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Article

Local environmental policies, health and climate risks: Citizens' perceptions in a Portuguese municipality

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Abstract: Climate change is a major public health hazard and a critical component of sustainable development. Understanding public perceptions of these risks is crucial for developing effective local environmental policies that contribute to health and sustainability goals. This research aimed to characterize the perceptions of an adult Portuguese population regarding climate change and its health impact and to examine their awareness of and compliance with municipal policies. The choice of Cascais as a case study reflects its urban character, exposure to climate risks, and its proactive stance in local environmental policy. We conducted research on the environmental programs/guidelines implemented in the urban municipality of Cascais. Subsequently, we employed an online survey to gather data on the perceptions of 200 adults residing/working in Cascais. People with higher awareness are more likely to engage in environmentally conscious behaviors, essential for sustainable development. However, many respondents were unaware of municipal programs and did not participate. Perceptions of climate risk and action priorities varied by sex, age, and education. Improved communication and awareness-raising are needed. This study contributes to the broader understanding of environmental perception by highlighting the influence of demographic factors on climate-related knowledge and behavior. It also demonstrates the value of integrating public perception data into municipal policy planning and sets a replicable framework for comparative research across urban contexts. Incorporating citizens' perceptions can help municipalities develop effective, community-adapted policies, fostering inclusive and resilient local climate actions to protect public health.

Keywords: climate change; local environmental policies; perceptions; health; sustainable development

1. Introduction

In contemporary societies, environmental risks have far-reaching consequences in all sectors of people's lives. Climate change (CC) refers to significant variations in the average state or inconstancy of the climate that persists for extended periods [1,2]. Increases in extreme events such as heat waves, heavy precipitation, and severe droughts are particularly noteworthy [3,4]. Temperature extremes, including wet-bulb conditions, significantly raise mortality risk [5–8].

In Portugal, the average temperature has risen by approximately 0.3 °C per decade since the mid-1970s, alongside more frequent heatwaves and declining annual precipitation [9]. The intersection of CC, health, and public policy is a central concern in international and national agendas, being recognized as a matter of social justice and equity, as its impacts cause significant social and distributive inequalities [8].

Public policy must integrate environmental and health dimensions, promoting

sustainable practices and equitable access to healthcare. This is exemplified in international efforts [10,11]. In Portugal, national and local governments are increasingly recognizing their role in mitigating and adapting to climate impacts through territorial planning, environmental regulation, and health promotion strategies [9]. CC presents a complex environmental health and justice challenge and an opportunity for public policy [12,13]. Embedding environmental justice in climate policies is essential to prioritize vulnerable populations and redress historical inequities [14]. The substantial health benefits of reduced pollution, particularly in the most polluted areas, not only offset but outweigh the costs of implementing carbon control and climate policies [15–17]. CC has direct implications for human health in terms of both biological organisms and public health [13,18]. These impacts include higher risks of death, increased indicators of morbidity and mortality due to extreme temperatures, and temporary reductions in air quality due to smog and smoke, reflecting the health and disease conditions of the population [3,19–21].

CC-related events such as heatwaves and air pollution increase the risk of respiratory, cardiovascular, and vector-borne diseases [3,8,12,18,20–22]. Health effects also include broader public.

In addition, water-related illnesses are due to the influence of water quality on water-bound diseases, such as viral hepatitis or diarrheal diseases [3,20]. Simultaneously, indirect health effects result from ecosystem change impacting food production, safety, nutrition, and distribution [3,20]. Droughts and extreme rainfall events alter agricultural yields, threatening food supply and security [23,24]. These effects are framed within the Sustainable Development Goals (SDG), specifically SDG 13 (Climate Action) and SDG 3 (Good Health and Well-being), which stress the need for integrated responses [25].

In a global risk society, CC emerges as an unforeseen consequence produced by society itself based on risk perception [26]. Public perception of CC consequences is crucial, as it shapes individual behavior [27,28].

