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Environment–Behaviour Perspective of Health Vulnerability of Residents in Lagos, Nigeria

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Abstract

Rapid urbanisation and the growth of informal settlements in Nigeria have intensified environmental and housing-related health risks, particularly among vulnerable populations. Using an environment–behaviour perspective, this study examines how built environment conditions and housing deficits influence health vulnerability and coping strategies in Makoko, Lagos. A mixed-method approach along with household questionnaires (n = 143) was used. Findings reveal severe overcrowding, poor housing quality, inadequate sanitation, and limited access to clean water shaping hygiene practices and environmental exposure. Women experience greater health vulnerability due to limited healthcare access, highlighting the need for integrated, community-driven urban health and planning interventions.

Keywords: Environment–behavior; Informal settlements; Gendered health vulnerability; Nigeria

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1.0 Introduction

The built environment has a significant impact on health outcomes. In rapidly urbanising countries like Nigeria, urban expansion has far outpaced infrastructure provision, resulting in the spread of informal settlements with substandard housing, overcrowding, poor sanitation, and restricted healthcare access (Ahmad, 2025). Lagos, Nigeria's commercial hub and one of Africa's fastest-growing megacities, exemplifies the duality of economic progress and profound spatial inequality. Over half of Nigeria's urban population lives in slum-like circumstances (Ahmad, 2025), with communities like Makoko, Ajegunle, and Iwaya demonstrating various types of environmental vulnerability. Makoko, which was once a fishing community on the Lagos Lagoon, now has between 85,000 and 250,000 persons living in substandard housing with inadequate potable water, poor drainage, open defecation, and few official health facilities (Adesina-Uthman et al., 2022; Bakare, 2024). These situations result in cumulative exposure to environmental hazards and public health problems.

Previous research has linked housing deprivation and infrastructure deficits in Lagos' informal settlements to communicable diseases such as cholera, typhoid, malaria, and respiratory infections (Liu et al., 2025). Recent publications also show repeated cholera outbreaks linked to flooding and poor sanitation (Solomon et al., 2026). Pregnant women and children are especially vulnerable because of their physiological susceptibility and lack of access to healthcare services. However, previous research primarily examines

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environmental factors and health consequences as linear connections, ignoring the behavioural processes by which residents adjust to limited surroundings. According to the environment-behavior approach, vulnerability occurs as a result of interactions between spatial factors and everyday practices. Overcrowding has an impact on ventilation behaviour and disease transmission; unreliable water supply encourages storage practices that may promote vector breeding; flood-prone environments influence sanitation behaviour, mobility, and psychosocial stress; and tenure insecurity discourages housing improvement.

This study uses Environment-Behaviour Theory, the Social Ecological Model, and the Health Belief Model to investigate how environmental deficits, behavioural responses, and structural disparities influence health outcomes. Gender and age also play a role in exposure, as women are responsible for caregiving, whereas children face developmental risks associated with poor housing and environmental dangers (Sayomi et al., 2025). Climate variability, particularly flooding and coastal threats, exacerbates vulnerability in Lagos (Ndimele et al., 2024; Abayomi, 2025). Despite policy initiatives, urban upgrading projects are frequently scattered and rarely include behavioural insights or community adaption measures (Bhanye, 2025). This study investigates the environment-behavior dynamics that shape health vulnerability in Lagos settlements. The objective was to identify environmental conditions, behavioural coping strategies, and socioeconomic mediators in order to propose integrated planning and public health strategies that improve urban health resilience.

2. **Literature review**

The built environment provides the physical setting for daily human activities, which has a substantial impact on health outcomes (Salmi et al., 2024). In informal settlements, however, these surroundings are generally characterised by structural deficiencies, overcrowding, insecure tenure, inadequate drainage systems, and limited access to water and sanitation services. Environmental deficiencies are often related with poor health outcomes. More than 70% of slum dwellers in Nigerian cities live in structurally deficient buildings, putting them at risk of respiratory illnesses and communicable diseases (Demehin, 2022). Similarly, the Chirisa et al., (2022) defines the "urban health penalty," in which urban poor populations have poorer health outcomes than rural populations due to concentrated environmental exposure and inadequate coping capacity. In coastal towns like Lagos, poor drainage systems and stagnant water promote vector breeding and flood-related illness outbreaks. Climate variability exacerbates these risks; recurring flooding destroys dwelling structures, alters sanitation practices, and contaminates water supplies, increasing waterborne illness transmission (Ndimele et al., 2024; Abayomi, 2025).

