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P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Assessment of the Socio-Demographic Profile and Awareness of Urban Residents on the Health Implications of Heavy Metal Contamination in Urban Soils: A Case Study of City Dwellers

Daniel Isaiah B. Raymundo
Isabela State University- Cabagan Campus, Garita Heights, Cabagan, Isabela
Corresponding Author e-mail: *rdanielisaiah@gmail.com*

Received: 20 June 2025 **Revised**: 24 July 2025 **Accepted**: 26 July 2025

Available Online: 28 July 2025

Volume IV (2025), Issue 3, P-ISSN – 2984-7567; E-ISSN - 2945-3577

https://doi.org/10.63498/etcor420

Abstract

Aim: This study investigated the relationship between urban residents' socio-demographic characteristics and their awareness of heavy metal contamination in Tarlac City, Philippines. It specifically examined variables such as household headship, sex, educational attainment, household size, and roadside food consumption behaviors.

Methodology: A total of 384 respondents were selected using stratified random sampling across nine barangays in Tarlac City. Data were gathered through a structured and validated survey instrument, which assessed socio-demographic profiles, environmental health awareness, perceived illness, and behavioral patterns associated with potential exposure to heavy metals in urban soils.

Results: Only 24% of participants reported household illness, with fever, chest pain, and body pain identified as the most common symptoms. While 53% of respondents were aware of the presence of heavy metals and 57% recognized their associated health risks, awareness of specific contamination sources and the dangers of consuming roadside food remained low. A significant association was found between household headship and awareness levels ($p < .001$). However, no statistically significant relationships were observed between educational attainment and awareness ($p > .05$), indicating a widespread gap in environmental health literacy across educational backgrounds. Notably, 53% of respondents reported regular consumption of roadside food despite limited awareness of contamination risks.

Conclusion: The findings underscored the urgent need for targeted environmental education campaigns, strengthened public health surveillance, and multi-sectoral collaboration. These efforts were deemed essential to promote informed, preventive behaviors and enhance environmental resilience in rapidly urbanizing communities such as Tarlac City.

Keywords: *heavy metal contamination, environmental awareness, socio-demographic factors, public health, urban soil pollution, Tarlac City*

INTRODUCTION

Urbanization, while often viewed as a driver of economic development and modernization, has increasingly been associated with serious environmental and public health challenges, especially in developing countries. The rapid expansion of urban centers often outpaces the development of critical infrastructure, leading to widespread issues such as inadequate waste disposal, pollution, and ecological degradation (Capps et al., 2016). One particularly pressing consequence of unregulated urbanization is the degradation of urban soils, notably through heavy metal contamination. This silent but hazardous form of pollution not only disrupts ecological balance but also poses significant health risks to urban populations, particularly those living in proximity to industrial zones, roadways, and informal economic areas.

Heavy metal contamination in urban soils is primarily driven by industrial activities, vehicular emissions, urban runoff, and legacy pollution from historical land uses (Ayaz et al., 2023; Wang et al., 2024). Studies from

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various countries have documented alarming levels of heavy metals such as lead (Pb), cadmium (Cd), and mercury (Hg) in urban environments, with concentrations frequently surpassing natural thresholds (Adewumi & Ogundele, 2023). These contaminants can enter the human body through ingestion, dermal contact, or consumption of contaminated food grown in polluted soils, leading to both carcinogenic and non-carcinogenic health effects (Ayaz et al., 2023; Gruszka et al., 2024). The ecological implications are equally severe, as persistent metals like Hg and Cd are known to accumulate in biotic systems, disrupting ecosystems and reducing biodiversity (Adewumi & Ogundele, 2023).

While the scientific community has made significant strides in characterizing the presence and toxicity of heavy metals, less attention has been paid to the social dimensions of this environmental threat—particularly the role of socio-demographic factors in shaping public awareness and health responses. Socio-economic status (SES), educational attainment, and gender dynamics critically influence how urban residents perceive and respond to environmental health risks (Jones et al., 2022). Conversely, residents with higher educational attainment tend to demonstrate greater environmental awareness and engage in more protective health behaviors (Monib et al., 2024). In the Philippine context, studies on leadership and community engagement have emphasized the role of localized, grassroots approaches in building environmental awareness and advocacy (Carvajal et al., 2024; Sanchez et al., 2024).

In the context of Tarlac City, a rapidly urbanizing area in the Philippines, the convergence of industrial development, population growth, and informal economic activities raises critical questions about soil health, environmental awareness, and public vulnerability. Despite emerging evidence of soil contamination in various Philippine urban centers, localized data on public perception, knowledge, and behavior remain scarce. This knowledge gap hinders effective policy formulation, health intervention, and environmental management at the community level.

Therefore, this study aims to assess the socio-demographic profile and environmental health awareness of urban residents in Tarlac City regarding heavy metal contamination in urban soils. By examining the relationships between education, household roles, and environmental knowledge, the research seeks to inform targeted risk communication, enhance environmental literacy, and support the development of inclusive public health policies. Ultimately, the study endeavors to contribute to a more resilient and informed urban population capable of responding effectively to the hidden yet urgent challenge of heavy metal pollution.

