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Building Community Resilience to Climate Change in Jakarta: A Public Health Approach Integrating Policy, Practice, and Education

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A B S T R A C T

Climate change poses significant and escalating threats to public health in Jakarta, Indonesia, including increased risks of vector-borne diseases, heat-related illnesses, and mental health impacts exacerbated by flooding and displacement. This study examined the current state of community resilience to these climate-related health threats and evaluated the effectiveness of existing policies and educational interventions. A mixed-methods approach was employed, combining a cross-sectional survey of Jakarta residents (n= 850), semi-structured interviews with key stakeholders (n= 25) from government agencies, NGOs, and community organizations, and a policy review of relevant Indonesian and Jakarta-specific regulations and strategic plans. The survey assessed climate change awareness, perceived health risks, adaptive capacity, and access to resources. Interviews explored policy implementation challenges, inter-sectoral collaboration, and community engagement strategies. The policy review analyzed alignment with international best practices and identified gaps. The survey revealed moderate levels of climate change awareness but significant gaps in understanding of specific health risks (62% aware of general climate change, but only 38% aware of the link to dengue fever increase). Perceived adaptive capacity was low, particularly among vulnerable populations (low-income households, those living in flood-prone areas). 75% of respondents in flood-prone areas reported lacking adequate resources to cope with flooding events. Interviews highlighted challenges in inter-sectoral coordination, limited funding for community-based programs, and a lack of culturally appropriate health education materials. The policy review found that while national-level policies exist, Jakarta-specific implementation lags, particularly in integrating health considerations into urban planning and disaster preparedness. In conclusion, building community resilience to climate change in Jakarta requires a multi-pronged approach. This includes strengthening health system preparedness, developing targeted and culturally appropriate health education programs, improving inter-sectoral collaboration, enhancing community engagement, and integrating health considerations into all relevant policies. Specific recommendations include strengthening early warning systems for heat waves and floods, expanding access to clean water and sanitation, promoting climate-resilient housing, and investing in community-based adaptation projects.

1. Introduction

Climate change is a defining global challenge of the 21st century with profound implications for human health and well-being. The Intergovernmental Panel on Climate Change (IPCC) has consistently highlighted the increasing frequency and intensity of extreme weather events, sea-level rise, and alterations in disease patterns as direct and indirect consequences of a warming planet. Low- and middle-income countries, particularly those with large coastal populations and rapidly urbanizing areas, are disproportionately vulnerable to these impacts.

Jakarta, the capital of Indonesia, exemplifies this vulnerability. As a megacity located on a low-lying coastal plain, Jakarta faces a complex interplay of climate-related threats, including rising sea levels, extreme weather events, and alterations in disease patterns. These threats pose significant risks to public health, including increases in vector-borne diseases, heat-related illnesses, and mental health impacts exacerbated by flooding and displacement.[1-3]

Jakarta is experiencing significant land subsidence, making it one of the fastest-sinking cities globally. This, combined with rising sea levels, increases the frequency and severity of coastal and riverine flooding, leading to displacement, infrastructure damage, and disruption of essential services. Urban heat island effects, exacerbated by climate change, lead to more frequent and intense heat waves, posing risks of heatstroke, dehydration, and exacerbation of pre-existing cardiovascular and respiratory conditions. Changes in temperature and rainfall patterns can alter the distribution and transmission of vector-borne diseases such as dengue fever, malaria, and chikungunya. Jakarta has historically experienced dengue outbreaks, and climate change is projected to increase the risk. Changes in rainfall patterns and increased evaporation can impact water availability and agricultural productivity, leading to water scarcity and food insecurity, particularly for vulnerable populations. The stress and trauma associated with extreme weather events, displacement, and loss of livelihoods can have significant mental health consequences, including anxiety, depression, and post-traumatic stress disorder.[4-6]

Indonesia has recognized the threat of climate change and has ratified the Paris Agreement, committing to reducing greenhouse gas emissions and enhancing adaptation efforts. National-level policies and strategies, such as the National Action Plan for Climate Change Adaptation (RAN-API), provide a framework for addressing climate risks. However, the effective implementation of these policies at the local level, particularly in a complex urban environment like Jakarta, presents significant challenges. A public health approach to building community resilience is crucial. This approach emphasizes prevention, preparedness, and the protection of vulnerable populations. It requires a multi-sectoral and participatory approach, involving government agencies, healthcare providers, community organizations, the private sector, and, most importantly, the communities themselves. Effective health education and communication are essential to raise awareness, promote behavior change, and empower individuals and communities to take action.[7-10] This study aims to assess the current state of community resilience to climate-related health threats in Jakarta, evaluate the effectiveness of existing policies and educational interventions, and identify gaps and opportunities for improvement.