Recurrent cholera outbreaks in Nigerian cities have been attributed to inadequate sanitation and environmental factors (Liu et al., 2025; Solomon et al., 2026). While the existing literature shows robust links between environmental deprivation and health consequences, few investigations investigate the behavioural mechanisms that regulate these correlations. According to the Environment-Behaviour Theory, physical settings influence daily activities and exposure pathways such as ventilation, water storage, waste disposal, and mobility patterns (Tian & Liu, 2022). Residents of Lagos informal settlements such as Makoko and Ajegunle use coping tactics such as lifting dwellings above water levels, storing water in containers, and relying on informal healthcare providers, all of which may reduce and increase health risks. Nigeria's housing deficit, estimated at more than 28 million units, exacerbates these vulnerabilities, especially in high-density settlements such as Makoko, Iwaya, and Ajegunle, where overcrowding, poor construction materials, and weak governance structures persist (Ilechukwu et al, 2022; Richards, 2025; Odoyi & Riekkinen, 2025). Climate-related threats including flooding and sea-level rise exacerbate environmental vulnerability in these areas (Ndimele, 2024).

Women and children face disproportionately high health risks. Children under the age of five in informal settlements have higher rates of malnutrition, diarrhoeal disease, and respiratory infections (Nigeria Population Commission, 2019). Meanwhile maternal health outcomes remain poor due to limited access to antenatal care and reliance on informal healthcare providers (Olubodun et al., 2025; Sayomi et al., 2025). Women's caregiving roles enhance their vulnerability to environmental dangers and emotional stress (Akinga & Oriaku, 2023; Olaya et al., 2023). The Health Belief Model (Sayomi et al., 2025) explains how perception, economic limitations, and institutional trust influence behavioural responses to risk. Although urban governance and policy initiatives try to improve slum conditions, they are frequently fragmented and fail to include behavioural insights or community coping mechanisms (Olubi & Aseyan, 2022; Bakare, 2024; Bhanye, 2025). As a result, there are still considerable gaps in understanding the interaction pathways that connect the environment, behaviour, and health vulnerabilities. This study contributes to an integrated environment-behaviour paradigm by investigating how built environment conditions, behavioural adaptability, gendered exposure, and socio-ecological systems interact to affect health outcomes and urban resilience in Lagos. Figure 1 present the conceptual framework for environment-behavior perspective of health vulnerability of residents in Lagos, Nigeria.

