural City, the poorest city in Brasilia which hosted the largest open dump in America Latina and second largest in the world for almost 60 years. Estrutural a city which arose due to the settlement of individuals working in the handling or collection of solid wastes. Although the open-air dumpsite is not available anymore, people are still living around this area, many of them continue sorting recyclable garbage at home and are subjected to a variety of social and environmental risks [8]. Estrutural has a population estimated at 35,801 inhabitants; Some areas of this city are covered by sanitation, and some are not.

There were 110 participants recruited via convenience sampling. Individuals were eligible to participate in the study if they were 18 years of age, worked as a waste picker or within close proximity to waste, and lived or worked in Santa Lucia in Estrutural City.

2.2 Research Design

This study aimed to understand the experiences of waste pickers and proximal populations on vector-borne diseases, with a focus on *Ae. aegypti* mosquito; a phenomenological qualitative study was used to explore these experiences and explore and understand the risks and proposed solutions regarding unimproved water and vector borne disease contraction. Merriam and Tisdell [9] explained that in qualitative research, researchers want to know how people perceive their experiences, how they ascribe meaning, and how they build their worlds. A phenomenological study looks at what participants experienced, as well as how they experienced it [10]. As the research seeks to understand their experiences, the results can help gain insights into their situation. However, just because phenomenological research attempts to explain and clarify a phenomenon does not mean it has a definitive understanding of the phenomenon; instead, it positively contributes to raising awareness and increasing insight into the phenomenon [11]. In any case, it is by examining subjectively lived experiences of this people in that new meanings and appreciations could be developed to inform, or even reorient, how vector borne diseases affect and are understood among this population [10].

In a phenomenological study, an important characteristic focuses on a particular phenomenon to be explored, which - in this research - were the reasons why waste pickers or people who live nearby open air dumps are more subject to vector-borne diseases because of poor or unimproved water sources. When it comes to studying a group through phenomenological research, one significant advantage is its tendency to study a homogeneous group and explore these experiences through the subjective and objective views of participants [12]. Waste pickers worldwide typically have similar characteristics (e.g., social disadvantage, environment, exposure to hazards, etc.). Therefore, this qualitative phenomenological research aimed to understand the experiences of an affected population subjected to poor working, home, and environmental conditions and one

aspect of consequences (e.g., vector borne diseases). In this study, the focus was to understand community reality and give the participants a voice based on participatory action research combined with environmental and health education.

This study was mainly interested in the interpretative phenomenological analysis (IPA), a suitable qualitative technique that allowed participants to focus on their lived experiences while exploring how they make sense of specific experiences [7]. The choice of IPA for this data analysis was in consideration of its inductive approach, enabling for topics to emerge from the data that were not previously anticipated by the researcher, as well as to ensure an understanding of poor or unimproved water sources and vector borne disease rates and interpret these phenomena [7]. The IPA follows a "bottom-up approach" in that the researcher generates codes from data instead of using already established theory to recognize codes that might be useful to the data [13, 14]. Again, IPA encourages an open-ended discussion between the researcher and the participant and can potentially facilitate insight into new ideas [15].

The research team was comprised of Brazilians and an American qualitative expert who have been working with waste pickers over the last decade. This partnership has worked together with waste pickers understanding health issues, social vulnerabilities, and ways to improve waste picker lives. It should be noted that the research team did not solely gather data and leave. Health education activities for correct garbage disposal, water storage, and hygiene habits were given after the visits at the selected houses that participated in the study. After the qualitative interview, the residents were invited to continue this training in small groups supervised and conducted by a University of Brasilia team of professors and students from "Stop, Think and Dispose project" to share their knowledges and experiences and build a strong connection between them. The main idea was to empower people to know the risks they are exposed to and ask for their rights to prevent diseases and improve their health and quality of life.