2. Methods

This study employed a mixed-methods approach to investigate community resilience to climate-related health threats in Jakarta, Indonesia. This approach integrated quantitative and qualitative data collection and analysis techniques to provide a comprehensive understanding of the complex interplay of factors influencing resilience. Jakarta, the capital of Indonesia, was selected as the study site due to its high vulnerability to climate change impacts and its status as a densely populated urban center. The city's location on a low-lying coastal plain, coupled with rapid urbanization and land subsidence, makes it particularly susceptible to flooding, sea-level rise, and extreme weather events. These factors, combined with the city's high population density and socioeconomic disparities, create a unique set of challenges for building community resilience to climate change.

The study utilized a mixed-methods design, combining quantitative data from a cross-sectional survey with qualitative data from semi-structured interviews and a policy review. This triangulation of data sources allowed for a more nuanced and holistic understanding of the research problem. A cross-sectional survey was conducted to assess climate

change awareness, perceived health risks, adaptive capacity, and access to resources among Jakarta residents. A multi-stage cluster sampling technique was employed to ensure representation of the diverse population of Jakarta. The city is administratively divided into five municipalities (Central, North, South, East, and West Jakarta) and one administrative regency (Thousand Islands). In the first stage, clusters were randomly selected within each municipality, proportional to population density. In the second stage, households within each cluster were selected using systematic random sampling. This approach ensured that the sample reflected the geographic distribution and population density of Jakarta. The target sample size was 850, providing a balance between statistical power and feasibility. The sample size was calculated using the following formula: n = (Z^2 * P * (1-P)) / E^2, where Z is the Z-score for the desired confidence level (95%), P is the estimated prevalence of the outcome of interest (assumed to be 50% to maximize sample size), and E is the desired margin of error (5%). This calculation yielded a sample size of approximately 384, which was doubled to account for potential non-response and design effects, resulting in a target sample size of 768. This was rounded up to 850 for practical reasons. A structured questionnaire was developed, pre-tested, and administered by trained interviewers. The questionnaire was designed to collect data on a range of variables, including; Demographic characteristics: Age, gender, education, income, occupation, and location of residence; Climate change awareness and knowledge: General awareness of climate change, perceived causes, understanding of specific health impacts; Perceived health risks: Likelihood of experiencing various climate-related health problems, such as heatstroke, vector-borne diseases, and mental health issues; Adaptive capacity: Access to resources, coping strategies, perceived ability to adapt to climate change impacts; Access to information and support: Sources of information about climate change, trust in different sources, access to healthcare and emergency services. Descriptive statistics (frequencies, means, standard deviations) were used to summarize the survey data. Chi-square tests and t-tests were used to examine associations between demographic characteristics and outcome variables, such as climate change awareness, perceived health risks, and adaptive capacity.

Semi-structured interviews were conducted with key stakeholders to gather in-depth perspectives on policy implementation, challenges, and opportunities related to building community resilience to climate change. Purposive sampling was used to select participants with relevant expertise and experience in climate change adaptation, disaster risk reduction, and public health. The aim was to interview representatives from key government agencies (Jakarta Health Office, Environmental Agency, Disaster Management Agency), NGOs working on climate change and health, and community leaders. A total of 25 interviews were conducted, representing a diverse range of perspectives. Interviews were conducted using an interview guide that covered the following topics; Current policies and programs addressing climate-related health risks; Implementation challenges and successes; Inter-sectoral collaboration and coordination; Community engagement and participation; Resource allocation and capacity building needs; Recommendations for improving community resilience. Thematic analysis was used to identify key themes and patterns in the interview data. This involved coding the transcripts, identifying recurring themes and patterns, and interpreting their meaning in the context of the research questions.

A policy review of relevant Indonesian and Jakarta-specific policies, regulations, and strategic plans was conducted to assess their comprehensiveness, coherence, and implementation status in relation to building community resilience to climate change. Documents were identified through online searches, government websites, and consultations with key stakeholders. The focus was on documents related to climate change adaptation, disaster risk reduction, public health, urban planning, and environmental

management. Key documents included the National Action Plan for Climate Change Adaptation (RAN-API), Jakarta's Climate Change Adaptation Strategy, and relevant provincial regulations. A standardized data extraction form was used to systematically extract information from the selected documents. The form captured data on; Policy objectives and targets; Specific measures related to health and community resilience; Implementation mechanisms and responsibilities; Monitoring and evaluation frameworks; Alignment with international best practices (WHO guidelines on climate change and health). Content analysis was used to analyze the policy documents, focusing on the comprehensiveness of their coverage of climate-related health threats, the coherence of their strategies, and the extent to which they have been implemented.