Given the intensified environmental risk scenario, concerns regarding the impact of CC on people's health are growing. Research on environmental and health perceptions has been going on since the 1970s [29]. However, perceiving long-term, distant threats like CC remains a challenge. Slovic [30] highlights that people often struggle to perceive and be concerned about long-term environmental threats that affect distant or future populations. These risks can be perceived as "distant," "uncertain," and "diffuse," leading to minimization or denial. Immediate threats, like natural disasters, elicit greater concern. Effective communication of the health risks of CC could increase public awareness, motivate action, and increase involvement in policymaking [30]. However, in Portugal, public knowledge about its causes and effects remains limited [31].

The scientific community advocates an efficient strategy for health, the environment, and CC, which requires environmental management that respects health [32]. However, messaging that emphasizes threat alone may backfire—triggering feelings of helplessness and withdrawal [33,34]. In contrast, demonstrations that showcase health benefits related to mitigation measures can enhance citizen participation more effectively [35]. Adaptation strategies, such as community-centered care, can improve public health outcomes by addressing the environmental

determinants of health [36]. Although CC is a worldwide problem, it is increasingly addressed at the local level [1,12]. Local governments play a crucial role in climate action, influencing urban development, economic activity, transportation infrastructure, and energy use [37]. In Portugal, municipalities implement environmental strategies and programs in territorial planning processes [9], addressing demographic pressures and urban air quality challenges [12,24], and Cities, as global players [26], Cities, as global actors [26], drive both public awareness and scientific outreach, promoting sustainable practices and public health protection [38].

Effective local policies should avoid fear-based messages, adopt an optimistic tone, enhance citizen engagement, and incorporate CC education at all school levels [39]. Key areas include sustainable urban planning, resilient infrastructure, and behavior change interventions [40], all aligned with SDG 11 (Sustainable Cities and Communities) [41]. Local governments can foster behavioral change and develop resilient infrastructure adapted to CC, prioritizing key systems like water, sanitation, and transport [38,42]. Sustainable urban planning helps reduce emissions and improve efficiency [38,43], supported by green building standards, compact design, and mixed land use [44]. Climate plans should also address air quality, extreme temperatures, and disease control [45].

Public attitudes and behaviors are central to the effectiveness of climate adaptation strategies [46]. Understanding how people perceive climate risks is essential to shaping communication strategies and fostering behavioral change [27,47].

Research shows that environmental behavior is influenced by multiple factors, including perceived costs and benefits, social norms, trust in institutions, perceived efficacy, and environmental values and ethics [40,48]. Besides that, health and environmental perceptions can also shape public policy [29] by empowering communities to take part in local decision-making processes [49]. CC perceptions are highly context-dependent, shaped by place attachment, professional activity, and locally perceived risks and priorities [50–54]. Incorporating local stakeholder perceptions leads to stronger adaptive strategies, resilient populations, and resilient environments [55], making it an essential step in designing adaptive management and governance systems [47]. This framework raises the question: What are the population's representations about climate change and its impacts on public and individual health? This research aimed to characterize the perceptions of an adult Portuguese population in an urban context of CC and its impact on public and individual health. By examining the perceptions of residents in a certain urban community, we sought to understand their knowledge of municipal policies and adherence to them, as well as what guides their environmental practices. By addressing how the health implications of CC are perceived, it explores the links between local governance, climate action, and individual behavior. It also considers how public understanding can support governance by contributing to an understanding of the socio-political dynamics that influence the effectiveness of local responses to environmental challenges.