Objectives

Despite the increasing evidence of soil contamination in urban areas, there is limited understanding of how socio-demographic variables influence community awareness and health behaviors in the Philippines. This gap weakens the efficacy of health and environmental policies aimed at promoting urban resilience, particularly in cities facing rapid urbanization and environmental degradation such as Tarlac City.

Generally, this study aimed to assess the socio-demographic profile and level of awareness of urban residents regarding the health implications associated with heavy metal contamination in urban soils.

Specifically, this study aimed to:

1. describe the socio-demographic characteristics of urban residents, including head of household status, sex, barangay of residence, years of residency, educational attainment, household size, and vehicle ownership;
2. assess the level of awareness of urban residents regarding the presence, sources, health effects, and environmental impacts of heavy metal contamination in urban soils, as well as their support for a heavy metal-free environment;
3. identify the prevalence, types, and perceived causes of common illnesses experienced by residents in the past five years and evaluate patterns in relation to health-related environmental concerns;
4. examine the relationship between socio-demographic variables and awareness levels regarding heavy metal contamination, including specific associations with head of household status, educational attainment, and other key demographic factors; and
5. determine the association between awareness levels and behavioral factors, such as the consumption of roadside food, and to identify target groups for health communication and environmental policy engagement.

Review of Related Literature and Studies

Many cities in developing nations lack adequate waste disposal systems, resulting in unsanitary conditions and increased public health risks (Capps et al., 2016). In addition, infrastructure deficiencies contribute to the

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intensification of urban stream syndrome, wherein stormwater runoff from urban areas degrades freshwater ecosystems (Capps et al., 2016). The environmental consequences of urbanization are not uniform; for example, while urban growth in India and Bangladesh has been linked to significant environmental degradation, Sri Lanka presents a contrasting case, demonstrating a more positive association between urbanization and environmental quality (Azam & Khan, 2015). Although urbanization holds potential for improving environmental management through more efficient resource distribution and technological advancements, this potential is rarely realized in developing contexts, where growth often outpaces planning and regulation. Consequently, sustainable urban planning is essential to reducing CO_2 emissions and ensuring long-term environmental sustainability (Azam & Khan, 2015).

Heavy metal contamination in urban soils is an increasingly critical environmental concern, primarily driven by rapid urbanization and intensified industrial activities. Empirical studies have consistently reported elevated levels of heavy metals such as lead (Pb), cadmium (Cd), and mercury (Hg) in urban environments, posing considerable ecological and public health risks. The significance of localized responses and public-private collaboration in mitigating environmental challenges has been echoed in recent Philippine research on workplace sustainability and strategic governance (Amihan & Sanchez, 2023).

A meta-analysis involving 174 cities found that the average concentrations of heavy metals in urban soils frequently surpass natural crustal values, with Pb concentrations recorded as high as 5780 mg/kg (Adewumi & Ogundele, 2023). In Pakistan, spatial analyses have revealed varying degrees of contamination, ranging from moderate to extreme, depending on the location and type of land use (Ayaz et al., 2023). The primary sources of heavy metal contamination include industrial emissions, vehicular exhaust, and urban flooding, all of which contribute to elevated pollutant loads in urban soils (Ayaz et al., 2023; Wang et al., 2024). Additionally, legacy contamination from historical industrial activities continues to affect areas such as urban gardens, where elevated levels of Pb and Zn have been detected (Gruszka et al., 2024). Health risk assessments underscore the gravity of these contaminants, indicating both carcinogenic and non-carcinogenic risks to urban populations, particularly through soil ingestion and dermal exposure (Adewumi & Ogundele, 2023; Ayaz et al., 2023). From an ecological perspective, heavy metals such as mercury and cadmium pose the most severe threats to environmental health due to their toxicity and persistence in soil systems (Adewumi & Ogundele, 2023). While the data reveal significant risks, they also underscore the urgent need for effective remediation efforts and policy interventions. Strategic approaches to soil management, pollution control, and urban planning could substantially reduce exposure risks and improve urban environmental quality for current and future populations.

The socio-economic status (SES) and educational attainment of urban residents significantly influence their awareness and understanding of the health risks associated with heavy metal contamination in urban soils. Studies have shown that low-income and minority communities are disproportionately affected by such contamination due to their increased proximity to industrial zones and reduced access to information and mitigation resources (Jones et al., 2022). Urbanization and industrial activities further exacerbate these risks, especially in densely populated areas (Adewumi & Ogundele, 2023). Education plays a critical role in shaping environmental health awareness. Individuals with higher levels of education tend to have a greater understanding of the dangers of heavy metal exposure and are more likely to engage in protective behaviors (Monib et al., 2024). The health implications of heavy metal exposure are severe and can include respiratory problems, neurological disorders, and other toxic effects (Monib et al., 2024). SES and education are key determinants; addressing environmental health disparities also requires comprehensive policy support and active community engagement. This aligns with the findings of Carvajal et al. (2024), who emphasized inclusive leadership frameworks and civic involvement in addressing community-based risks and promoting well-being.