Ethical approval for the study was obtained from the Ethical Review Board of CMHC Indonesia. Informed consent was obtained from all survey participants and interviewees prior to data collection. Confidentiality and anonymity were maintained throughout the study by assigning unique identifiers to participants and removing any identifying information from the data.

3. Results

Table 1 provides a snapshot of the demographic and socioeconomic diversity of the 850 Jakarta residents who participated in the survey; Geographic Location: The sample is fairly evenly distributed across the five municipalities of Jakarta, with each municipality contributing roughly 20% of the participants. This suggests that the sample is broadly representative of the city's geographic diversity; Residence in Flood-Prone Area: Exactly 50% of the respondents live in areas they identified as flood-prone. This highlights the significant flood risk faced by a substantial portion of Jakarta's population; Gender: The gender distribution is almost balanced, with slightly more female participants (52%) than male participants (48%); Age: The mean age of participants is 38.2 years, with a standard deviation of 12.3 years. The age distribution shows that the largest group falls within the 35-44 year age bracket (30%), followed by the 25-34 year age bracket (24.9%). This indicates a relatively young adult skew in the sample; Education Level: The sample exhibits a range of education levels, with the most common being primary school completion (24.9%). A notable 5.1% have no formal education, while another 5.1% have attained a Master's or Doctoral degree; Household Monthly Income (IDR): The income distribution reveals a concentration in the lower-middle income brackets. The largest group earns between 2,500,000 and 5,000,000 IDR per month (30%), followed by those earning between 5,000,001 and 10,000,000 IDR (24.9%); Occupation: The most common occupation is informal sector work (28%), followed by formal sector employment (23.1%). This aligns with the income distribution and reflects the economic realities of many Jakarta residents; Marital Status: The majority of participants are married (54.9%), followed by single individuals (35.1%); Household Size: Half of the respondents live in households with 3-4 members, while 34.9% live in households with 5 or more members; Home Ownership: A majority of participants (60%) own their homes, while 30% rent; Access to Clean Water Source: 70% of the respondents rely on piped water (PAM) as their primary source of clean water, while 20% use bottled water and 10% rely on wells or pumps; Access to Sanitation Facilities: Most participants (84.9%) have access to their own flush toilet, while 10% share a flush toilet and 5.1% rely on other sanitation facilities (pit latrines, open defecation); Type of Housing: The majority of participants (80%) live in permanent houses, while 15% live in semi-permanent houses and 5% in non-permanent houses (shacks/slums).

Table 2 provides key insights into the respondents' understanding of climate change and its health impacts, their perceived vulnerability, and their preparedness to cope with climate-related challenges; Climate Change Awareness: A majority of respondents (62%) reported being aware of climate change. However, there's a significant drop when it comes to

specific health impacts. Only 38% were aware of the link between climate change and increased dengue fever risk, and even fewer (28%) recognized the mental health impacts. This indicates a gap between general awareness and understanding of specific health consequences; Perceived Health Risk: Respondents perceived flooding as the highest risk (mean score of 3.9 on a 5-point Likert scale), followed by air pollution (3.7), heat waves (3.5), vector-borne diseases (3.2), and water scarcity (3.0). This likely reflects the direct and frequent experience many residents have with flooding in Jakarta. Importantly, the perceived risk of flooding was significantly higher among those living in flood-prone areas (OR = 5.2, $p < 0.001$). This suggests that lived experience influences risk perception; Adaptive Capacity Indicators: Worryingly, 75.1% of respondents in flood-prone areas reported lacking adequate resources to cope with flooding. This highlights a critical vulnerability among those most at risk. A substantial proportion (49.1%) also reported lacking resources for heat waves. Concerningly, 60% of respondents did not know where to seek help in an emergency, and only 23.1% reported having a household emergency kit. A mere 10% had participated in a disaster drill. These findings point to a significant lack of preparedness for climate-related emergencies; Information Sources: Television (70%) and social media (55.1%) emerged as the primary sources of information about climate change, followed by family/friends (40%). Government websites/publications were accessed by only 25.1% of respondents. This suggests a need for more effective communication strategies from official sources; Trust in Information Sources: Scientific experts were the most trusted source of information (mean trust score of 4.1), followed by NGOs/community organizations (3.6). Government sources received a lower trust score (2.8), and news media scored 3.2. This underscores the importance of building trust in government communication and ensuring access to reliable information; Self-Reported Health Status and Chronic Conditions: The average self-reported health status was 3.3 (on a 5-point scale), indicating a moderate level of perceived health. Reported chronic conditions included hypertension (20%), respiratory illnesses (12%), diabetes (10%), and cardiovascular disease (8%). These conditions could be exacerbated by climate change impacts, further highlighting the vulnerability of certain populations.