2. Materials and methods

To focus on the working population, we conducted a poll of inhabitants or workers in a Portuguese municipality. As a case study, we selected the municipality of Cascais, in the Lisbon metropolitan region, with approximately 215,000 inhabitants. Cascais combines urban and natural landscapes and faces environmental challenges such as coastal erosion, air quality concerns, and climate-related risks. The municipality has adopted adaptation and mitigation strategies aligned with national and international frameworks, including its Climate Change Adaptation Action Plan 2030. Cascais was chosen for its urban coastal context, proactive climate policies, and the absence of acute environmental hazards, which allows for a clearer assessment of climate risk perception based on everyday experience rather than direct exposure. As noted by Lujala et al. [27], proximity to environmental hazards can significantly shape risk perception. This choice is based on urban characteristics, coastal location, and the municipality's commitment to sustainability and climate action, as expressed in its Climate Change Adaptation Action Plan 2030 and related initiatives. Cascais was also selected for being a municipality without acute environmental hazards that might bias perceptions, allowing for a clearer analysis of risk perception in relation to lived experience [27]. The research design followed a mixed-methods strategy, aligning with the study's conceptual framework on local environmental policies, health, and climate risks. First, we conducted documentary research and a desk review of local environmental programs and guidelines applied to the municipality of Cascais, identifying relevant initiatives.

We then implemented an online survey using Google Forms, targeting residents and/or workers aged 20 to 65 years in Cascais.

The survey instrument included closed and open-ended questions and was structured around key dimensions: i) sociodemographic data (age, sex, education, profession/occupation and household), ii) social representations of CC (associated phenomena and subjective risk validation), iii) perceived impact of CC on individual health (subjective risk assessment, identification of risks to individual health, possibility of preventing their individual health from being affected by CC) and on public health (subjective risk assessment, identification of risks to public health, possibility of preventing public health from being affected by CC), iv) knowledge of local environmental policies (*Climate Change Adaptation Action Plan of Cascais 2030; Oxygen Program, Clean Up the Ocean, Environmental Education and Awareness Program, The Sea Starts Here, Natura Observes, Neighborhood Tutor, + Sea, Dive for All, Mussel Campaign, Land of Cascais" Project*), and v) environmental practices (waste separation consumption habits, use of public water, and barriers to environmentally responsible behavior).

The questionnaire was available online during April and May 2021 and disseminated using a snowball sampling strategy. It was also complemented by systematic outreach to diverse local networks (associations, social networks, businesses, sports clubs, and cultural clubs) to obtain a diverse social sample. In total, 200 responses were received.

A desk evaluation of local regulations and standards was conducted. Quantitative data were analyzed using SPSS (version 25), beginning with descriptive statistics to

outline trends, followed by bivariate and multivariate analyses to explore associations between variables. When appropriate, group comparison techniques were applied to assess the statistical significance between sociodemographic groups and their responses, using the Mann-Whitney, Kruskal-Wallis, and Chi-square tests. The significance level was set at $p = 0.001$.

Open-ended responses were analyzed using content analysis, enabling the identification of categories linked to environmental practice and rationales. This methodological approach supports the interpretation of perceptions, behaviors, and policy knowledge in an integrated manner, consistent with the conceptual framework adopted.

Characterization of the Sample

From the responses obtained, we considered the 200 who met the inclusion criteria. The mean age was forty-two years. The majority were female (72.5%), and with respect to academic qualifications, university graduates stood out (38.5%). The households in the municipality of Cascais were divided into four parishes.

3. Results

3.1. Climate change (CC) and environmental literacy

The overwhelming majority of the participants interviewed ($N = 198$; 99%) were familiar with the term CC. Regarding knowledge of the CC phenomena, 6.5% had misunderstandings (considering that CC refers to meteorological changes, it is not relevant to the temporal space in which they occur). Although these differences were not statistically significant, more women answered incorrectly than men. Although not statistically significant, there was a higher proportion of incorrect answers in the older age group. More people with higher academic degrees responded correctly, considering that CC refers to a change in the state of the climate, which can be demonstrated by changes in the mean and variability of its properties that persist for a prolonged period, usually decades or more. This correlation was statistically significant (Mann-Whitney test with Sig < $\alpha = 0.05$ [$p = 0.014$]).

Respondents obtained information on the subject mainly from television, radio, newspapers, and generalist magazines (59%). Books and scientific articles were sources for 12.5% of them.

