

ORIGINAL RESEARCH

Location-Specific Barriers to Health Equity in Low-Income Housing Projects

Barreras específicas para la equidad en el acceso a servicios de salud por la ubicación de proyectos de vivienda para personas de bajos ingresos

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Abstract

Introduction: Rapid urbanization in India poses significant challenges to achieving health equity, particularly in low-income neighbourhoods where environmental hazards are prevalent. Development projects aimed at improving living conditions may be undermined by location-specific barriers that can impact residents' health. This study examined how location-specific health impacts influence the effectiveness of urban development projects in achieving health equity, focusing on the Vellalloor Housing Project in Coimbatore district, Tamil Nadu, India. **Methods:** A cross-sectional survey conducted among 120 residents, ages 24-40 years, selected through cluster sampling. A semi-structured interview schedule measured (1) facilities provided through the housing project, (2) health equity in access to these facilities, and (3) location-specific health impacts from a nearby garbage treatment plant. **Results:** Multiple linear regression with interaction analysis tested the moderating effect of location-specific impacts. Facility provision positively correlated with health equity ($r = 0.739$, $p < 0.01$), while location-specific health impacts were negatively correlated ($r = -0.676$, $p < 0.01$). Regression results showed that location-specific health impacts significantly moderated the relationship between facilities and health equity (β - interaction = -0.013 , $p = 0.015$), reducing the positive effect of facilities. The model explained 67.1% of the variance in health equity ($R^2 = 0.671$). **Conclusion:** Although the development project improved access to facilities, its impact on health equity was weakened by environmental hazards from the adjacent garbage unit. Urban planning for marginalized communities should integrate location-specific environmental assessments to ensure projects achieve their intended health outcomes.

Keywords: Urban Planning, Health Equity, Location Specific Health Impacts, Environmental Hazards.

Resumen

Introducción. La rápida urbanización en India plantea desafíos significativos para lograr la equidad en salud, particularmente en barrios de bajos ingresos donde abundan los riesgos ambientales. Los proyectos de desarrollo destinados a mejorar las condiciones de vida pueden verse socavados por barreras específicas, a partir de su ubicación, que pueden afectar la salud de los residentes. Este estudio examinó cómo los impactos sobre la salud específicos a la ubicación influyen en la efectividad de los proyectos de desarrollo urbano para lograr la equidad en salud, centrándose en el Proyecto de Vivienda Vellalloor en el distrito de Coimbatore, Tamil Nadu, India. **Metodología.** Se realizó una encuesta transversal entre 120 residentes, de 24 a 40 años, seleccionados mediante muestreo por conglomerados. Un cuestionario de entrevista semiestructurada midió (1) las instalaciones proporcionadas a través del proyecto de vivienda, (2) la equidad en el acceso a la salud a partir de estas instalaciones y (3) los impactos sobre la salud específicos derivados de la ubicación de una planta de tratamiento de basura cercana. **Resultados.** La regresión lineal múltiple con análisis de interacción probó el efecto moderador de los impactos específicos de la ubicación. La provisión de instalaciones se correlacionó positivamente con la equidad en salud ($r = 0.739$, $p < 0.01$), mientras que los impactos en la salud específicos de la ubicación se correlacionaron negativamente ($r = -0.676$, $p < 0.01$). Los resultados de la regresión mostraron que los impactos en la salud específicos a la ubicación moderaron significativamente la relación entre las instalaciones y la equidad en salud (β - interacción = -0.013 , $p = 0.015$), reduciendo el efecto positivo de las instalaciones. El modelo explicó el 67.1 % de la varianza en la equidad en salud ($R^2 = 0.671$). **Conclusión.** Si bien el proyecto de desarrollo habitacional mejoró el acceso a las instalaciones de atención a la salud, su impacto en la equidad en salud se vio debilitado por los riesgos ambientales derivados de la unidad de basura adyacente. La planificación urbana para comunidades marginadas debe integrar evaluaciones ambientales específicas a la ubicación para garantizar que estos proyectos alcancen los resultados de salud previstos.

Palabras clave: Planificación urbana, equidad en salud, impactos en la salud específicos del sitio, riesgos ambientales.