2.3 Data Collection and Analysis

Merriam and Tisdell [9] explained that qualitative research is based on the idea that knowledge is constructed through individuals interacting with their social worlds (p. 23-24). Using basic qualitative research methods was deemed suitable for this research project because the purpose and objective of this study was to explore the experiences of waste pickers with vector-borne diseases. Researchers conducted in-depth interviews and surveys with 110 participants in a private setting (e.g., their houses). The researchers talked with participants of their rights before being interviewed and obtained written informed consent demonstrating the adults agreement to participate in the study. These interviews were conducted in-person, in a semi-structured manner. Interviews lasted approximately 30 to 45 minutes and were completed in confidential settings. Participants also consented for the interview to be audio recorded and later transcribed. Additionally, all transcripts were de-identified and the names of all participants were redacted to ensure confidentiality. Although interviewers had a comprehensive set of questions, they had the ability to rephrase or alter the order of the questions and ask any clarifying or follow-up questions when necessary.

Data was then transcribed, then translated into English and transcribed again; after transcription coding began and was used to gain insight into participants' experiences and perspectives. The emerging codes were cataloged while looking for patterns in the coding, which were regarded as

themes [16]. Themes that emerged were organized in meaningful wholeness while maintaining a certain level of reflectivity born out of thoughtfulness and carefulness [15]. Meanings arising from participants' experiences were organized in a meaningful text grouped in themes with much broader themes developed into "superordinate themes" [17]. For example, a major theme was "prevention" and subthemes within this category included "prophylaxis", "healthcare", and "government."

At the early stage of analysis, the researchers formulated a clear third-person description of participants' experiences, which were as close to their perceptions as possible. This is in line with participatory action research—grounded in experience and social history—that seeks to understand a phenomenon by changing it, collaboratively, and following reflection [18]. Subsequently, a "more overtly interpretive analysis" was attempted to situate the data in the context of culture, external variables, and theory, providing some semblance of commentary of the participants' "sensemaking activities" [17]. This process moved the analysis from idiographic—unique personal experience—to interpretive and theoretical worldviews [17].

2.4 Ethical Considerations

The research team is very familiar with the waste pickers and many of the individuals who were participants in this study; this is because we have been working together for nearly a decade. During this time, we encounter difficulties, and we address them to the best of our abilities. For example, caring for children, facing challenges in the old open-air dumpsite, or living in constant social vulnerability can evoke emotion. The research team will console, hug, and provide information on mental health, if needed. These situations create a stronger relationship with participants but can also be seen as a type of response bias. The team continually balances being humanistic and being researchers to the best of their ability.

In this study, the researchers established trustworthiness through validity, credibility, and transferability. This study's validity will be determined by the soundness and justification of the research findings, which can be appraised by the reader(s) [19]. The validity of qualitative phenomenological research is anchored on the rigorousness and clarity of its methodological principles concerning reflexivity, credibility, and transferability [20]. This study worked to maintain reflexivity during the entire process as the researcher sought to bring a reflective attitude to bear throughout the process. The researcher also questioned the understanding of data and themes derived and attempt to reflect on what the data actually state instead of what the researcher's understanding or preconceived notion is [10]. Nothing was taken for granted, and there was an active effort made to compare original data with the descriptive text of themes derived [7].

Concerning credibility, a thorough presentation of the findings without taking anything for granted and ensuring a transparent analysis was the focus. Efforts to maintain credibility throughout the analysis and coding process were used by engaging in ongoing peer debriefing and consultation. The rigorous following of the stipulated IPA steps also helped to consolidate the credibility of the study. Credibility was gained through triangulation of sources and member checking. Multiple participant perspectives were sought when female and males of various ages in different parts of the world working in different occupations were all included to participate in the interviews. Peer debriefing and review occurred before and after developing interview questions and analyzing themes in the data. Reflexive journaling and field notes occurred in a diary, which was used to report

on questions related participant reactions and impressions of each interview.

As for transferability, the researcher will ensure the usefulness and relevance of the study's findings. Because transferability measures the soundness of the study as well as its ability to contribute to the body of knowledge, the researcher made great effort to present clear findings that were understandable and transferable to a broader context and/or to other research. That being said, limitations in all research exists. Limitations of this study included researcher personal bias and research participant bias. This project was approved by the National Research Ethics Committee (CONEP) at University of Brasilia (id: 51331521.8.0000.8093) through the Plataforma Brazil and the World Health Organization ethics committee (id: AP20-00018). All participants signed the informed consent form and ethics approval was received prior to study implementation.