The three phenomena indicated as most associated with CC are the “increase in the average temperature of the atmosphere” (82%), the “occurrence of extreme weather events” (75.8%), and the “rise in the average sea level” (62.2%).

Unlike CC, the majority knew the term “global warming” (94.5%), gained knowledge through the media (66%), and 17.5% identified books and scientific publications as sources of information. Regarding the awareness of global warming as a phenomenon related to an increase in the planet’s average temperature recorded in recent decades [56], 5.5% of the respondents believed that it only refers to an increase in temperature in particular places in the world. Similar to their knowledge of CC, although women and older individuals provided more incorrect responses regarding global warming, the differences between these groups were not statistically

significant.

3.2. Health risks of climate change (CC)

CC introduces the idea of risk [26]. Both men and women believed that CC represented a high or significant health hazard. 36% consider it extreme risk and 49.0% high risk (**Table 1**).

Table 1. CC risk for individual health.

		1 None Risk	2 Little Risk	3 Moderate Risk	4 High Risk	5 Extreme Risk	Total
CC risk for individual health	Freq	1	2	27	98	72	200
	%	0.5%	1.0%	13.5%	49.0%	36.0%	100.0%
CC risk for public health	Freq	0	1	24	95	80	200
	%	0.0%	0.5%	12.0%	47.5%	40.0%	100.0%

Most (90.5%) saw allergies and respiratory disorders as the most serious threats to their health. This was followed by metabolic disorders (40.2%), cerebrovascular diseases (33.9%), reproductive issues (35.2%), oncological diseases (26.6%), psychological difficulties (23.1%), physical problems (14.1%), and vector-borne diseases (12.6%).

In the field of public health, they also considered periods of extreme drought (26%) and heat waves (30%) to be the most significant risks (**Table 2**).

Table 2. Public health risks of CC.

		1 None Risk	2 Little Risk	3 Moderate Risk	4 High Risk	5 Extreme Risk	Total
Changing patterns of disease-carrying mosquitoes	Freq	1	17	67	88	27	200
	%	0.5%	8.5%	33.5%	44.0%	13.5%	100%
Droughts	Freq	1	8	54	85	52	200
	%	0.5%	4.0%	27.0%	42.5%	26.0%	100%
Heat waves	Freq	1	9	44	86	60	200
	%	0.5%	4.5%	22.0%	43.0%	30.0%	100%
Floods	Freq	1	15	48	92	44	200
	%	0.5%	7.5%	24.0%	46.0%	22.0%	100%
Hurricanes	Freq	3	25	58	76	38	200
	%	1.5%	12.5%	29.0%	38.0%	19.0%	100%
Poor air quality	Freq	1	7	43	74	75	200
	%	0.5%	3.5%	21.5%	37.0%	37.5	100%

3.3. Climate change (CC) and national health service

Upon being asked about the representation of the burden that CC can bring to the NHS, on a scale of '1' to '5', most respondents (45%) attributed '4' (**Table 3**). Compared to men, women were considered to have a more significant burden (Mann-Whitney test with Sig < $\alpha = 0.05$ [$p = 0.001$]). This variable did not differ between the age and education groups.

Table 3. Level of burden that CC can bring to the NHS.

		1 Lower overload	2	3	4	5 Larger overload	Total
Total	Freq	1	6	51	89	51	198
	%	0.5%	3.0%	25.8%	44.9%	25.8%	100.0%

3.4. Local environmental policy

Cascais adopted the Aalborg Charter and agreed upon its principles in 1996. Cascais Agenda 21 and Cascais Sustainability Strategy are interwoven into all local environmental and public engagement policies. The 2030 Cascais Action Plan for Climate Change Adaptation combines ten initiatives for sustainability and combating CC, allowing people to contribute. Most respondents (70%) claimed that they knew about the 2030 Cascais Action Plan for Climate Change Adaptation. However, the sample was not informed about the municipality's environmental efforts. The participation rates in these programs were significantly lower. The maximum achieved was 49% for natura observers (**Table 4**).