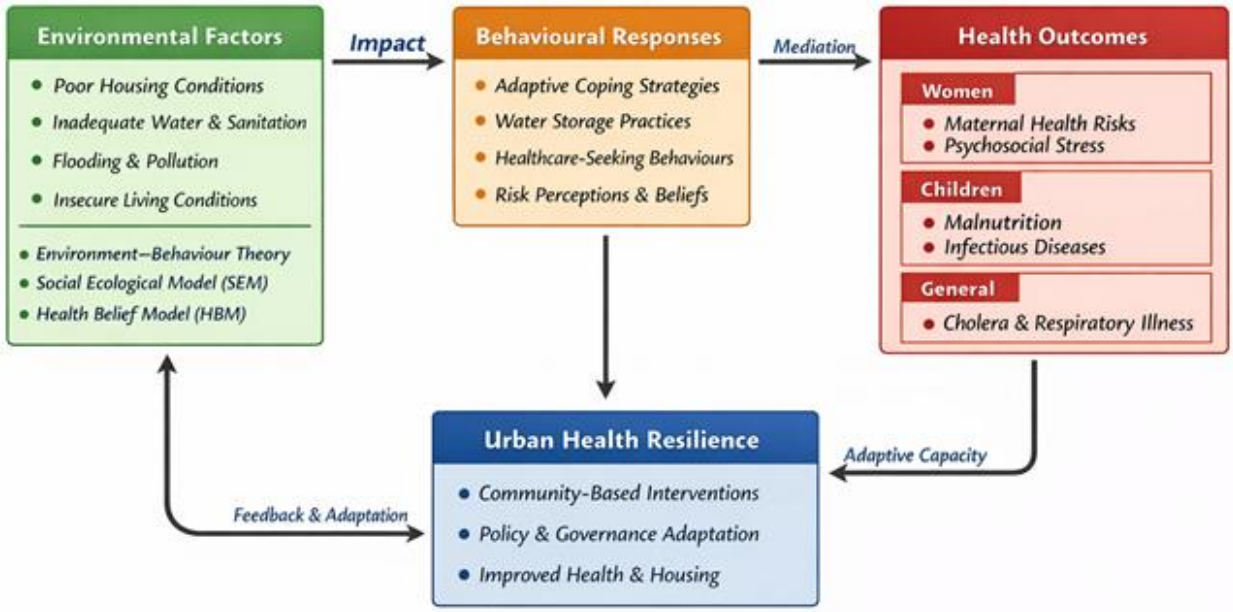

Figure 1: Conceptual framework for environment-behavior perspective of health vulnerability of residents in Lagos, Nigeria

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Methodology

This study was carried out in Makoko, a well-known informal waterfront town in Lagos, Nigeria, which is located at roughly 6.4960° N and 3.3915° E. Makoko settlement is divided into two distinct spatial typologies: a land-based section with semi-permanent structures on reclaimed or informally occupied land, and a water-based section known as the "Venice of Africa," with wooden stilt houses built over the Lagos Lagoon and primarily inhabited by the Egun fishing community. The population estimates range from 85,000 to 250,000 residents (Akinga & Oriaku, 2023; Bakare, 2024). Household sizes typically range from six to ten people per room, resulting in extreme overcrowding and population densities surpassing 30,000 people per square kilometre (Ahmad, 2025). Makoko was chosen because it is a climate-vulnerable coastal informal settlement that is prone to flooding and environmental contamination, has significant housing and infrastructural deficits, and provides an important context for investigating interactions between environmental conditions, behavioural adaptation, and health vulnerability (Ndimele et al., 2024; Abayomi, 2025).

The study used a convergent mixed-methods research design that included quantitative and qualitative methodologies to reflect the multifaceted character of health vulnerability in informal settlements. This methodology enables statistical analysis of the links between housing conditions, behaviour, and health outcomes while also capturing lived experiences and decision-making processes that influence adaptive behaviour. Adult women aged 18 to 49, carers, community health professionals, traditional birth attendants, community leaders, and household heads made up the study population. These categories were chosen because women and carers are frequently exposed to disproportionate environmental health risks, particularly in terms of maternal and child health (Sayomi et al., 2025). For the quantitative component, 200 structured questionnaires were distributed in both the land-based and water-based areas of Makoko via systematic random sampling along accessible routes and walkways. A total of 143 valid responses were collected for analysis, representing a response rate of 71.5%.

The questionnaire instrument had five sections that covered socio-demographic characteristics, housing and environmental conditions, behavioural practices such as water storage, sanitation, and healthcare-seeking behaviour, perceived environmental risks based on Health Belief Model constructs, and self-reported health outcomes (Liu et al., 2025). Purposive sampling of 30 participants, including women residents, community health workers, traditional birth attendants, and community leaders, was used to collect qualitative data on environmental risk and behavioural adaptation. Data collection methods included in-depth semi-structured interviews exploring environmental perceptions, coping strategies, and healthcare decision-making processes; focus group discussions with women from land-based and water-based areas to examine shared experiences of flooding, sanitation practices, and maternal health behaviour; and key informant interviews with local leaders and NGO representatives to understand governance gaps, institutional responses, and communication. Structured field observations were also carried out to record house materials, ventilation conditions, drainage systems, waste disposal practices, water sources, and flood markers, resulting in objective environmental indicators.