Introduction

The phenomenon of urbanization, marked by the increasing migration of populations from rural areas to urban centres, has played a transformative role in shaping human history¹. Its emergence has been a multifaceted journey, driven by a complex interplay of historical, economic, and technological factors². Globally, over 56% of the world's population, or 4.4 billion people, live in cities and this number is anticipated to double by 2050³. In India, natural population growth and burgeoning economic opportunities in urban centres have propelled rural-to-urban migration, constituting approximately 31% of the total populace, as of the 2011^{4, 5}. Mega-cities including Mumbai, Delhi, and Bengaluru have emerged as significant urban behemoths, grappling with challenges encompassing infrastructure development, housing shortages, and environmental sustainability^{6, 7}. This urban expansion has introduced complex challenges to urban planning, particularly in ensuring health equity across diverse communities living in urban areas. Low-income neighbourhoods are often disproportionately affected by these challenges, as they are located in hazardous environments and residents face difficulties in accessing healthcare services⁸. Thus, urban planning has become a crucial element of sustainable development. This rapid urbanization raises significant concerns regarding environmental sustainability and health equity^{9, 10}, and planning frameworks often overlook the unique needs and vulnerabilities of different communities within cities^{11, 12}. Health equity, which refers to the fair and just access to healthcare and health-promoting resources, is critical to the sustainability of urban development¹³. However, achieving health equity through development projects requires a deep understanding of location-specific barriers that may hinder the outcome of the project. Urban development project planners should consider potential environmental impacts and social impacts, rather than approaching the project from a purely economic or elitist point of view. For instance, development projects for marginalized groups in cities should consider proximity to hazardous sites, inadequate infrastructure, and insufficient public services that can exacerbate health disparities¹⁴. This study is grounded in the Social Determinants of Health (SDH) framework,

which emphasizes that health outcomes are shaped by the conditions in which people are born, grow, live, work, and age, influenced by the distribution of resources, power, and opportunity^{8, 13}. In this framework, facilities provided by urban development projects represent structural determinants of health, while location-specific environmental hazards represent physical environmental determinants. The interaction between these determinants ultimately influences health equity. Complementing this, Environmental Justice Theory highlights the inequitable distribution of environmental benefits and burdens, noting that marginalized communities are often situated in environmentally hazardous areas^{15, 16}. In such cases, even well-designed development projects may fail to achieve their intended benefits if environmental burdens remain unaddressed. In the Indian context, the Tamil Nadu Urban Habitat Development Board (TNUHDB) has implemented several development projects aimed at improving living conditions for low-income communities. Despite these efforts, the effectiveness of these projects in enhancing health equity remains a critical concern, particularly in areas where location-specific barriers, such as environmental hazards, play a significant role in shaping health outcomes¹⁷. While studies have examined urban poverty, housing quality, and environmental health risks independently, few have empirically tested how location-specific environmental hazards impact the outcome of urban development projects in achieving health equity. Addressing this gap is essential for designing inclusive, safe, resilient, and sustainable urban settlements. This study investigates the impact of location-specific health hazards on the effectiveness of housing development projects in promoting health equity, using the Vellaloor Housing Project in Coimbatore—located adjacent to a large garbage treatment plant—as a study area.

Methods

Study Area

The study conducted in the Vellaloor Housing Project, Coimbatore district, Tamil Nadu, developed and maintained by the Tamil Nadu Urban Habitat Development Board (TNUHDB) Government of Tamil Nadu. The housing project is

comprised of 88 blocks and 2,816 household units, of which 2,182 were occupied at the time of the study. A significant environmental concern for this community is its proximity to the Coimbatore Corporation's garbage treatment plant, established in 2003 and spanning approximately 650 acres. This facility processes 900–1,100 tonnes of waste daily, contributing to air and water quality issues and representing a location-specific health hazard.

Study Design and Participants

A cross-sectional survey design was adopted to examine the effect of development project facilities and location-specific health impacts on health equity. The target population included residents aged 24–40 years, chosen because this group represents the economically active age group most engaged in household decision-making and community health-related activities.

Cluster sampling was employed: the 88 blocks were divided into four clusters (North, East, West, South), each with 22 blocks. Two blocks were randomly selected from each cluster, and 15 households from each block were chosen, yielding a total sample size of 120 respondents. The sample size meets Tabachnick and Fidell's (2013) guideline for multiple regression ($N \geq 50 + 8m$, where m = number of predictors), ensuring adequate statistical power.