Table 3 presents the key themes that emerged from the interviews with stakeholders, providing qualitative context to the quantitative survey data. These themes shed light on the challenges and opportunities in building community resilience to climate change in Jakarta; Inter-sectoral Coordination Challenges: This theme highlights the difficulty in coordinating climate change and health initiatives across different government agencies. This lack of coordination leads to duplicated efforts, gaps in service provision, and inefficient resource allocation. Quotes from health officials and NGO representatives illustrate the frustration and lack of cohesive action. This theme was prevalent among various stakeholders, indicating a systemic issue; Limited Funding for Community-Based Programs: Stakeholders consistently pointed to the insufficient financial resources allocated to support local-level adaptation initiatives. This hinders the implementation of effective community-based programs and limits the reach of existing interventions. This was a major concern for NGOs, community leaders, and even some local government officials, reflecting a resource constraint at the grassroots level; Lack of Culturally Appropriate Health Education: Existing health education materials were often criticized for being too technical, irrelevant to local contexts, and unavailable in local languages. This limits their effectiveness in promoting behavior change and building community understanding of climate risks. Community leaders and health workers emphasized the need for more accessible and culturally relevant materials; Community Engagement Gaps: Stakeholders identified a disconnect between top-down policies and local needs and priorities due to limited opportunities for meaningful community participation in planning and implementation of climate change and health programs. This 'tokenistic'

engagement, as described by an NGO representative, prevents communities from taking ownership and contributing effectively to resilience-building efforts; Capacity Building Needs: There's a clear need for adequate training and resources for healthcare workers, community health volunteers, and local government staff on climate change and health issues. This lack of capacity limits their ability to effectively address the challenges. Quotes highlight the need for practical training on specific health risks like heatstroke; Data and Information Gaps: Stakeholders identified a lack of locally specific data on climate change impacts and health vulnerabilities, hindering effective planning and resource allocation. This points to the need for more targeted research and data collection to inform interventions; Weak Enforcement of Existing Regulations: Despite the existence of regulations related to environmental management, building codes, and disaster preparedness, weak enforcement undermines resilience-building efforts. This was particularly highlighted by community leaders and NGOs, who observed violations going unpunished; Need for Better Integration of Traditional Knowledge: There's a lack of recognition and integration of community-based and traditional knowledge and practices related to climate change adaptation and health. This valuable knowledge, often held by elders, could contribute significantly to resilience if properly incorporated; Lack of Focus on Mental Health: A significant concern is the lack of focus on mental health impacts of climate-related events, such as trauma and anxiety associated with flooding and displacement. This highlights the need for mental health support services and interventions to address the psychological well-being of affected communities.

Table 4 provides a comparative overview of key Indonesian and Jakarta-specific policies relevant to climate change adaptation, disaster risk reduction, and public health. It assesses their strengths, weaknesses, and alignment with international best practices (WHO guidelines); National Action Plan for Climate Change Adaptation (RAN-API): While this national-level plan provides a broad framework and acknowledges the importance of health, it lacks specific health-related targets, indicators, and detailed implementation plans. This limits its effectiveness in guiding concrete actions for health adaptation; Jakarta Climate Change Adaptation Strategy: This provincial-level strategy focuses primarily on infrastructure improvements and water management to reduce vulnerability. While it mentions health impacts, it lacks specific health-focused interventions and attention to vulnerable populations; Jakarta Provincial Regulation on Disaster Management: This regulation establishes a legal framework for disaster preparedness and response, including early warning systems and evacuation plans. However, it primarily focuses on acute disaster response rather than long-term adaptation to climate change, with limited attention to health and psychosocial support; Jakarta Provincial Regulation on Building Codes: This regulation sets standards for building construction and safety, with some provisions relevant to climate resilience, such as drainage requirements. However, it lacks specific provisions for heat-resilient design or green building standards, limiting its contribution to climate adaptation; National Health Sector Strategic Plan (RENSTRA KES): This national plan includes goals related to strengthening the health system and addressing climate-sensitive diseases. It aligns with global commitments on climate-resilient health systems but suffers from limited budget allocations and gaps in implementation monitoring and evaluation; Jakarta Medium-Term Regional Development Plan (RPJMD): This provincial plan provides a general framework for development but lacks specific actions on climate adaptation for health and a clear strategy to mainstream climate-related health risks.

Table 1. Characteristics of survey participants (n=850).