3. Results

This research uncovered novel experiences from waste pickers and nearby populations that confirmed the plethora of knowledge that they have regarding exposure to vectors, specifically dengue; this was a major theme. Participants mentioned contributing factors to the disease, while identifying mosquitos that carry dengue, and how often and how specifically it was to have dengue; they also mention preventative techniques that they currently take and strategies to improve upon these. These were also major themes in the data.

A total of 110 inhabitants were invited to participate in this study and were interviewed. Participants were deidentified and given codes; for example, P1.2 was participant two on day one. They were chosen and recruited from the local healthcare unit. There were 96 women (89%) and 14 men (11%). The average age was 38 years old, women (36) and men (46). A total of 80 lived at the Estrutural City and 20 in Santa Luzia; there were 10 people who did not respond with their location. Santa Lucia is an irregular favela where more than 7,000 people live; the majority of the population are waste pickers and informal workers.

3.1 Contributing Factors to Vector-borne Diseases

The built environment in slums or favelas can contribute to transmission of disease, which may be due to high levels of contamination through poor sanitation, unimproved water sources, and unregulated waste alongside overcrowding and poor housing structures (e.g., no windows or doors) as noted by participants. The Santa Lucia favela was described as “mud, rain, dust... there’s no water to pump.” (1.9) and how “...the lack of hygiene [garbage] of people who [also] leave water accumulated...all of this influences exposure.” (2.16)

Participants understood many factors that contributed to disease and focused significantly on how the build environment contributed to the spread of vector-borne disease. One major aspect mentioned was “puddled water” (2.7) or “[potholes on the road accumulating water]” (2.2). This is because the roads in the slum “[are] not paved.” (2.16) Housing was another focal point, in that housing was unfinished and that did not offer much protection. “The house...is still falling apart... It has a bathroom, but it's a shack. There was wind and the roof tiles were blown off.” (1.5)

Garbage that was not sorted and instead was thrown amongst the streets was another area of concern. Participants understand the link between “the street was all dirty” (2.6) and when “they throw the garbage... we have mosquitoes because of this.” (2.5) Garbage accumulates until waste pickers gather it “the garbage collector doesn’t even pick it up, [it’s the waste pickers] who recycle

that pick it up.” (2.7)

3.2 Identifying Vector-borne Diseases

Because participants are exposed to diseases, especially cases of dengue, they can easily identify it and know when they have contracted it. “There are many cases of disease [here], especially dengue.” (2.4) They are frequently sick from disease exposure, “we get sick all the time.” (1.1) Because of the frequency of contraction, dengue gets worse over time and waste pickers can become very ill.

My husband has had dengue fever three times, this last time it was hemorrhagic. He got very bad. He had to go to Hospital do Guar, where he was hospitalized for three days and took medication. There they did all the exams correctly. He stayed home for 15 days without working. He is 26 years old. (2.11)

They are able to recognize the signs and symptoms of their illness, “I had dengue fever less than a month ago; it was horrible, my eyes hurt.” (2.17) Participants have so much knowledge on the disease that they can even distinguish the mosquito that carries dengue, *Ae. aegypti*. “My husband also saw a mosquito very similar to the dengue mosquito; he caught it and showed it to me and said, ‘look, here it’s [a] dengue mosquito.’” (2.14) Because they can spot the mosquito that carries the virus, they are able to react accordingly when they see it. “When we see them, we poison them.” (2.10)

3.3 Prevention of Vector-borne Diseases

Participants used many tools or interventions to avoid exposure to vectors. They were very aware and used:

bleach...then we always take care of [water treatment] ... store water and [keep it in the fridge]...only recycle the water from washing clothes...but the water [thrown to plants] is very little... there is [some water for the] dogs there, but their water is changed every day and the water container is small. (2.13)

Other strategies included “repellent on children” (2.11), “plug in the outlet [repellent against mosquitos]” (2.14), “the mosquito coil to burn [and] also put poison [into], Baygon (brand of insecticide) out.” (2.15), and “put up screens.” (1.2) Many times the repellent and tools are frequently used when children are around, “I use repellent on my children.” (1.2)