Data Collection Tool

Data were collected using a semi-structured interview schedule comprising four sections: The first section collected **socio-demographic details of the participants** (e.g., age, gender, education, occupation, income, family type). The second section gathered information related to the **facilities** provided in the housing projects. This section included 12 items assessing access to infrastructure and services (e.g., water, sanitation, healthcare, and transportation). The third section included 10 items measuring **equitable access** to health-related facilities without discrimination, as well as the health conditions of the respondent. Finally, the fourth section collected information related to **location specific health impacts**; it included 9 items capturing health issues arising from the nearby garbage unit (e.g., odour, respiratory issues, incidence of communicable

diseases). Content validity was established through expert review, and internal consistency was confirmed with Cronbach's alpha values, Facilities ($\alpha = 0.82$), Health Equity ($\alpha = 0.86$), Location-Specific Health Impacts ($\alpha = 0.88$).

Data Collection Procedure

Ethical clearance was obtained from the Department Ethical Committee, Bharathiar University. Permission for data collection was secured from TNUHDB. Informed verbal consent was obtained from each participant after explaining the study's objectives and assuring confidentiality. Data were collected through face-to-face interviewer-administered surveys in Tamil, with responses later translated into English. Each interview lasted approximately 25–30 minutes.

Data Analysis

Data were analysed using SPSS v.21. Descriptive statistics were computed for socio-demographic variables. Pearson's correlation was used to examine bivariate associations between Facilities, Health Equity, and Location-Specific Health Impacts. Multiple linear regression with an interaction term (Facilities $\times$ Location-Specific Health Impacts) tested the moderating effect of environmental hazards on the facilities–health equity relationship. All predictor variables were mean-centred before creating the interaction term to reduce multicollinearity¹⁸. Assumptions of linearity, homoscedasticity, normality, and absence of multicollinearity were checked and met prior to analysis. To graphically represent the effect of the independent variable (Facilities) on the dependent variable (Health Equity), a statistical software package was used to plot the interaction at high and low levels of the moderating variable (Location-Specific Health Impacts)¹⁹.

Research Approval and Consent to Participate

This study was registered with Ph.D. Registration Communication from Bharathiar University Coimbatore (CRE/SOW21PDEC02/22. Date: 03.02.2022). The approval, permission and ethical clearance was granted by the Doctoral Committee and Ethical Committee from the Department of Social Work, Bharathiar University Coimbatore, dated on 04.07.2024. Informed consent forms

were collected from all the respondents participated in the main study.

Results

The study included 120 residents aged 24-40 years, with the largest age group being 36-40 years (40.8%). Slightly more than half of the respondents were female (54.2%). Education levels varied, with most having completed higher

secondary school (26.7%) or possessing an undergraduate degree (22.5%). Occupations were diverse, with business (41.7%) and daily wage labour (27.5%) most common. The majority of households (40%) reported a monthly income between Rs. 10,001 – Rs 20,000. Most families were nuclear (70.8%), with two or three children. Commonly reported acute illnesses included body aches (38.3%), headaches (27.5%), and coughs (18.3%), as seen in Table 1.

Table 1: Socio-Demographic Details of the Respondents

Demographic Details		Frequency	Percent
Age	24-29	38	31.7
	30-35	33	27.5
	36-40	49	40.8
Gender	Male	55	45.8
	Female	65	54.2
Education	Primary	23	19.2
	Secondary	21	17.5
	Higher Secondary	32	26.7
	UG	27	22.5
	PG	17	14.2
Occupation	Daily Wage Laborer	33	27.5
	Private	8	6.7
	Government	29	24.2
	Business	50	41.7
Family Monthly Income	5000 to 10,000	39	32.5
	10,001 to 20,000	48	40.0
	20,001 to 30,000	33	27.5
Religion	Hindu	60	50.0
	Christian	23	19.2
	Muslim	37	30.8
Family Type	Nuclear	85	70.8
	Joint	35	29.2
Number of Children	1	26	21.7
	2	40	33.3
	3	26	21.7
	4	28	23.3
Acute Illness	Fever	17	14.2
	Cough	22	18.3
	Headache	33	27.5
	Body ache	46	38.3
	Others	1	.8
	Nothing	1	.8