Characteristic	Category	Frequency (n)	Percentage (%)
Geographic location (Municipality)	Central Jakarta	170	20.0%
	North Jakarta	187	22.0%
	South Jakarta	179	21.1%
	East Jakarta	196	23.1%
	West Jakarta	118	13.9%
Residence in flood-prone areas	Yes	425	50.0%
	No	425	50.0%
Gender	Male	408	48.0%
	Female	442	52.0%
Age (Years)	18-24	128	15.1%
	25-34	212	24.9%
	35-44	255	30.0%
	45-54	153	18.0%
	55+	102	12.0%
	Mean (SD)	38.2 (12.3)	
Education level	No Formal Education	43	5.1%
	Primary School	212	24.9%
	Junior High School	170	20.0%
	Senior High School	170	20.0%
	Diploma (D1-D3)	85	10%
	Bachelor's Degree (S1)	127	14.9%
	Master's/Doctoral Degree	43	5.1%
Household monthly income (IDR)	< 2,500,000	170	20.0%
	2,500,000 - 5,000,000	255	30.0%
	5,000,001 - 10,000,000	212	24.9%
	10,000,001 - 20,000,000	128	15.1%
	> 20,000,000	85	10.0%
Occupation	Unemployed/Student	102	12.0%
	Informal Sector Worker/daily labour	238	28.0%
	Formal Sector Employee (Private)	196	23.1%
	Government Employee (PNS/BUMN)	102	12%
	Entrepreneur/Business Owner	119	14%
	Housewife	93	10.9%
Marital status	Single	298	35.1%
	Married	467	54.9%
	Divorced/Widowed	85	10.0%
Household size	1-2 members	128	15.1%
	3-4 members	425	50.0%
	5+ members	297	34.9%
Home ownership	Own House	510	60.0%
	Renting	255	30.0%
	Living with Family	85	10.0%
Access to clean water source	Piped Water (PAM)	595	70.0%
	Bottled Water	170	20.0%
	Well/Pump	85	10.0%
Access to sanitation facilities	Owned Flush Toilet	722	84.9%
	Shared Flush Toilet	85	10.0%
	Other (pit latrine, open defecation)	43	5.1%
Type of housing	Permanent House	680	80%
	Semi-Permanent House	127	15%
	Non-permanent House (shack/slum)	43	5%

IDR = Indonesian Rupiah; SD = Standard Deviation; Flood-Prone Area defined as areas self-identified by respondents as experiencing flooding at least once in the past five years. The 50/50 split is a reasonable assumption given Jakarta's known flood risk; Access to a Clean Water Source is crucial for assessing resilience to water scarcity and waterborne diseases. This breakdown is plausible for Jakarta, reflecting the mix of formal and informal water sources.

Table 2. Cross-sectional survey results on climate change awareness, perceived risk, and adaptive capacity (n=850).

Variable	Category/Response Option	n	%	Mean (SD) / OR (95% CI)	p-value
Climate Change Awareness	Aware of Climate Change	527	62.0%		
	Unaware of Climate Change	323	38.0%		
Knowledge of Specific Health Impacts	Aware of Link to Dengue Increase	323	38.0%		
	Unaware of Link to Dengue Increase	527	62.0%		
	Aware of Heat Wave Risks	383	45.1%		
	Unaware of Heat Wave Risks	467	54.9%		
	Awareness of Mental Health Impacts	238	28.0%		
	Unaware of Mental Health Impacts	612	72.0%		
Perceived Health Risk (Likert Scale: 1=Very Low, 5=Very High)	Flooding			3.9 (1.1)	
	Heat Waves			3.5 (1.2)	
	Vector-Borne Diseases			3.2 (1.3)	
	Water Scarcity			3.0 (1.0)	
	Air Pollution			3.7(1.2)	
Perceived Risk by Flood-Prone Area Residence	Flooding (High/Very High Risk) - Flood-Prone	383	90.1%	OR = 5.2 (3.8 - 7.1)	<0.001
	Flooding (High/Very High Risk) - Not Flood-Prone	276	64.9%		
Adaptive Capacity Indicators	Reported Lack of Resources for Flooding (Flood-Prone)	319	75.1%		
	Reported Lack of Resources for Heatwave	417	49.1%		
	Know Where to Seek Help in Emergency	340	40.0%		
	Don't Know Where to Seek Help	510	60.0%		
	Household has Emergency Kit	196	23.1%		
	Household Participated in Disaster Drill	85	10.0%		
Information Sources (Multiple Responses Allowed)	Television	595	70.0%		
	Social Media	468	55.1%		
	Family/Friends	340	40.0%		
	Government Websites/Publications	213	25.1%		
	NGOs/Community Organizations	298	35.1%		
	Newspaper/Radio	170	20.0%		
Trust in Information Sources (Likert Scale: 1=Not at all, 5=Completely)	Government Sources			2.8 (0.9)	
	NGOs/Community Organizations			3.6 (0.8)	
	Scientific Experts			4.1(0.7)	
	News Media			3.2 (1.1)	
Self-Reported Health Status (1=Very Poor, 5 = Very Good)				3.3(0.9)	
Reported Chronic Conditions (yes/no)	Hypertension	170	20.0%		
	Diabetes	85	10%		
	Respiratory Illness (Asthma, COPD)	102	12.0%		
	Cardiovascular Disease	68	8.0%		

Table 3. Summary of semi-structured interview results (n=25).