Conceptual Framework

The IPO (Input-Process-Output) model offers a comprehensive framework for understanding the multifaceted issue of heavy metal contamination in urban soils, particularly in the context of developing urban environments. The Input phase highlights the primary contributors to soil contamination, including rapid urbanization and industrialization, inadequate waste disposal systems, and insufficient urban infrastructure (Capps et al., 2016). Additional environmental stressors such as vehicular emissions, industrial pollutants, urban flooding (Ayaz et al., 2023; Wang et al., 2024), and legacy contamination from previous industrial activities (Gruszka et al., 2024) further exacerbate the problem. Socio-demographic variables, particularly socio-economic status (SES) and educational attainment, also influence community vulnerability and awareness levels (Jones et al., 2022; Monib et al., 2024).

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In the Process phase, these inputs result in the accumulation of toxic heavy metals like lead (Pb), cadmium (Cd), and mercury (Hg) in urban soils (Adewumi & Ogundele, 2023), leading to environmental degradation and ecological toxicity. Health risk assessments have identified both carcinogenic and non-carcinogenic impacts from prolonged exposure to these metals (Adewumi & Ogundele, 2023; Ayaz et al., 2023). Additionally, this stage includes the responses from government and community sectors, such as policy interventions, urban planning efforts, and public health campaigns aimed at mitigating these risks.

The Output phase reveals the consequences of these interactions: increased ecological and health risks for urban populations, particularly among low-income and less-educated communities who often reside closer to pollution sources and have limited access to mitigation resources. This disproportionate exposure reflects inequities in environmental health protection. Furthermore, there is evident variability in awareness and preventive behaviors, closely tied to levels of education and household leadership roles. These outcomes emphasize the urgent need for targeted policies, inclusive environmental education, and strategic remediation initiatives. Strengthening risk communication and implementing sustainable urban planning reforms are essential to reducing exposure and enhancing public health outcomes in urban settings (see Figure 1).