3.4 Future Solutions to Vector-borne Diseases

Creating future solutions to decrease or eliminate disease exposure is important for creating positive change. Participants did not discuss specific ways to improve vector-borne disease exposure but focused more on a macro-scale picture of it. Education and support were highlighted, “there has to be an awareness.” (1.2) It was also suggested to improve awareness through health agents, “the health agents have to visit more [often]; they only visit once a month.” (2.9). It was mentioned how the government needed to become more actively involved in fighting disease and addressing health, “the biggest [contributor to the disease exposure] is the government... they don’t want to spend [money] on health; they don’t want to spend [money] on medicine to fight the mosquitoes. The only [prevention] we have is the fumigation spray.” (2.13)

Participants understood that avoiding vector-borne diseases (e.g., taking care of mosquitos, decreasing pools of standing water or areas where garbage builds up, using fumigation strategies) is difficult. “The problem is that we don’t have enough time to take care of things, the time to take care of the garbage, the environment...” It was recommended that waste pickers come together to fight these issues, instead of deal with them individually. “Have willpower... It would be the greatest [change] in this world out there... if the waste pickers were united, knew how to fight for their freedom... To work in partnership. I advise all the waste pickers in [the entire country of] Brazil: unite!” (1.5)

4. Discussion

Prior research specifically on waste pickers and their exposure to vector-borne diseases was conducted and published in 2020 [21]; this mixed methods study confirmed that approximately 30% of workers suffered from a vector-borne disease, with Dengue being the most common [21]. Qualitative data corroborated the quantitative data and confirmed that waste pickers knew standing pools of water bred vectors which in turn would pass on disease, they self-treated or went to the clinic to receive treatment, and they understood that prevention occurred mostly with avoiding or decreasing these pools, which would ultimately also improve their work environments (e.g., sorting garbage) [21].

This current research dove more into understanding vector-borne diseases from an experiential standpoint in order to create more directed prevention techniques or tools to decrease exposure. This basis for this research came from the fact that despite the closure of the open dump in Estrutural city in Brasilia, Brazil, waste pickers and surrounding populations still live with their families in the proximities of the open-air dumpsite [21]. In general, and in Estrutural, this population is subject to rapid urbanization, an increase in population density, and poor water, sanitation, and hygiene [22-25]. This situation can create a significant challenge with exposure to vector-borne diseases, more specifically on dengue control in dengue-endemic countries, as *Ae. aegypti* prefers to breed in buckets, drums, tires, pots, plastic/artificial containers, discarded tires, which are all aspects of discarded garbage in open-air dumps [26, 27]. Thus, the risk for dengue increases in this scenario through garbage accumulation [28] or a lack of consistency in garbage collection [29-31]. Moreover, Kenneson et al. [29] confirmed the incidence of dengue fever to be positively associated with dwellings subjected to more than 50% shading, with adjacent abandoned properties, the lack of premise plumbing, and irregular or absent daily garbage collection.

The first major novel finding of this research was that the built environment has a major contribution to dengue's incidence, which is also supported by the findings in this qualitative study. Participants highlighted that, among other contributing factors, poor sanitation, unimproved water sources, and unregulated waste alongside overcrowding and poor housing structures were contributing factors for the high prevalence of dengue in their population. Literature confirms that among other occupational health issues, dengue and other vector-borne diseases are both economic and social burdens to waster pickers across the globe [21, 32-34]. In a systematic review conducted in 2022 with studies in 23 geographic locations that examined the relationship between socioeconomic factors and infections caused by seven arboviruses, they found a higher risk of arbovirus infection associated with markers of lower education, income poverty, low healthcare coverage, poor housing materials, interrupted water supply [35]. These characteristics are similar

to our population.

Waste pickers are one group of people who frequently suffer from dengue. Because of the familiarities of dengue among this population, waste pickers are highly knowledgeable about the symptoms of the disease as well as healthcare treatment measures, which was one of the key findings in the current study. This information was further supported by previous research as well [28] or a lack of consistency in garbage collection [21, 29-34]. This phenomenon could be perceived in two ways: 1. knowing about the symptoms enables waste pickers to seek healthcare or 2. preventing dengue amongst the frequent onset of the disease results in decreased immunity among these vulnerable groups resulting in low productivity and subsequent socioeconomic loss.