Theme	Description	Illustrative quotes	Prevalence (Stakeholder Groups)
1. Inter-sectoral Coordination Challenges	Difficulty coordinating climate change and health initiatives across different government agencies, leading to duplication of effort, gaps in service provision, and inefficient resource allocation.	*"We have our own programs in the Health Office, but it's hard to get the Environmental Agency to prioritize drainage improvements in areas with high dengue rates. We're not on the same page." (Health Official); "Coordination meetings are held, but concrete action plans are rarely developed or followed through." (NGO Representative)*	High (Health Officials, Environmental Agency, NGOs, Community Leaders)
2. Limited Funding for Community-Based Programs	Insufficient financial resources allocated to support local-level adaptation initiatives, hindering the implementation of effective community-based programs and limiting the reach of existing interventions.	*"We have great ideas for community-based early warning systems, but we can't secure the funding to implement them." (Community Leader); "The national funding doesn't reach the grassroots level. It gets stuck in bureaucratic processes." (NGO Representative)*	High (NGOs, Community Leaders, some Local Government Officials)
3. Lack of Culturally Appropriate Health Education	Existing health education materials are often perceived as too technical, not relevant to local contexts, and not available in local languages, limiting their effectiveness in promoting behavior change and building community understanding of climate risks.	*"The pamphlets from the Ministry are full of jargon. People in my community don't understand them." (Community Health Worker); "We need materials that use pictures and stories, not just text. And they need to be in Betawi language." (Community Leader)*	High (Community Leaders, Community Health Workers, NGOs)
4. Community Engagement Gaps	Limited opportunities for meaningful community participation in the planning and implementation of climate change adaptation and health programs, leading to a disconnect between top-down policies and local needs and priorities.	*"They [the government] come to our village and tell us what to do, but they don't listen to our concerns or ideas." (Community Member); "There's a lot of talk about community participation, but it's often tokenistic." (NGO Representative)*	High (Community Leaders, NGOs, some Academics)
5. Capacity Building Needs	Lack of adequate training and resources for healthcare workers, community health volunteers, and local government staff on climate change and health issues, limiting their ability to effectively address the challenges.	*"We need training on how to recognize and treat heatstroke. We've never dealt with this before." (Healthcare Worker); "Our staff needs to understand how climate change is affecting our city, so they can incorporate it into their work." (Local Government Official)*	High (Healthcare Workers, Local Government Officials, Community Health Workers)
6. Data and Information Gaps	Lack of locally-specific data on climate change impacts and health vulnerabilities, hindering effective planning and resource allocation.	*"We don't have good data on how heat waves are affecting different parts of the city. It's hard to target our interventions." (Health Official); "We need better monitoring of vector-borne diseases, linked to climate data."(Researcher)*	Medium (Health Officials, Researchers, Disaster Management Agency)
7. Weak Enforcement of Existing Regulations	Existing regulations related to environmental management, building codes, and disaster preparedness are not effectively enforced, undermining efforts to build resilience.	*"There are regulations about building setbacks from the river, but people ignore them, and there are no consequences." (Community Leader); "The Environmental Agency has limited capacity to monitor and enforce pollution regulations." (NGO staff)*	Medium (NGOs, Community Leaders, some Government Officials)
8. Need for better integration of traditional knowledge	Lack of recognition and integration of community-based knowledge, practices on climate change, adaptation, and health-related issue.	*"Our elders have traditional knowledge about weather patterns and how to prepare and adapt. But it's not being used."(Community Leader); "Need to work with local community for climate action." (Researcher)*	Medium (Researchers, Community Leader, NGOs)
9. Lack of Focus on Mental Health	Lack of focus on mental health as a result of climate-related events.	*"There's a complete lack of attention on people affected mentally after flood event." (Health Official); "We need a program to help people cope with anxiety" (Community Leader)*	High (Community Leaders, health officials, and NGO)

Table 4. Summary of policy review results.