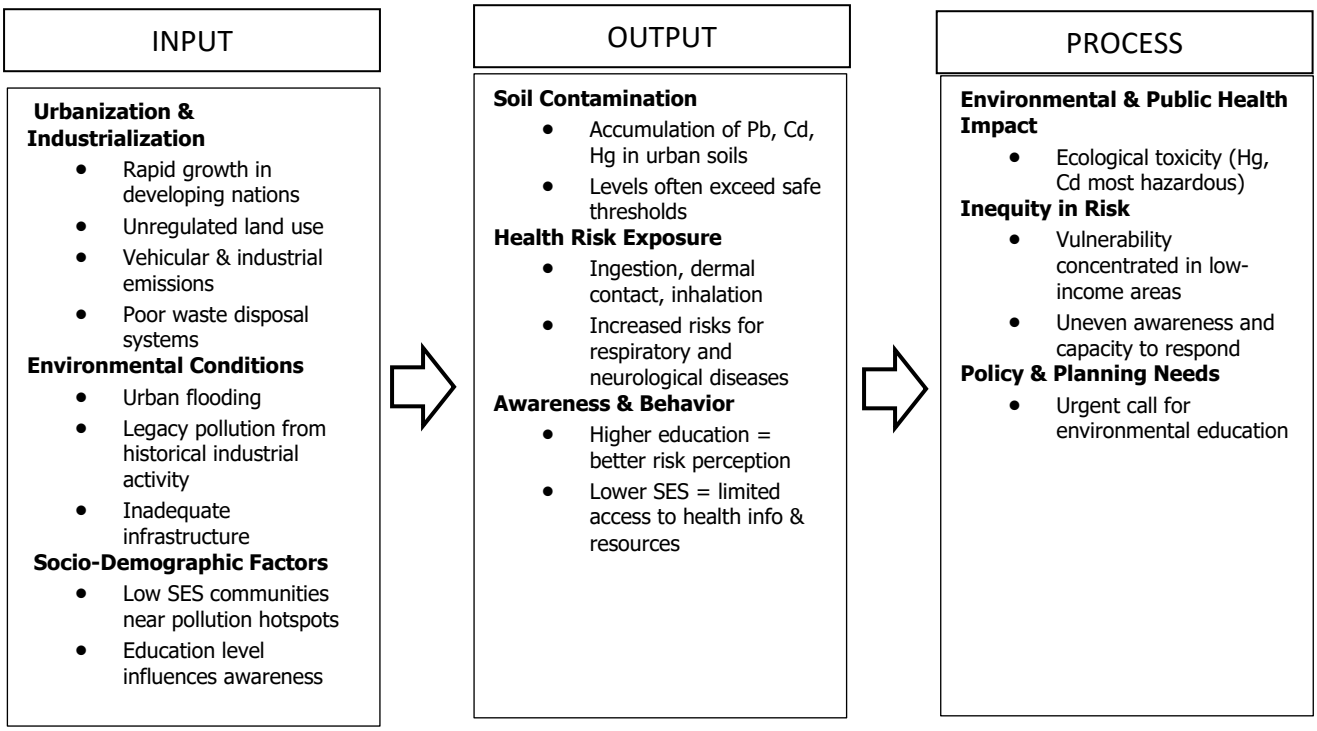

Figure 1. *Paradigm of the Study*

METHODS

Research Design

This study utilized a descriptive-correlational research design to examine the socio-demographic profiles and awareness levels of urban residents regarding heavy metal contamination in urban soils. This methodology was chosen to explore potential relationships between demographic factors and environmental awareness. By employing structured survey instruments for data collection, the study generated quantitative, context-specific insights that informed targeted health education initiatives and supported evidence-based policy development at the local level.

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Population and Sampling

The study population consisted of urban residents in Tarlac City who may be exposed to heavy metal contamination risks due to their proximity to busy roads, industrial zones, and informal food vending areas. The Cochran formula was used to determine the appropriate sample size, ensuring a 95% confidence level with a population proportion of 0.5. A stratified random sampling technique was applied across nine pre-identified barangays to obtain representative data across the city's diverse neighborhoods.

Instrument

The main research instrument was a structured survey questionnaire developed by the researchers based on a comprehensive review of related literature. It was designed to capture data on respondents' socio-demographic profiles, awareness levels, perceptions, and experiences regarding heavy metal contamination in urban soils. The instrument underwent expert validation by professionals in public health, environmental science, and research methodology to ensure clarity, relevance, and reliability. A pilot test was also conducted with a small sample to refine the questionnaire before full deployment.

Data Collection

Data were collected from April to May 2025 across nine selected barangays in Tarlac City. The data collection process involved both face-to-face interviews and the use of digital forms to accommodate varying levels of accessibility and to ensure the safety of participants. Trained enumerators administered the structured questionnaires in a consistent manner across all locations. This dual-mode approach facilitated broad participation from diverse socio-demographic groups within the urban population and allowed for efficient and accurate data gathering in both densely populated and more remote areas of the city.

Treatment of Data

The collected data were organized and analyzed using statistical software. Descriptive statistics were used to summarize socio-demographic characteristics and awareness levels. To determine the association between socio-demographic factors and awareness of heavy metal contamination, the Chi-square test was employed. Findings were presented in tables and graphical formats to support interpretation and discussion.

Ethical Considerations

Informed consent was obtained from all participants after clearly explaining the purpose, methods, risks, and benefits of the study. Participants were assured of their right to withdraw at any point without consequence. Strict confidentiality and anonymity were observed no identifying information was collected, and all responses were securely stored and accessed only by the research team.

While this study was not formally reviewed by an institutional ethics board, this study adhered to core ethical principles, including beneficence, non-maleficence, autonomy, and justice. The questionnaire was designed to be non-intrusive and respectful, avoiding sensitive or distressing questions. The primary goal of the research was to generate knowledge that would benefit the public and inform local communities about the health risks associated with urban soil contamination by heavy metals.

RESULTS and DISCUSSION

Socio-Demographic Characteristics

The socio-demographic characteristics of the respondents, as presented in Table 1, provide critical context for understanding the structural composition, lived experiences, and potential responsiveness of the community to socio-environmental transitions and policy interventions (World Bank, 2010; UN-Habitat, 2020). Among all respondents, only 19.50% identified as heads of households, while the remaining 80.50% were not, indicating that the study captured a broader cross-section of household members beyond primary decision-makers. This inclusive representation enriches the analysis by reflecting diverse perspectives within each home (Asian Development Bank [ADB], 2013).

In terms of gender distribution, females constituted a slight majority at 53.60%, compared to 46.40% male respondents. This near balance, with a minor skew toward female representation, may suggest trends such as male outmigration for labor or increased female participation in community affairs common in urbanizing areas of Southeast Asia (Yap & De Wandeler, 2010). All nine participating barangays Sta. Cruz, Aguso, Paraiso, San Miguel,

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Santo Cristo, San Rafael, San Roque, San Sebastian, and Burot contributed equally to the sample (11.20% each), providing geographic homogeneity that strengthens the representativeness of the data and supports localized analysis.

Residential tenure data revealed that the community is largely composed of long-term residents. A significant proportion (36.20%) had lived in the area for 21–40 years, followed by 21.88% who had resided for 1–10 years and 21.35% for 11–20 years. Notably, 17.19% had lived there for 41–60 years, while 3.39% reported over 60 years of residence. These figures indicate deep-rootedness and generational continuity, although the presence of newer residents suggests ongoing migration or shifts in land use patterns (Philippine Statistics Authority [PSA], 2020).