Table 4. Environmental programs promoted by Cascais municipality.

	Knows		Participates or has Participated	
	Freq	%	Freq	%
Natura Observes	111	55.2	25	49
Oxygen Program	63	31.3	24	47.1
PESA - Environmental Education and Awareness Program	59	28.9	16	31.4
Clean Up the Atlantic	66	32.8	13	25.5
The Sea Starts Here	72	35.8	18	35.3
Neighborhood Tutor	82	40.8	7	13.7
+ Sea	16	8	6	11.8
Dive for All	42	20.9	8	15.7
Mussel Campaign	34	16.9	7	13.7
Land of Cascais" Project	59	29.4	14	27.5

3.5. Citizens' behavior and responsibilities

Environmentally conscious behaviors are key catalysts for sustainable development, supporting a transition toward responsible consumption (SDG 12). Most respondents (52.7%) often thought about the environmental impacts of their actions and behaviors (**Table 5**). As statistically proven, people with a higher level of education think more often about the impact of their actions (Kruskal-Wallis test with Sig < $\alpha = 0.05$ [$p = 0.023$]), without differences between the sexes or age groups.

Table 5. Thinking about the environmental impacts of their actions.

		Always	Many often	Sometimes	Rarely	Never	Total
Total	Freq	42	106	48	4	0	200
	%	21.0%	53.0%	24.0%	2.0%	0.0%	100.0%

When asked about the possibility of avoiding CC affecting health, 9% of our

sample considered the probability to be low. Compared to women, men considered that they had a lower possibility of avoiding their health being affected (Mann-Whitney test with Sig < α = 0.05 [p = 0.031]) (**Table 6**). This issue seems to raise the old idea that behavior will do little to positively affect the environment.

Table 6. The possibility of preventing health from being affected by CC.

		1 Smaller possibility	2	3	4	5 Greater possibility	Total
Possibility of preventing individual health from being affected	Freq	18	19	73	53	37	200
	%	9.0%	9.5%	36.5%	26.5%	18.5%	100.0%

They believed that actions such as trash separation (21.5%), conscientious and sustainable consumption (12.5%), avoiding pollution (7.5%), the use of plastics (7.5%), nutritional care (6%), and reconsidering transportation modes were effective strategies to protect one's health (6%). When asked how they could protect public health, environmental awareness and information stood out. The content analysis reveals references to 'more social duty', 'proper environmental liability measures', 'increased citizenship and awareness', and 'education for citizenship put high on the agenda'. This research also reveals conscious political participation: "voting for the party that provides better government action for environmental preservation". Once again, the lack of public health awareness limits this to politics.

Regarding the environmentally responsible behavior of the sample, more than half of the respondents (50.2%) said that they always had the habit of separating waste. Of those who do it never, rarely, or only sometimes, only 4.5% justify it by i) the recycling point is "too far away" or ii) they believe that "after being collected, the rubbish is deposited all at the same place." It was statistically confirmed that the respondents who performed the most waste separation were those who most often thought about the environmental impacts of their actions (Kruskal-Wallis test with Sig < α = 0.05 [p = 0.00]). Individuals who were aware of the Cascais 2030 Action Plan for Adaptation to Climate Change carried out waste separation more frequently (Mann-Whitney test with Sig < α = 0.05 [p = 0.008]).

Only 12.5% of the respondents say that they are always concerned about buying/consuming local products, but 40.8% say that they do it 'often.' Compared to men, women were more concerned about the purchase of local products (Mann-Whitney test with Sig < α = 0.05 [p = 0.046]). The 60–65 age group was most concerned with buying local products (Kruskal-Wallis test with Sig < α = 0.05 [p = 0.021]), as were the individuals who most think about the impact of their actions (Kruskal-Wallis test with Sig < α = 0.05 [p = 0.001]) and people who know the Cascais 2030 Action Plan for Adaptation to Climate Change (Mann-Whitney test with Sig > α = 0.05 [p = 0.003]).