Quantitative data were coded and analysed with SPSS Version 26, which used descriptive statistics, cross-tabulations, chi-square tests, and logistic regression analysis to find determinants of health vulnerability. Qualitative data were transcribed verbatim and processed thematically. Prior to data collection, ethical permission was obtained, all subjects provided informed consent, and confidentiality and anonymity were rigorously adhered to. The methodological framework is based on Environment-Behaviour Theory, the Social Ecological Model, and the Health Belief Model, allowing researchers to investigate how spatial conditions, behavioural responses, and socio-ecological factors influence health vulnerability and resilience in Lagos informal settlements.

1.3 Findings

The findings demonstrate substantial socio-demographic and environmental factors that influence Makoko inhabitants' health

vulnerability. The socio-demographic profile identifies structural susceptibility, which determines environmental exposure. Approximately 69.3% of respondents were aged 18-40, and 48.3% lived in homes with six or more people, indicating significant overcrowding. Overall, educational attainment was poor, with 69.2% having received only primary education or less. The most common occupations were fishing (39.2%) and petty trading (36.4%), with almost 71% earning less than ₦70,000 ($50) per month. Furthermore, 81.1% had resided in Makoko for more than six years, indicating long-term rather than transient exposure to environmental dangers. These traits reflect the socioeconomic precarity typical of Lagos' informal seaside communities, where overcrowding, poor income, and limited education increase exposure to environmental dangers, notably water and sanitation-related problems. According to findings in Table 1, in terms of housing conditions, chi-square cross-tabulations revealed widespread agreement among education levels that Makoko's housing is overcrowded, buildings are poorly constructed and unsafe, housing supply is insufficient in relation to population, and poor sanitation significantly increases health risks.

TABLE 1: Education vs level of agreement on built environment and housing deficit

Statement	Response Options	Crosstab			
Housing in Makoko is overcrowded.					
Education	SD	D	N	A	SA
No Formal	0	0	8	6	9
Primary	5	9	14	11	37
Secondary	0	2	7	12	14
Tertiary	0	0	0	4	5
Total	5	11	29	33	65
2. The buildings in this community are poorly constructed and unsafe					
No Formal	0	0	1	4	18
Primary	1	3	10	9	53
Secondary	5	1	0	4	25
Tertiary	0	0	0	3	6
Total	6	4	11	20	102
3. Lack of access to proper sanitation facilities increases health Risks.					
No Formal	1	1	0	4	17
Primary	4	3	6	12	51
Secondary	0	1	3	11	20
Tertiary	1	1	1	0	6
Total	6	6	10	27	94
4. Women are more affected by poor housing and environmental conditions					
No Formal	0	0	0	3	20
Primary	0	0	17	13	46
Secondary	0	3	4	5	23
Tertiary	0	0	1	2	6
Total	0	3	22	23	95
5. There is a visible gap in housing availability relative to the population.					
No Formal	0	2	1	4	16
Primary	1	1	3	16	55
Secondary	0	0	1	10	24
Tertiary	0	0	2	0	7
Total	1	3	7	30	102

Scale: 1 – Strongly Disagree | 2 – Disagree | 3 – Neutral | 4 – Agree | 5 – Strongly Agree

Although some chi-square cells had low anticipated counts, which hindered statistical inference, the descriptive patterns show agreement across educational levels. This shows that perception of built environment shortfalls goes beyond educational background and represents a common lived experience of structural inadequacy, which is consistent with Lagos' recorded housing deficit. Similarly, respondents from various occupational groups ranked structural housing quality, internal ventilation, drainage and flood control, access to clean water, waste management, and healthcare services primarily as "very poor" or "poor." Fishers and petty traders reported particularly poor drainage and water access, implying that environmental exposure is linked to occupation, particularly for lagoon-dependent livelihoods. This finding is consistent with prior research emphasising lagoon contamination and flood risk in coastal Lagos areas. Table 2-4 present different regression analysis that found that period of residence strongly predicted agreement that buildings are unsafe (β = +0.181, p =.032), while longer residence lowered agreement that overcrowding was problematic (β = -0.191, p =.021).