Another major theme in this study focused on the built environment, which is known to have a major role in larva proliferation and possible high incidence of dengue. For example, waste pickers knew that the dirt roads and land that they lived and walked through created puddles of water that they were unable to drain; these puddles would at some point become breeding grounds for vectors. Although participants had some knowledge about preventive measures specific to the built environment, it is always important to intervene in the environmental management strategies of the larger community. A meta-analysis by Buhler and colleagues [27] highlighted that dengue vector control could be achieved effectively through waste management and clean-up campaigns and the elimination of breeding sites by rendering potential mosquito breeding sites unusable or by eliminating them [27]. Similarly, the data in our study highlights that continued fumigation along with health education is one of the key measures that could be taken as a mitigation strategy near garbage sites; thus, the partnering of a macro-approach (e.g., waste management) alongside a person-centered (e.g., home fumigation) approach can be used simultaneously to achieve the most effective results.

In fact, there are several health education intervention programs are proven effective and efficient for dengue control across the world [36]; a primary strategy is to create and implement a sustainable plan for health education interventions, such as promoting behavioral change at the individual, household, and community levels. Hence, dengue hemorrhagic fever control measures should focus on community education and action toward the elimination of mosquito breeding sites near human dwellings. For waste pickers and nearby populations, the link between solid waste and garbage sites is expected to increase the risk of dengue epidemics if the mitigation strategies for both dengue and waste management have not drawn enough attention from policymakers. Based on the study findings, it is strongly recommended that sustainable contextualized health intervention models for waste pickers uses environmental control measures in the high-risk sites, such as open-air dumpsites. It is also recommended to generate more of a waste picker-centered approach, which focuses on their continued involvement working in a site that heightens the risk of disease. The study highlights how one vulnerable population has and uses gained health literacy on topics to minimize occupational hazards, which is a novel finding that can produce positive outcome for education interventions.

Finally, this study has a couple limitations. Generally, it is possible that dengue knowledge and health literacy differs in the world depending on exposure to disease and environmental context (e.g., wet or semi-arid), thus the results may not be transferable. There are also possibilities with translation and transcription errors, though all measures were taken to ensure consistency (e.g., such as peer-review, team reads, etc.). Finally, researcher bias may always exist, as the lens wherein these dialogues were viewed were through a team who actively works to fight for the rights of waste

pickers; this could lead to influence or persuasion on some level.

5. Conclusions

The current study identified the lived experiences of 110 waste pickers and nearby populations who continue to live nearby or next to the closed Estrutural dumpsite in Brasilia, Brazil, the second largest of its kind in the world. Estrutural has a population of approximately 35,000 individuals within this area, with a significant amount of them continuing work as waste pickers. The environment of the dumpsite nearby can contribute to vector-borne diseases in part due to garbage accumulation, the built environment (e.g., dirt surface, debris in or around and standing pools of water, which included poor housing structures (e.g., slums or favelas with open sewage disposal). The study highlights how people use accrued health literacy to mitigate hazards of the built environment, which is a novel finding that can contribute to beneficial outcomes for health interventions. Data indicated how participants are highly cognizant of the transmission method, risk factors, and symptoms of dengue, and have broad familiarity with the *Ae. aegypti* mosquito responsible for spreading the disease. There was a general comprehension of specific events such as the role that poor or unimproved water sources have on waste pickers' exposure to vector borne diseases. Incorporating knowledge of dengue and building on their current preventative techniques can lead to enhanced public health strategies that decrease the incidence rate of vector borne diseases. Moreover, knowledge of how the built environment contributes to disease transmission (e.g., puddled water and unpaved roads) should inform public policy on waste picker protection and health.

Future research could seek to understand how policy measures could align with public health interventions, as identified by the needs of waste pickers, including expanded education, the value of organized labor, increased government spending to fight mosquitos, and improved housing as solutions to decrease or eliminate disease. The current study reinforces research that shows that promoting individual behavioral changes can enhance community health [10].