The majority (50.5%) always took their bags with them when they went shopping and did not buy plastic bags, a behavior that was more frequent among women (Mann-Whitney test with Sig < α = 0.05 [p = 0.021]) (again corroborating the literature) and the most educated groups (Kruskal-Wallis test with Sig < α = 0.05 [p = 0.015]). The majority (68.5%) preferred that when they buy a drink and are offered a straw, they do not use it, especially women (Chi-square test with Sig < α = 0.05) and the most

educated (Kruskal-Wallis test with Sig < α = 0.05 [p = 0.028]). A few (3.5%) never bought vegetables or fruits packed in plastic. 44.3% said that they 'always' drink public water, with a higher frequency among the most educated (Kruskal-Wallis test with Sig < α = 0.05 [p = 0.017]).

Most (77.1%) traveled in a gasoline-powered vehicle daily but wanted to improve their mobility patterns (68.7%). They defend their desire to protect the environment but are also concerned about their health and financial consequences. In contrast, 31.3% of those who did not wish to modify their mobility habits believed that they required their automobiles daily and had no other option.

3.6. Environmental responsibilities

Health is present in all aspects of life in modern society, necessitating a duty that includes all individuals in addition to political and private players [57]. According to respondents' perceptions, international policymakers are responsible for managing CC issues, followed by national policymakers and the corporate sector. Local officials and residents do not have the same level of authority. However, most (91%) believed that playing an active role in environmental policy choices was critical (**Table 7**).

Table 7. Level of responsibility in the management of CC.

	1 No Responsibility	**2 Low Responsibility**	**3 Moderate Responsibility**	**4 Much Responsibility**	**5 Extreme Responsibility**	**Total**
Me and Every Citizen	0	14	39	58	89	200
	0	7	19.5	29.0	44.5	100
International Policy Makers	0	10	26	34	130	200
	0	5.0	13.0	17.0	65.0	100
National Policy Makers	0	9	28	37	126	200
	0	4.5	14.0	18.5	63.0	100
Local Policy Makers	1	8	29	42	120	200
	0.5	4.0	14.5	21.0	60.0	100
Business Sector	5	9	24	42	120	200
	2.5	4.5	12.0	21.0	60.0	100

The respondents wanted to improve the distribution of existing initiatives and reinforce awareness-raising methods. Given the lack of understanding regarding these measurements, this approach is logical.

4. Discussion

This study examined views, habits, and understanding of CC and its implications for health in the adult population. These findings enabled the identification of trends and profiles relevant to local environmental policies, particularly at the urban level. This study fits within the period of health governance, thus increasing people's accountability. This obligation extends beyond measures related to health management and includes efforts to improve public health. These results refer to intergenerational justice and people's participation in environmental policies.

We began this study by assuming that prior research has demonstrated that, in the public view, events affecting ecosystems and human health are more connected with CC than social phenomena [58]. Individual involvement, action planning, and behavior were also considered to explain why they integrated differently with the same group, space, and place [59].

Both men and women perceived CC as a significant health hazard. However, awareness and concern varied across demographics. Women provided more incorrect responses than men, which is consistent with the findings of Polonsky et al. [60] and Diamantopoulos et al. [61], who found that women generally had less environmental knowledge. These findings also open the discussion on the relevance of gendered differences in environmental knowledge, which has been identified in the literature as significant to the design of targeted environmental education. However, our findings suggest that female respondents are more environmentally conscious. Women are more likely to consider paying more attention to i) buying local, ii) practicing regular garbage separation, and iii) regularly taking their bags when they go shopping. This could be explained by the fact that women spend significantly more time at home than men do. Another element used to explain this behavior is age.