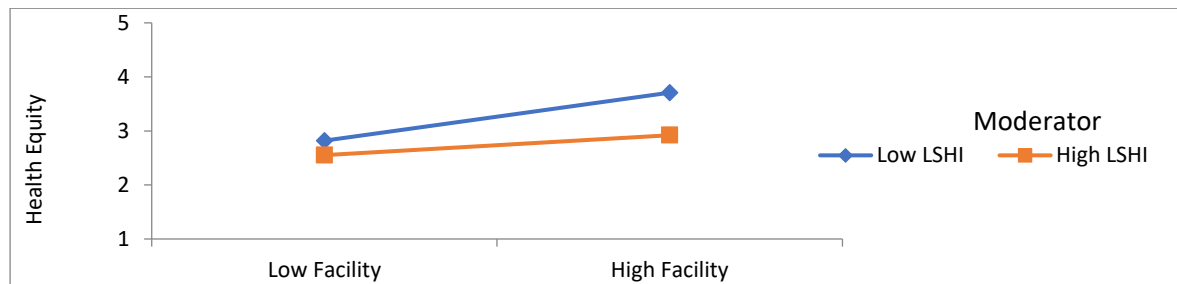
Table 2: Correlation between Health Equity and the Assessment of Available Facility

Correlations btw Health Equity & Facility		Facility Assessment	Location Specific Health Impact
Health Equity	Pearson Correlation	.739**	-.676**
	Sig. (2-tailed)	.000	.000
	N	120	
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 3: Coefficients

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.
	β	Beta		
Facility	.314	.457	6.574	.000
LSHI	-.264	-.375	-5.888	.000
Int-Facility x LSHI	-.013	.153	2.457	.015
a. Dependent variable = Health Equity				

Figure 1: Effect of Facility on Health Equity with Low- And High-Level Location Specific Health Impacts.



Pearson's correlation analysis revealed a strong positive association between facilities and health equity ($r = 0.739$, $p < 0.01$), indicating that better provision of facilities was linked to improved health equity. In contrast, location-specific health impacts showed a strong negative correlation with health equity ($r = -0.676$, $p < 0.01$), suggesting that environmental hazards reduced equitable access to health benefits (see Table 2).

A multiple linear regression analysis was carried out to see how facilities, local environmental health issues, and their combined effect influenced health equity. The model was statistically significant ($F(3,116) = 78.72$, $p < .001$) and explained about 67% of the variation in health equity with the R square value = 0.671.

- Facilities had a strong positive impact ($\beta = 0.314$, $p < .001$), showing that better infrastructure and services improved health equity.
- Location-specific health impacts (like pollution from a nearby garbage unit) had a negative effect ($\beta = -0.264$, $p < .001$), reducing health equity.
- The interaction effect ($\beta = -0.013$, $p = .015$) showed that when environmental hazards were high, the positive influence of good facilities on health equity became weaker (see Table 3).

The results show that the project's positive impact on health equity is reduced because of its location near the Vellaloor garbage unit. Although the Tamil Nadu Urban Habitat Development Board

has improved infrastructure and health facilities, the nearby environmental hazards limit these benefits. In short, the unfavourable location of the development project weakens progress toward achieving health equity (see Figure 1).

Figure 1, shows that the facilities provided by the Tamil Nadu Housing Board are adequate and accessible to all residents, fulfilling the project's purpose of community welfare. However, the health of residents is still affected by the location's environmental conditions. People living near the Vellalloor garbage unit report constant foul odours and frequent health issues, especially among children and the elderly, such as dengue and malaria. Thus, while the facilities are sufficient, the nearby garbage unit significantly reduces the project's positive impact on health equity. Figure 1 was obtained by calculating the unstandardized regression weights of the model pathways, where the independent variable (Facilities) was 0.314, the moderating variable (Location-Specific Health Impacts) was -0.264, and the dependent variable (Health Equity) was -0.13.