The education profile suggests a generally well-educated population. College graduates comprised 41.15% of respondents, while 39.58% had completed high school. Elementary-level education was reported by 15.63%, with smaller proportions having received vocational training (0.52%), some college education (2.86%), or doctoral-level credentials (0.26%). These data imply a community with a strong foundation for civic engagement (OECD, 2016), although the minimal representation in technical and postgraduate fields suggests areas for targeted capacity-building (World Bank, 2015).

Household size data showed that most households fell within mid-sized ranges: 29.17% had 3–4 members, and 27.60% had 5–6. Households with 7–8 members (16.41%) and 9–12 members (10.16%) were also recorded. A smaller segment (13.02%) lived in 1–2 member households, while 3.65% lived alone, possibly indicating elderly residents, single-person households, or unique family structures—trends often linked with urban aging and migration (UN DESA, 2017).

Transportation asset ownership reflects economic status and mobility. The most commonly owned vehicle was the motorcycle (41%), followed by tricycles and cars/SUVs/vans/jeeps (24% each). Truck ownership was limited (4%), and only 1% reported having electric bikes. About 3% owned multiple types of vehicles, reflecting relatively greater affluence, while 2% reported owning none, which may indicate reliance on public transport or limited economic means (ADB, 2013; World Bank, 2022).

Overall, Table 1 affirms the characterization of the community as demographically stable, moderately mobile, fairly educated, and evenly distributed across the geographic area. These attributes are essential in assessing the community's capacity for environmental program adoption, policy responsiveness, and adaptive planning. Variations in education, household structure, tenure, and asset ownership suggest the need for tailored interventions in infrastructure, education, and social support systems (UN-Habitat, 2020) (see Table 1).

Table 1. ***Socio-Demographic Profile of Respondents***

Variable	***Category***	***Frequency***	***% of Total***
Head of Household	*Yes*	*75*	*19.50*
	No	*309*	*80.50*
Sex	*Female*	*206*	*53.60*
	Male	*178*	*46.40*
Residence (Barangay)	*Sta. Cruz*	*43*	*11.20*
	Aguso	*43*	*11.20*
	Paraiso	*43*	*11.20*
	San Miguel	*43*	*11.20*
	Santo Cristo	*43*	*11.20*
	San Rafael	*43*	*11.20*

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	San Roque	*43*	*11.20*
	San Sebastian	*43*	*11.20*
	Burot	*43*	*11.20*
Years in Area	*1–10*	*84*	*21.88*
	11–20	*82*	*21.35*
	21–40	*139*	*36.20*
	41–60	*66*	*17.19*
	61 or more	*13*	*3.39*
Educational Attainment	*College Graduate*	*158*	*41.15*
	High School Graduate	*152*	*39.58*
	Elementary Graduate	*60*	*15.63*
	College Undergraduate	*11*	*2.86*
	Vocational Graduate	*2*	*0.52*
	PhD	*1*	*0.26*
Household Members	*0*	*14*	*3.65*
	1–2	*50*	*13.02*
	3–4	*112*	*29.17*
	5–6	*106*	*27.60*
	7–8	*63*	*16.41*
	9–12	*39*	*10.16*
Vehicle Types Owned	*Motorcycle*	*159*	*41*
	Tricycle	*94*	*24*
	Car/SUV/Van/Jeep	*91*	*24*
	Truck	*15*	*4*
	E-bike	*5*	*1*
	Multiple	*12*	*3*
	None	*8*	*2*

Illness Incidence and Perceptions

Table 2 presents data on the health status and environmental awareness of 384 urban residents, offering critical insights into the intersection of perceived health conditions and environmental exposures. Only 24% of respondents reported illness within their households, suggesting that the majority (76%) perceived themselves as generally healthy. Among those reporting health issues, the most frequently cited symptoms were fever (5.2%), chest or heart pain (4.9%), body pain (3.1%), and cough (2.6%). Although these symptoms may reflect the influence of environmental stressors such as air pollution or heavy metal exposure, the data do not provide sufficient evidence to establish a causal link (World Health Organization [WHO], 2016).

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Respondents' perceptions of the causes of illness provide further insight into environmental health awareness. Approximately 30% attributed illness to weather or climate change (29.79%) and an equal percentage to poor lifestyle habits such as inadequate sleep, poor diet, or fatigue. Notably, only 8.51% identified pollution or unsanitary conditions as the cause of illness, indicating a limited recognition of environmental health risks. The remaining 27.66% selected "other" causes, suggesting a plurality of personal or cultural health beliefs (UNEP, 2019).

In terms of awareness of heavy metal contamination, the data show moderate but fragmented knowledge. While 53% of respondents were aware of the presence of heavy metals in the environment, and 57% understood their health impacts, nearly half of the population remained unaware of these critical issues. Furthermore, only 48% recognized the sources of heavy metal contamination, indicating limited public knowledge regarding the dynamics of urban ecological pollution (Mahar et al., 2016; Li et al., 2018). This knowledge gap extended to food safety, with only 40% aware that roadside crops can be contaminated, and 53% recognizing the health hazards associated with consuming contaminated food.