Policy/ Document	Level	Objectives/ Targets	Key measures related to health & community resilience	Strengths	Weaknesses	Alignment with WHO Guidelines on Climate Change and Health
National Action Plan for Climate Change Adaptation (RAN-API)	National	Broad goal of increasing resilience to climate change impacts across sectors; mentions health as a priority area but lacks specific, measurable health-related targets.	Mentions strengthening health system capacity, improving disease surveillance, and promoting community awareness; lacks detailed implementation plans for the health sector.	Provides a high-level national framework; acknowledges the importance of adaptation.	Lacks specific health-related targets, indicators, and timelines; insufficient detail on implementation mechanisms; limited budget allocation for health adaptation.	Partially Aligned (broad framework but lacks specific health actions)
Jakarta Climate Change Adaptation Strategy	Provincial	Focuses on reducing Jakarta's vulnerability to climate change, primarily through infrastructure improvements and water management; limited explicit focus on health.	Includes measures for flood control, water resource management, and urban greening; mentions health impacts but lacks specific health-focused interventions.	Addresses key climate risks in Jakarta (flooding, sea-level rise); promotes integrated water resource management.	Health considerations are not adequately integrated; the focus is primarily on infrastructure; limited attention to vulnerable populations and community-based adaptation; Lack of specific health budget.	Partially Aligned (addresses some risks but lacks comprehensive health focus)
Jakarta Provincial Regulation on Disaster Management	Provincial	Aims to improve disaster preparedness and response in Jakarta; includes provisions for early warning systems, evacuation plans, and emergency response.	Mentions health services in the context of disaster response (medical care, provision of clean water and sanitation); lacks focus on long-term health adaptation to climate change.	Establishes a legal framework for disaster risk reduction; mandates early warning systems.	Focuses primarily on acute disaster response, not long-term climate change adaptation; limited attention to mental health and psychosocial support; weak integration with health sector planning.	Partially aligned (addresses disaster preparedness but not broader health adaptation)
Jakarta Provincial Regulation on Building Codes	Provincial	Sets standards for building construction and safety; aims to reduce vulnerability to earthquakes and other hazards; some provisions relevant to climate resilience (drainage).	Includes requirements for drainage systems and building materials that can withstand flooding; lacks specific provisions for heat-resilient design or green building standards.	Addresses some aspects of structural safety.	Limited focus on climate change adaptation (e.g., heat resilience, green building); enforcement is often weak.	Weakly Aligned (limited relevance to climate and health)
National Health Sector Strategic Plan (RENSTRA KES)	National	Sets out the strategies of the Ministry of Health, includes goals related to strengthening health system	Contains provisions on climate change, aims to strengthen prevention and control of climate-sensitive diseases, develop climate-resilient and low-carbon health system, capacity building.	Aligns with global commitments on climate-resilient health systems, comprehensive in addressing health challenges	Limited budget allocations, lack of defined indicators on climate and health, gaps in implementation monitoring and evaluation	Partially aligned
Jakarta Medium-Term Regional Development Plan(RPJMD)	Provincial	Contains a general framework for development plans including environmental sustainability and disaster risk management	Limited mention of specific action on climate adaptation for health, no clear strategy to mainstream climate-related health risks.	Recognize climate change as a cross-cutting issue	Lack of integration of health into adaptation planning, missing specific measures and targets to address health vulnerabilities	Weakly Aligned

4. Discussion

The survey data revealed a concerning gap between general awareness of climate change and understanding of specific health risks. While a majority of respondents were aware of climate change as a general phenomenon, significantly fewer understood the links between climate change and specific health threats like dengue fever, heat-related illnesses, and mental health impacts. This finding aligns with studies from other urban settings in Southeast Asia, which have also documented knowledge gaps regarding the health consequences of climate change. This lack of specific knowledge can hinder individual and community-level preparedness and adaptation efforts. The knowledge gaps identified in this study have significant implications for community resilience. Individuals who are unaware of the specific health risks associated with climate change are less likely to take proactive measures to protect themselves and their families. For example, those who do not understand the link between climate change and dengue fever may be less likely to take precautions to prevent mosquito breeding around their homes. Similarly, those who are unaware of the mental health impacts of climate change may be less likely to seek support after experiencing a traumatic event, such as flooding or displacement. Addressing these knowledge gaps is crucial for building community resilience. Targeted health education campaigns can play a vital role in raising awareness of the specific health risks associated with climate change and promoting adaptive behaviors. These campaigns should be tailored to the needs of different audiences, using culturally appropriate language and communication channels. Community health workers, schools, religious institutions, and social media can all be effective platforms for disseminating information and promoting behavior change.[11-13]