The results also highlight the exploration of the concept of age-related patterns in environmental responsibility. According to the questions analyzed, there was a more significant concern among the older age groups for having environmentally responsible behaviors, as evidenced by i) having a more significant concern for purchasing local products, ii) more frequent waste separation, and iii) a more significant concern for carrying their bags when shopping. This may reflect lifestyle differences and raises important questions about intergenerational responsibility. As younger age groups have grown up hearing about environmental issues, more environmentally responsible behavior by young people could be expected. At this point, we may look at the issue via the intergenerational justice lens, which invites us not to think on a generationally selfish and narcissistic scale but instead to aim for attitudes and actions that are not limited to our life cycle [62]. Younger and older age groups differ in their perceptions of its severity and urgency [63]. Despite growing awareness of CC, these findings also open the discussion on the relevance of misperceptions and knowledge gaps about CC across age groups, a recurring theme in risk communication literature, affecting how individuals interpret its risks and impacts [64].

We can also explore the influence of education on both knowledge and environmentally conscious practices. Less-educated respondents demonstrated less accurate knowledge of CC. This aligns with Furlow and Knott [65]. Polonsky et al. [60] consider that the level of education may be a key element in gaining more environmental knowledge and information. Better-educated respondents were also more likely to adopt environmentally conscious behaviors, including drinking tap water and avoiding plastic packaging, confirming findings from previous literature [60,61]. These findings highlight the need for more investment in programs and research that encourage scientific development, improved adaptation, and more measures to influence behaviors that reduce the effects of CC [24]. The lack of information about local initiatives and their poor participation is consistent with the notion that they have a moderate chance of avoiding the health effects of CC through

their actions. This implies that the communication strategy must be changed because it does not reach all the interested parties [59].

Health was one of the most strongly perceived dimensions of CC, highlighting gaps in public understanding and underlining the importance of integrating health literacy into climate communication strategies. Regarding health impacts, respondents associated CC mainly with respiratory diseases, which is consistent with previous research [24]. Studies of this type have discovered allusions to chronic diseases that address the long-term health impacts of environmental risks and rising prevalence of health problems [29]. The majority considered CC to pose an extreme public health risk. These results are similar to those of the study by Lázaro et al. [58] but reveal the difficulty in understanding that the diseases mentioned are public health problems.

Exploring mobility patterns and their environmental implications in an urban setting, it is essential to highlight less environmentally friendly behaviors such as transportation patterns. Most respondents used gasoline-powered vehicles daily, though many expressed a desire to change their mobility habits. However, a notable subset did not intend to abandon car use, citing lack of alternatives. Our findings support the study by Seixas et al. [66], conducted in the same territorial unit, which identified a small group interested in soft mobility methods for daily commuting. The emphasis on pollution prevention is also consistent with research such as Eyles et al. [29], which highlights the role of health in shaping public perceptions.

The study underlines a gap between the perceived responsibility of institutions and the role of individuals in environmental governance. This refers to the discussion on the perception of shared responsibility. Health is present in all aspects of life in modern society, necessitating a duty that includes all individuals in addition to political and private players [57]. According to respondents, international policymakers were perceived as having the most responsibility for CC, followed by national institutions. However, 91% believed that citizens should also play an active role in environmental decision-making.

Educated individuals were more likely to engage in environmentally conscious behaviors such as waste separation or avoiding plastic straws. However, many respondents expressed limited knowledge of local initiatives and felt they had little capacity to prevent CC-related health risks. This highlights potential shortcomings in existing communication strategies, which may not be effectively reaching all stakeholders [59]. Awareness-raising was consistently identified by respondents as a key priority. According to Rodrigues et al. [59], such measures are essential tools for environmental governance and can significantly support both adaptation and mitigation efforts. Given the persistent lack of public understanding and low levels of participation, public education remains a central strategy for promoting behavioral change and protecting health against the impacts of climate change [3].