Table 2: Duration of stay in Makoko vs level of agreement on built environment and housing deficit

	R Square Change	F Change	df1	df2	Sig. F Change
1	.105[a]	3.230	5	137	.009

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.656	.689		5.309	.000
	LABEHD1	-.130	.056	-.191	-2.337	.021
	LABEHD2	.135	.062	.181	2.166	.032
	LABEHD3	-.085	.060	-.118	-1.430	.155
	LABEHD4	-.159	.078	-.171	-2.048	.042
	LABEHD5	.087	.085	.083	1.014	.312

Table 3: Duration of stay in Makoko vs rating of environmental and housing conditions

	R Square Change	F Change	df1	df2	
1	.015[a]	.351	6	136	

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.140	.259		12.123	.000
	REHC1	.034	.053	.055	.637	.525
	REHC2	-.024	.050	-.042	-.485	.628
	REHC3	-.054	.051	-.093	-1.051	.295
	REHC4	-.027	.054	-.043	-.498	.619
	REHC5	.033	.057	.051	.584	.560
	REHC6	.001	.061	.001	.014	.989

Table 4: Duration of stay in Makoko vs perceived health risks associated with the built environment

	R Square Change	F Change	df1	df2	Sig. F Change
1	.046[a]	1.327	5	137	.257

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.872	.828		3.469	.001
	PHRAWBE1	.083	.080	.088	1.044	.298
	PHRAWBE2	.108	.061	.150	1.762	.080
	PHRAWBE3	-.005	.068	-.007	-.075	.940
	PHRAWBE4	-.123	.100	-.105	-1.230	.221
	PHRAWBE5	-.017	.089	-.017	-.196	.845

This shows that long-term occupancy may normalise overcrowding while raising awareness of structural degradation, demonstrating perceptual adaptation to environmental stress. Qualitative data also revealed behavioural responses to environmental constraints, such as water storage in open containers due to unreliable supply, reliance on informal drainage systems, reliance on traditional birth attendants, delayed healthcare access due to financial barriers, and collective coping during flooding. These adaptive actions can both reduce and increase health hazards. Health outcomes reported included diarrhoeal diseases, cholera outbreaks, malaria, respiratory infections, maternity problems, and psychological stress. Women were seen to be disproportionately affected by caregiving obligations and prolonged exposure to environmental dangers, highlighting the gendered aspect of health vulnerability in informal settlements.

Discussion

The findings confirm that environmental limitations alone cannot fully explain health vulnerability. Instead, health outcomes result from the interplay of environmental exposure and behavioural adaptation. According to Environment-Behaviour Theory, physical circumstances constrain behaviour (Tian & Liu, 2022). In Makoko: Poor drainage leads to water storage and vector breeding. Overcrowding leads to poor ventilation and respiratory illnesses. Flooding leads to pollution, which causes diarrhoeal disorders. As a result, behaviour acts as a mediator of environmental risk. Applying the Social Ecological Model (Petersen, 2025): Individual level: risk perception and healthcare seeking. Interpersonal level: Gender roles and caregiving. Sanitation procedures are implemented collectively at the community level. Policy: Weak enforcement and insufficient slum upgrading. The findings show that health vulnerability is multi-scale and influenced by structural inequalities (Chirisa et al., 2022). The regression finding that long-term residents normalise congestion reflects the following Health Belief Model constructs: Reduced perceived harshness over time. Adaptation to prolonged exposure. Perceived impediments influence behaviour. This may limit proactive health-seeking activity, notwithstanding objective danger. Furthermore, the findings go beyond Makoko, demonstrating that climate change exacerbates flood-health links (Ndimele, 2024), infrastructure-only measures may fail if behavioural patterns are disregarded, and urban resilience must incorporate environmental improvement and behavioural change. The policy consequences include: Behaviour-based WASH initiatives Gender-sensitive housing strategies. Community-based flood adaptation. Integrating informal health providers into public health systems.

Paper Contribution to Related Field of Study

This study builds upon prior Lagos research by: Empirically correlating environment, behaviour, and health consequences. Chronic exposure demonstrates normalisation effects. Including gendered vulnerability in built-environment analysis. Integrating health vulnerability into an urban resilience framework.