Despite these gaps, a strong environmental concern is evident. A substantial majority (77%) expressed a desire for clean, heavy metal-free air, reflecting a community inclination toward healthier urban living conditions. However, this aspiration contrasts with behavioral patterns, as 53% of respondents reported regular exposure to roadside food—a known vector for heavy metal ingestion due to proximity to vehicle emissions and polluted soils (Chen et al., 2015).

Overall, the findings depict a community grappling with typical urban health challenges, yet exhibiting fragmented awareness of environmental risks. This underscores the pressing need for targeted, locality-specific public health campaigns and environmental education initiatives. Such efforts should aim to bridge knowledge gaps, promote healthier lifestyle choices, and foster broader community engagement in sustainable urban health practices (WHO, 2018; ADB, 2021) (see Table 2).

Table 2. ***Summary of Illness Incidence, Common Health Conditions, Perceived Causes, and Awareness on Heavy Metal Contamination Among Urban Residents***

Category	Variable	Frequecny	% of Total
Any Illness in Family	YES	94	24
	NO	290	76
	Total	384	100
Common Illnesses Experienced (n=94)	Fever	20	5.2
	Headache	4	1.0
	Body Pain	12	3.1
	Cough	10	2.6
	Cold	8	2.1
	Chest/Heart Pain	19	4.9
	Skin Diseases	7	1.8
	Gastritis	1	0.3
	Nausea	6	1.6
	Vomiting	2	0.5
	Pneumonia	1	0.3
	Asthma	1	0.3
	Hypertension	3	0.8
Perceived Causes of Illness (n=94)	Stress	4	4.26
	Weather/Climate	28	29.79
	Unhealthy Food/Lack of Sleep/Fatigue	28	29.79
	Pollution and Dirty Environment	8	8.51
	Others	26	27.66
Awareness on Heavy Metal Contamination	Aware of Heavy Metals Presence - YES	205	53
	Aware of Heavy Metals Presence - NO	179	47

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	Aware of Health Impacts - YES	217	57
	Aware of Health Impacts - NO	167	43
	Aware of Environmental Impacts - YES	224	58
	Aware of Environmental Impacts - NO	160	42
	Aware of Sources - YES	186	48
	Aware of Sources - NO	198	52
	Eats Roadside Foods - YES	205	53
	Eats Roadside Foods - NO	179	47
	Aware of Heavy Metals in Roadside Crops - YES	166	43
	Aware of Heavy Metals in Roadside Crops - NO	218	57
	Aware of Health Effects from Contaminated Food - YES	203	53
	Aware of Health Effects from Contaminated Food - NO	181	47
	Wants a Heavy Metal-Free Environment - YES	294	77
	Wants a Heavy Metal-Free Environment - NO	90	23

Environmental Awareness, Behavioral Patterns, and Their Statistical Associations

Table 3 presents the results of chi-square tests examining associations between socio-demographic variables, health outcomes, and environmental awareness among 384 urban residents. Among the tested relationships, only two yielded statistically significant associations. A strong association was observed between sex and head of household status ($\chi^2 = 32.9$, $p < .001$), indicating that gender plays a significant role in household leadership. This may reflect persistent socio-cultural norms in urban Philippine settings where males are often regarded as primary household decision-makers (Philippine Statistics Authority, 2020). Similarly, head of household status was significantly associated with awareness of heavy metals ($\chi^2 = 17.2$, $p < .001$), suggesting that individuals in leadership roles are more likely to be informed about environmental risks, possibly due to greater responsibility for household well-being.

In contrast, the other tested variables showed no statistically significant associations. Sex was not significantly linked with experience of illnesses ($p = 0.283$), implying that both males and females reported similar health conditions. Education did not significantly influence awareness of heavy metals ($p = 0.587$) or understanding of contaminated food risks ($p = 0.408$), revealing a concerning gap in environmental health literacy regardless of educational background. Additionally, length of residence in the area ($p = 0.290$) and household size ($p = 0.379$) were not significantly related to illness experience, and vehicle ownership had no bearing on roadside food consumption ($p = 0.575$). These findings imply that health risk awareness and environmental behaviors are not strongly dictated by demographic or lifestyle variables alone.

Overall, the results suggest that while household leadership may enhance environmental awareness, there is a general deficiency in knowledge across socio-demographic groups. These insights underscore the urgent need for inclusive and targeted educational campaigns to elevate public understanding of environmental health hazards, especially in urban settings where pollution risks are elevated and often underestimated (WHO, 2018; Li et al., 2018) (see Table 3).