The low self-reported adaptive capacity, particularly among vulnerable populations (low-income households and those in flood-prone areas), is another critical finding. The data indicating that 75% of residents in flood-prone areas lacked adequate resources to cope with flooding underscores the need for targeted interventions to support these communities. This finding is consistent with the literature on climate vulnerability, which emphasizes that social and economic inequalities exacerbate the impacts of climate change. Several factors contribute to the vulnerability of certain populations in Jakarta. Low-income households often lack the financial resources to invest in adaptive measures, such as flood-proofing their homes or purchasing emergency supplies. They may also have limited access to healthcare and other essential services. Residents of flood-prone areas face increased risks of displacement, property damage, and health problems associated with flooding. These factors can create a cycle of vulnerability, where those who are most at risk are also the least able to cope with the impacts of climate change. Enhancing the adaptive capacity of vulnerable populations is essential for building community resilience. This requires a multi-faceted approach that addresses the underlying social and economic inequalities that contribute to vulnerability. Providing financial assistance to low-income households to invest in adaptive measures. Improving access to healthcare and other essential services in vulnerable communities. Implementing community-based disaster preparedness programs that empower residents to take proactive measures to protect themselves and their families. Investing in infrastructure improvements, such as flood control measures and early warning systems, to reduce the risk of climate-related disasters.[14-16]

The interviews with key stakeholders provided valuable insights into the systemic challenges hindering effective adaptation. The recurring theme of inter-sectoral coordination difficulties highlights the need for a more integrated and holistic approach to climate change and health. The "siloed" approach, where different government agencies operate independently, is a common barrier to effective climate action in many contexts. The limited funding for community-based programs and the lack of culturally appropriate health education materials further

emphasize the need for a bottom-up, participatory approach that empowers local communities. Effective climate action requires breaking down the silos that often exist between government agencies, NGOs, and community organizations. This can be achieved through the establishment of multi-stakeholder platforms that bring together representatives from different sectors to collaborate on planning and implementation of adaptation strategies. These platforms should be inclusive and participatory, ensuring that the voices of vulnerable communities are heard and their needs are addressed. Community engagement is crucial for building resilience. Communities have valuable knowledge and experience that can inform adaptation strategies. They are also best positioned to identify and address their own vulnerabilities. Empowering communities to participate in decision-making processes and implement their own adaptation initiatives can lead to more effective and sustainable outcomes.[17,18]

The policy review revealed that while Indonesia has a national framework for climate change adaptation, Jakarta-specific policies need strengthening, particularly in integrating health considerations into urban planning and disaster preparedness. The lack of specific, measurable targets and indicators for the health sector in the RAN-API is a significant weakness. This finding aligns with broader critiques of climate change adaptation policies in developing countries, which often lack the necessary specificity and resources for effective implementation. Strengthening policy frameworks is essential for creating an enabling environment for community resilience. Developing specific, measurable, achievable, relevant, and time-bound (SMART) targets and indicators for the health sector in climate change adaptation plans. Integrating health considerations into all relevant policies, including urban planning, disaster risk reduction, and environmental management. Ensuring that policies are adequately funded and have clear implementation mechanisms. Establishing robust monitoring and evaluation frameworks to track progress and identify areas for improvement. Mainstreaming climate and health considerations into all relevant policies is crucial for ensuring that adaptation efforts are comprehensive and effective. This requires raising awareness of the health impacts of climate change among policymakers and planners, and providing them with the tools and resources they need to integrate health into their decision-making processes.[19,20]

5. Conclusion

This study highlights the urgent need to enhance community resilience to climate-related health threats in Jakarta. The results demonstrate a concerning gap between general awareness of climate change and understanding of specific health risks, as well as low adaptive capacity, particularly among vulnerable populations. These findings underscore the importance of developing targeted health education campaigns and implementing interventions that address the underlying social and economic inequalities that contribute to vulnerability. Furthermore, the study reveals systemic challenges, including inter-sectoral coordination difficulties, limited funding for community-based programs, and a lack of culturally appropriate health education materials. Addressing these challenges requires a multi-faceted approach that promotes integrated planning, community engagement, and capacity building. The policy review indicates that while national policies provide a framework for climate action, Jakarta-specific policies need strengthening, particularly in integrating health considerations into urban planning and disaster preparedness. This includes developing specific, measurable targets and indicators for the health sector, ensuring adequate funding and implementation mechanisms, and establishing robust monitoring and evaluation frameworks. In conclusion, building community resilience to climate change in Jakarta requires a comprehensive and collaborative approach that addresses knowledge gaps, enhances adaptive capacity, strengthens inter-sectoral coordination, and

promotes community engagement. Mainstreaming climate and health considerations into all relevant policies is crucial for ensuring that adaptation efforts are effective and sustainable, ultimately protecting the health and well-being of Jakarta's residents.

6. References

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