Conclusion

This study used an integrated Environment-Behaviour paradigm to investigate health vulnerability in Makoko, Lagos, and found that health risks are co-produced by physical environmental conditions and behavioural adaption mechanisms within a socio-ecological setting. The findings show that:Makoko's environmental deprivation is systemic, persistent, and multidimensional. Behavioural adaptations (water storage, informal sanitation, and healthcare choices) act as mediators of exposure routes. Gender-based caregiving roles increase vulnerability for women and children. Risk normalisation happens over time, thereby decreasing the apparent need for

preventive behaviour. Flooding and climate stress exacerbate health burdens, placing vulnerability within a larger resilience narrative. Unlike earlier studies, which examined housing and health as linear associations, this analysis shows that health vulnerability results from the combination of environment, behaviour, and structural inequality. The findings so advance urban health scholarship by: Validating an environment-behavior-health pathway through empirical evidence. Gendered vulnerability will be integrated into built-environment studies. Framing Makoko's health concerns in the context of urban climate resiliency. Importantly, the consequences stretch beyond Makoko to include other informal coastal settlements in Lagos and other rapidly urbanising African towns.

Limitations of the study

The study has significant drawbacks. Initially, it was held solely in Makoko, a coastal informal area in Lagos. While Makoko is an important case study for investigating waterfront environmental vulnerability, the findings may not be fully applicable to other types of informal settlements, such as inland high-density slums or peri-urban communities, where environmental risk pathways differ due to differences in geography, infrastructure, and livelihoods. Second, the cross-sectional research design only captured environmental conditions, behavioural responses, and health outcomes at a single point in time, making it difficult to establish causal relationships or assess temporal changes in vulnerability in climate-sensitive environments. Third, most health outcomes were self-reported rather than clinically validated, which may have introduced recollection bias or underreporting due to normalisation of chronic exposure, as described by the Health Belief Model. Furthermore, while 143 surveys and 30 qualitative interviews were examined, the sample size restricts statistical generalisation. Finally, environmental exposure indicators, such as water quality or air monitoring, were determined through observation rather than laboratory measures.

Recommendations for Strengthening the Research

Future rounds of this research should include: Water microbiological examination (for example, coliform levels), indoor particulate matter (PM2.5) monitoring, Temperature and humidity monitoring, GIS flood risk mapping This would enable the triangulation of behavioural data with environmental exposure measures. A longitudinal or panel research that tracked homes throughout numerous seasons (dry and rainy) would better capture: Flood health interactions, Behavioural adaptation shifts Climate-induced vulnerability cycles. Such an approach is consistent with resilience research that emphasises temporal dynamics. There should be an expansion of comparative settlements. Incorporating other Lagos settlements (such as Ajegunle, Iwaya, and Ilaje-Bariga) would enable: Comparative analysis of coastal vs inland vulnerability, identification of common vs context-specific environment-behavior pathways, and improvement of external validity. Future research could apply: Structural Equation Modelling (SEM - statistical, not theoretical), multilevel modelling, Mediation analysis, to explicitly test Environment, Behaviour and Health connections. Collaboration with local clinics or health organisations to acquire anonymised health records would improve the veracity of disease burden estimates. Embedding community researchers could: Reduce the response bias. Improve the contextual accuracy. Strengthen local ownership of resilience methods.

Directions for Further Research

Following this investigation, several relevant research directions arise. Future research should look into how increased flood frequency and sea-level rise affect behavioural adaptability and health vulnerability in Lagos coastal towns. This research could be expanded through climate resilience modelling. A specific gender-spatial analysis could look into: Women's daily movement patterns. Time-based exposure mapping, Gender-based stress and sleep quality in congested homes. This would provide a better understanding of intersectional vulnerability. Research could investigate: Early Childhood Development Outcomes Cognitive and educational effects of overcrowding, Long-term respiratory exposure consequences Few Nigerian studies now consider housing, the environment, and child development. Further research should look into the role of traditional birth attendants, informal pharmacies, community health networks, and how hybrid health systems might improve policy integration.

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A typical full paper should be as follows: -

Abstract

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Acknowledgement

Paper Contribution to Related Field of Study

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