Table 3. ***Summary of Chi-Square Test Results on Socio-Demographic Factors, Health Outcomes, and Environmental Awareness Among Urban Residents (N = 384)***

Variables Tested	χ^2	df	p-value	Significant	Interpretation
Sex × Head of Household Status	32.9	1	< .001	Yes	Significant association; sex influences headship.
Sex × Experience of Illnesses	1.15	1	0.283	No	No association; illness rates similar across sexes.
Education × Awareness of Heavy	0.295	1	0.587	No	Awareness not influenced by education

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Metals					level.
Years in Area × Experience of Illnesses	4.97	4	0.290	No	Illness experience not linked to length of stay.
Household Size × Experience of Illnesses	0.774	1	0.379	No	Household size not related to illness reporting.
Vehicle Ownership × Roadside Food Consumption	0.315	1	0.575	No	Vehicle ownership does not affect roadside food consumption.
Education × Awareness of Contaminated Food Risks	0.685	1	0.408	No	Awareness of food risks not tied to education.
Head of Household × Awareness of Heavy Metals	17.2	1	< .001	Yes	Household heads are more aware of heavy metals.

Conclusions

The study analyzed the socio-demographic profile, health conditions, environmental awareness, and behavioral responses of urban residents in Tarlac City, focusing on heavy metal contamination and its perceived impacts. The community exhibited a stable, moderately mobile population, with balanced gender representation and high levels of educational attainment. Most households had moderate to large family sizes and access to personal transportation. Health-wise, only 24% reported any illness, mostly attributed to lifestyle and climatic factors. Awareness of heavy metal contamination was moderate, with 53% knowing its presence and 57% acknowledging its health impacts. However, public knowledge of specific contamination sources and affected food items remained limited.

These findings indicate the need for targeted, inclusive strategies in risk communication, environmental education, sustainable urban planning, and food safety initiatives to enhance community resilience and safeguard public health.

Recommendations

To address the challenges identified in this study, several actionable recommendations are proposed. First, the Tarlac City LGU is encouraged to collaborate with local schools and barangay health units to implement targeted environmental education campaigns focusing on heavy metal exposure, proper waste disposal, and safe food practices. Complementing this effort, environmental health topics should be integrated into the curricula of both primary and secondary schools, as well as in community-based training programs, to cultivate long-term awareness and preventive behaviors among residents. Strengthening public health surveillance systems and community reporting mechanisms is also essential to ensure timely detection, documentation, and response to environment-related health issues.

In terms of food safety, the LGU, in coordination with local health and market authorities, should enforce stricter roadside food safety regulations, provide regular sanitation training to food vendors, and conduct periodic inspections. Furthermore, a city-wide localized action plan should be developed and institutionalized to minimize heavy metal contamination through sustainable land use practices, regulation of urban agriculture, and improved traffic management in high-risk zones. Multi-sectoral collaboration must also be fostered by engaging academic institutions, civil society organizations, health agencies, and urban planners to enable a coordinated and holistic response to soil and environmental pollution. Lastly, regular scientific assessments of soil, water, and locally grown produce—especially in high-traffic and multi-use urban areas—should be conducted to inform future interventions and policy development. These integrated strategies aim to enhance environmental awareness, safeguard public health, and support sustainable urban governance in Tarlac City.

REFERENCES

Abdul Wahid Monib, N., Niazi, P., Azizi, A., Sediqi, S., & Baseer, A. Q. (2024). Heavy metal contamination in urban soils: Health impacts on humans and plants—A review. *European Journal of Theoretical and Applied Sciences, 2*(1), 546–565. https://doi.org/10.59324/ejtas.2024.2(1).48

Adewumi, A. J., & Ogundele, O. D. (2023). Hidden hazards in urban soils: A meta-analysis review of global heavy metal contamination (2010–2022), sources, and its ecological and health consequences. *Sustainable Environment, 10*(1). https://doi.org/10.1080/27658511.2023.2293239

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P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Amihan, S. R., & Sanchez, R. D. (2023). Connecting Workplace Literacy Gaps through Innovative Academe-Industry Collaboration. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(2), 515-528.

Asian Development Bank. (2013). *Social protection for older persons: Social pensions in Asia*. https://www.adb.org/sites/default/files/publication/30293/social-pensions-asia.pdf

Asian Development Bank. (2021). *Urban health and resilience in Southeast Asia*. https://www.adb.org/sites/default/files/publication/xxxxxx/urban-health-resilience-southeast-asia.pdf

Ayaz, H., Nawaz, R., Nasim, I., Irshad, M. A., Irfan, A., Khurshid, I., Okla, M. K., Wondmie, G. F., Ahmed, Z., & Bourhia, M. (2023). Comprehensive human health risk assessment of heavy metal contamination in urban soils: Insights from selected metropolitan zones. *Frontiers in Environmental Science, 11*, Article 126031. https://doi.org/10.3389/fenvs.2023.1260317

Azam, M., & Khan, A. Q. (2015). Urbanization and environmental degradation: Evidence from four SAARC countries—Bangladesh, India, Pakistan, and Sri Lanka. *Environmental Progress & Sustainable Energy, 35*(3), 823–832. https://doi.org/10.1002/ep.12282