Discussion

This study examined how location-specific environmental hazards influence the relationship between urban housing project facilities and health equity, using the Vellalloor Housing Project in Coimbatore as a study area. The findings clearly show that while facilities provided under the Tamil Nadu Urban Habitat Development Board (TNUHDB) initiative significantly improve health equity, these benefits are weakened by environmental health hazards²⁰, such as those arising from proximity to a large garbage treatment plant²¹. The positive relationship between facilities and health equity supports the Social Determinants of Health (SDH) framework^{8, 20}, which identifies infrastructure and service provision as structural determinants that shape health outcomes. Adequate access to water, sanitation, healthcare, and transportation has shown to reduce health disparities²² and promote equitable well-being^{11, 13}. In this study, residents reported higher health equity with respect to the facilities provided to them, aligning with global literatures that infrastructure provision is a critical

pathway to reducing urban health inequalities^{14, 23}. However, the significant negative relationship between location-specific health impacts and health equity reflects the environmental justice theory^{15, 16}, which argues that marginalized communities are disproportionately burdened by environmental hazards²⁴. In the case of the Vellalloor Housing Project, the proximity to the garbage treatment plant creates persistent issues such as air pollution, odour, and increased incidence of communicable diseases. These hazards directly undermine the benefits of improved facilities, resulting in reduced overall health equity. The moderating effect observed in this study offers an important empirical contribution. While prior literature has highlighted environmental hazards as independent determinants of health, fewer studies, particularly in the Indian context, have tested their interactive effect with development interventions^{25, 26}. The findings here show that environmental burdens can erode the returns on investment in infrastructure, meaning that even well-designed projects may underperform if the environmental context is not addressed. This interaction echoes the argument that urban health cannot be understood without considering environmental and locational factors¹⁷. From a policy standpoint, the results suggest that urban housing projects must integrate environmental risk assessment into planning and implementation. Placing housing developments near high-risk zones should be avoided^{27, 28}. If unavoidable, mitigation strategies—such as air quality monitoring, community-based waste management, and regular public health screenings—should be embedded into the project design. This approach is consistent with the Sustainable Development Goals, particularly SDG 3 (Good Health and Well-Being) and SDG 11 (Sustainable Cities and Communities), which call for holistic urban development²⁹ that addresses both infrastructure and environmental health risks. Finally, by situating these findings within the Social Determinants of Health and Environmental Justice frameworks, this study reinforces the importance of addressing multiple, interacting determinants of health equity. Facilities are necessary but not sufficient; environmental burdens can negate their impact, and only integrated solutions that combine infrastructure

provision with environmental protection can deliver sustained health equity for marginalized urban communities.

Conclusion

This study demonstrates that while the provision of facilities in urban housing projects significantly enhances health equity, these benefits diminish when residents are exposed to high levels of location-specific environmental hazards. Drawing on the Social Determinants of Health framework and Environmental Justice Theory, the findings show that infrastructure improvements alone cannot guarantee equitable health outcomes if environmental risks remain unaddressed. The case of the Vellalloor Housing Project highlights the complex interplay between development interventions and environmental context. Proximity to a large garbage treatment plant not only compromises residents' health but also weakens the positive impact of facilities, underscoring the need for integrated urban planning that combines service provision with environmental safeguards. Policy efforts should prioritise environmental risk assessments in the siting and design of housing projects, ensure active community participation in environmental management, and implement targeted mitigation measures in high-risk areas. Achieving sustainable and equitable urban health outcomes requires moving beyond infrastructure delivery to address the broader environmental and social determinants that shape well-being. Future research should examine similar interactions in other urban contexts, using mixed-method approaches to capture both quantitative effects and lived experiences, thereby informing more context-sensitive public health policies.

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for providing technological facilities for data analysis. We wholeheartedly thank all the participants of the study for their valuable inputs & responses. **Data Availability .** The author confirms that all data generated or analysed during this study are included in this published article. **Informed Consent:** Informed consent obtained from the respondents' prior data collection. Only after clear explanation about the objectives and importance of the study, data collected from the respondents. **Authors Contribution:** Our collaboration is driven by our collective competence in social work, including various diverse interests within the field. We have come together to investigate the crucial role of urban planning in promoting an inclusive society, with the goal of ensuring widespread access and sustainable advancement. Despite the implementation of various urban development programmes, the attainment of health equity continues to be a challenge. To comprehend the complex factors contributing to these project failures, we initiated this study. We aim to understand and address the intricate barriers to achieving health equity in these efforts, driven by the urgent necessity to understand these numerous difficulties. First Author: Conceptualization, Methodology, Validation, Data Analysis, Article writing, Statistical Data Revision. Second Author: Methodology, Data analysis, Original draft editing, Statistical Data Revision and Third Author: Data collection, Coding, Editing. Sixth Author: Original draft editing, Shortening the Manuscript. Fourth and Fifth Author: Supervision, Visualization. Seventh Author: Statistical Data Revision, Shortening the Manuscript.

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