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Author Contributions

TRZ conceptualized the research, MO and VRC created the other parts of the research project that contributed to this qualitative component. ACSM collected data. TRZ analyzed the data and wrote the results. TC, FF, YS wrote the introduction, methods, and discussion. TRZ edited and wrote the conclusion. VRC and MO edited the final version.

Competing Interests

The authors have declared that no competing interests exist.

References

1. Dias SM. Waste pickers and cities. *Environ Urban*. 2016; 28: 375-390.
2. Hay SI, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, et al. Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 2017; 390: 1260-1344.
3. Stanaway JD, Shepard DS, Undurraga EA, Halasa YA, Coffeng LE, Brady OJ, et al. The global burden of dengue: An analysis from the Global Burden of Disease Study 2013. *Lancet Infect Dis*. 2016; 16: 712-723.
4. Brazil Ministry of Health. Monitoring of cases of arboviruses until epidemiological week 52 of 2022 [Internet]. Brasília: Brazil Ministry of Health; 2023 [cited date 2023 January 10]. Available from: <https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/edicoes/2023/boletim-epidemiologico-volume-54-no-01/>.
5. Cruvinel VR, Marques CP, Cardoso V, Novaes MR, Araújo WN, Angulo-Tuesta A, et al. Health conditions and occupational risks in a novel group: Waste pickers in the largest open garbage dump in Latin America. *BMC Public Health*. 2019; 19: 581.
6. Quintero J, Brochero H, Manrique-Saide P, Barrera-Pérez M, Basso C, Romero S, et al. Ecological, biological and social dimensions of dengue vector breeding in five urban settings of Latin America: A multi-country study. *BMC Infect Dis*. 2014; 14: 38.
7. Sundler AJ, Lindberg E, Nilsson C, Palmér L. Qualitative thematic analysis based on descriptive phenomenology. *Nurs Open*. 2019; 6: 733-739.
8. Marques CP, Zolnikov TR, Noronha JM, Angulo-Tuesta A, Bashashi M, Cruvinel VR. Social vulnerabilities of female waste pickers in Brasília, Brazil. *Arch Environ Occup Health*. 2021; 76: 173-180.
9. Merriam SB, Tisdell EJ. *Qualitative research: A guide to design and implementation*. 4th ed. San Francisco, CA: Jossey-Bass; 2016.
10. Neubauer BE, Witkop CT, Varpio L. How phenomenology can help us learn from the experiences of others. *Perspect Med Educ*. 2019; 8: 90-97.
11. Tassone BG. The relevance of Husserl's phenomenological exploration of interiority to contemporary epistemology. *Palgrave Commun*. 2017; 3: 17066.
12. Tichenor S, Yaruss JS. A phenomenological analysis of the experience of stuttering. *Am J Speech Lang Pathol*. 2018; 27: 1180-1194.
13. Brooks J, McCluskey S, Turley E, King N. The utility of template analysis in qualitative psychology research. *Qual Res Psychol*. 2015; 12: 202-222.
14. King N, Brooks J, Tabari S. Template analysis in business and management research. In: *Qualitative methodologies in organization studies: Volume II: Methods and possibilities*. Cham: Springer; 2018. pp. 179-206.
15. Alase A. The interpretative phenomenological analysis (IPA): A guide to a good qualitative research approach. *Int J Educ Lit Stud*. 2017; 5: 9-19.