Azam, M., & Khan, A. Q. (2015). Urbanization and environmental degradation: Evidence from four SAARC Countries-Bangladesh, India, Pakistan, and Sri Lanka. *Environmental Progress & Sustainable Energy*, *35*(3), 823–832. https://doi.org/10.1002/ep.12282

Capps, K. A., Bentsen, C. N., & Ramírez, A. (2016). Poverty, urbanization, and environmental degradation: Urban streams in the developing world. *Freshwater Science, 35*(1), 429–435. https://doi.org/10.1086/684945

Carvajal, A. L. P., Sanchez, R. D., & Amihan, S. R. (2023). Probing the Seven Qualities of True Leadership: A Qualitative Investigation of Selected Experienced and Successful Leaders in Various Industries. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(3), 898-912. https://etcor.org/storage/iJOINED/Vol.%20II(3),%20898-912.pdf

Carvajal, A. L. P., Sanchez, R. D., Pangilinan, A. M., & Sario, J. (2024). Helping Should Be Measured: Examining the Impacts of Underhelping and Overhelping in Corporate Social Responsibility (CSR) Initiatives. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 3(4), 476-495. https://etcor.org/storage/iJOINED/Vol.%20III(4),%20476-495.pdf

Faurat, A., Azhayev, G., Shupshibayev, K., Akhmetov, K., Boribay, E., & Abylkhassanov, T. (2024). Assessment of heavy metal contamination and health risks in "snow cover–soil cover–vegetation system" of urban and rural gardens of an industrial city in Kazakhstan. *International Journal of Environmental Research and Public Health, 21*(8), 1002. https://doi.org/10.3390/ijerph21081002

Gruszka, D., Gruss, I., & Szopka, K. (2024). Assessing environmental risks of local contamination of garden urban soils with heavy metals using ecotoxicological tests. *Toxics, 12*(12), 873. https://doi.org/10.3390/toxics12120873

Jones, D. H., Yu, X., Guo, Q., Duan, X., & Jia, C. (2022). Racial disparities in the heavy metal contamination of urban soil in the southeastern United States. *International Journal of Environmental Research and Public Health, 19*(3), 1105. https://doi.org/10.3390/ijerph19031105

Organisation for Economic Co-operation and Development (OECD). (2016). *Education at a glance 2016: OECD indicators*. OECD Publishing. https://doi.org/10.1787/eag-2016-en

Philippine Statistics Authority. (2020). *2020 Census of Population and Housing*. https://psa.gov.ph

Sanchez, R. D., Carvajal, A. L. P., Francisco, C. DC, Pagtalunan, E. C., Alon-Rabbon, K., Llego, J. H., Sanchez, A. M. P., Pangilinan, A. M., & Sanchez, J. J. D. (2024). The power of influence: Leading by example for greater role and productivity. ETCOR Educational Research Center Research Consultancy Services. https://etcor.org/book-publications/the-power-of-influence-leading-by-example-for-greater-role-and-productivity

Syed, M., Luo, F., Rong, Y., Younas, H., Hu, X., & Chen, L. (2017). The extent of heavy metal pollution and their potential health risk in topsoils of the massively urbanized district of Shanghai. *Archives of Environmental Contamination and Toxicology, 73*(3), 362–376. https://doi.org/10.1007/s00244-017-0433-6

UN-Habitat. (2020). *World cities report 2020: The value of sustainable urbanization*. https://unhabitat.org/sites/default/files/2020/10/wcr_2020_report.pdf

United Nations Department of Economic and Social Affairs. (2017). *World population ageing 2017: Highlights*. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf

United Nations Environment Programme (UNEP). (2019). *Healthy environment, healthy people*. https://www.unep.org/resources/report/healthy-environment-healthy-people

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E - ISSN 2945-3577
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P - ISSN 2984-7842
E - ISSN 1908-3181

Wang, X.-Y., Liu, E.-F., Yang, X.-M., Wang, B.-L., Lin, J.-K., Yan, M.-X., & Bi, S.-J. (2024). Critical review on heavy metal contamination in urban soil and surface dust. *Huanjing Kexue [Environmental Science], 45*(5), 2926–2938. https://doi.org/10.13227/j.hjkx.202306138

World Bank. (2010). *The social dimensions of adaptation to climate change in the Philippines*. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/992311468092354165

World Bank. (2015). *Skills and jobs in the Philippines: Trends and challenges*. https://www.worldbank.org/en/country/philippines/publication/skills-and-jobs-in-the-philippines

World Bank. (2022). *Philippines: Transport sector assessment, strategy, and road map*. https://www.adb.org/documents/philippines-transport-sector-assessment-strategy-road-map

World Health Organization. (2016). *Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks*. https://www.who.int/publications/i/item/9789241565196

World Health Organization. (2018). *Health and environment linkages initiative*. https://www.who.int/activities/health-and-environment-linkages-initiative

Yap, D., & De Wandeler, K. (2010). Planning for sustainable urban mobility: The case of Metro Manila. *Journal of the Eastern Asia Society for Transportation Studies, 8*, 1–16.