16. Wiggins TS. An interpretive phenomenological analysis of the lived experiences and mentoring relationships of black women student affairs administrators. Norfolk, VA: Old Dominion University; 2017.
17. Willey CR. Meaningful teaching: An interpretive phenomenological analysis of how international school teachers experience meaningful work. Boston, MA: Northeastern University; 2016.
18. MacDonald C. Understanding participatory action research: A qualitative research methodology option. *Can J Action Res.* 2012; 13: 34-50.
19. Tong A, Palmer S, Craig JC, Strippoli GF. A guide to reading and using systematic reviews of qualitative research. *Nephrol Dial Transplant.* 2016; 31: 897-903.
20. Attia M, Edge J. Being a reflexive researcher: A developmental approach to research methodology. *Open Rev Educ Res.* 2017; 4: 33-45.
21. Cruvinel VR, Zolnikov TR, Obara MT, de Oliveira VT, Vianna EN, do Santos FS, et al. Vector-borne diseases in waste pickers in Brasilia, Brazil. *Waste Manage.* 2020; 105: 223-232.
22. Espinosa M, Weinberg D, Rotela CH, Polop F, Abril M, Scavuzzo CM. Temporal dynamics and spatial patterns of *Aedes aegypti* breeding sites, in the context of a dengue control program in Tartagal (Salta province, Argentina). *PLoS Negl Trop Dis.* 2016; 10: e0004621.
23. Ngugi HN, Mutuku FM, Ndenga BA, Musunzaji PS, Mbakaya JO, Aswani P, et al. Characterization and productivity profiles of *Aedes aegypti* (L.) breeding habitats across rural and urban landscapes in western and coastal Kenya. *Parasites Vectors.* 2017; 10: 331.
24. Getachew D, Tekie H, Gebre-Michael T, Balkew M, Mesfin A. Breeding sites of *Aedes aegypti*: Potential dengue vectors in Dire Dawa, East Ethiopia. *Interdiscip Perspect Infect Dis.* 2015; 2015: 706276.
25. Cordeiro DC, Fonseca FL, Arab C, Leitão FN, Zangirolami-Raimundo J, Raimundo RD. Factors associated with dengue cases in Brazilian industrial area: An ecological study. *J Human Growth Dev.* 2020; 30: 451-460.
26. Guzmán MG, Kouri G. Dengue: An update. *Lancet Infect Dis.* 2002; 2: 33-42.
27. Buhler C, Winkler V, Runge-Ranzinger S, Boyce R, Horstick O. Environmental methods for dengue vector control—A systematic review and meta-analysis. *PLoS Negl Trop Dis.* 2019; 13: e0007420.
28. Krystosik A, Njoroge G, Odhiambo L, Forsyth JE, Mutuku F, LaBeaud AD. Solid wastes provide breeding sites, burrows, and food for biological disease vectors, and urban zoonotic reservoirs: A call to action for solutions-based research. *Front Public Health.* 2020; 7: 405.
29. Kenneson A, Beltrán-Ayala E, Borbor-Cordova MJ, Polhemus ME, Ryan SJ, Endy TP, et al. Social-ecological factors and preventive actions decrease the risk of dengue infection at the household-level: Results from a prospective dengue surveillance study in Machala, Ecuador. *PLoS Negl Trop Dis.* 2017; 11: e0006150.
30. Heukelbach J, De Oliveira FA, Kerr-Pontes LR, Feldmeier H. Risk factors associated with an outbreak of dengue fever in a favela in Fortaleza, north-east Brazil. *Trop Med Int Health.* 2001; 6: 635-642.
31. Brunkard JM, López JL, Ramirez J, Cifuentes E, Rothenberg SJ, Hunsperger EA, et al. Dengue fever seroprevalence and risk factors, Texas–Mexico border, 2004. *Emerging Infect Dis.* 2007; 13: 1477.
32. Cassemiro ÉM, Cilião-Alves DC, Moura DR, Slavov SN, Quintão TD, Scott JA, et al. Dengue and

- Chikungunya seroprevalence in waste pickers from the largest Latin American open-air dump. *J Infect.* 2021; 83: 709-737.
33. Kumari S, Kiran UV. Prevalence of health problems of rag pickers due to various hazards at Lucknow city. *Hum Factors Healthcare.* 2022; 2: 100023.
 34. Chokhandre P, Singh S, Kashyap GC. Prevalence, predictors and economic burden of morbidities among waste-pickers of Mumbai, India: A cross-sectional study. *J Occup Med Toxicol.* 2017; 12: 30.
 35. Power GM, Vaughan AM, Qiao L, Clemente NS, Pescarini JM, Paixão ES, et al. Socioeconomic risk markers of arthropod-borne virus (arbovirus) infections: A systematic literature review and meta-analysis. *BMJ Global Health.* 2022; 7: e007735.
 36. Llorente-Pérez YJ, Rodríguez-Acelas AL, Cañon-Montañez W. Educational interventions for the prevention and control of dengue in adults: An integrative review. *Enferm Clin.* 2023; 33: 157-166.