Adaptive governance, an emerging management approach to complex environmental concerns, frames people's participation. When the knowledge is contextual and partial, it is considered functional. This policy requires small stages and top-down and bottom-up decision-making. Participation by local stakeholders in adaptation policies could help overcome barriers to policy implementation, making local actions more effective and sustainable. Aligning these efforts with SDG is essential, emphasizing urban resilience and climate-adaptive infrastructure, and

calling for health equity and awareness of long-term environmental threats. As local stakeholders, opinions on CC and its consequences can affect adaptation policies and strategies, helping them overcome obstacles to implementation. These policies are prioritized on the agenda due to their alignment with SDG 8, which emphasizes the responsible management of natural resources, as well as the broad economic, social, and demographic implications of CC.

Future research should examine environmental perceptions and practices in the context of socioeconomic inequality, particularly in impoverished areas, with a focus on health disparities. Furthermore, low-income populations are more likely to reside in poorly designed and under-resourced metropolitan areas, live near pollution sources, and be less able to pay for protection from or recover from climate-related disasters [12]. Addressing these inequalities through targeted policies can help promote inclusive and resilient urban environments, creating a pathway toward sustainable development that prioritizes the health and well-being of all citizens. This research has contextual and methodological limitations. It was conducted during the COVID-19 pandemic, which may have affected participation levels and response patterns. It is also possible that individuals more sensitized to environmental issues were overrepresented. Furthermore, interpretation is constrained by the limited availability of national literature and the underdevelopment of key concepts such as environmental communication, health literacy, and environmental literacy in the Portuguese context. Further research is needed to strengthen these areas and support the design of more effective public policies.

5. Conclusion

This study contributes to the understanding of how adult populations in urban Portugal perceive CC and its health implications. The results reveal high levels of general awareness but also identify critical gaps in environmental knowledge, public health literacy, and participation in local initiatives, particularly regarding the understanding of adaptation concepts and measures.

The findings emphasize the role of education in shaping climate knowledge and behaviors and underline the need for more inclusive and targeted communication strategies to support behavioral change and foster public engagement. Although women and older adults reported more sustainable practices, knowledge gaps remain. Participants widely recognized CC as a health risk and expressed openness to civic action, though low levels of local engagement reinforce the importance of promoting public participation and climate literacy in adaptation efforts. This study also highlights important demographic patterns in climate risk perception and proposes a replicable methodology suitable for cross-municipality comparisons. Applying this framework in other urban contexts can help policymakers develop regionally adapted climate strategies, improving both environmental governance and public health resilience. Such comparative analyses may inform broader governance approaches and strengthen the integration of climate adaptation with health planning.

Further research should explore how social and territorial inequalities shape climate-related behaviors and perceptions. Understanding these dynamics is key to fostering inclusive environmental governance and designing locally grounded

responses that align with the Sustainable Development Goals. Strengthening local policy through citizen participation and inter-municipal collaboration will be essential for building resilient and health-promoting urban environments.

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References

1. Clegg L. Party Politics and the Effectiveness of Local Climate Change Policy Frameworks: Green Influence from the Sidelines. Local Government Studies. 2023; 50(3): 643–62. doi: 10.1080/03003930.2023.2292662
2. IPCC. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC; 2014.
3. Hathaway J, Maibach EW. Health Implications of Climate Change: a Review of the Literature About the Perception of the Public and Health Professionals. Current Environmental Health Reports. 2018; 5: 197–204. doi: 10.1007/s40572-018-0190-3
4. Newman WE. 2024. Climate Changes. Technology|Architecture + Design. 2024; 8(1): 1. doi: 10.1080/24751448.2024.2308497
5. Guo Q, Mistry MN, Zhou X, et al. Regional variation in the role of humidity on city-level heat-related mortality. PNAS nexus. 2024; 3(8): 290. doi: 10.1093/pnasnexus/pgae290
6. Ivanovich CC, Sobel AH, Horton RM, Colin R. Stickiness: A New Variable to Characterize the Temperature and Humidity Contributions toward Extreme Humid Heat. Journal of the Atmospheric Sciences. 2023; 81(5): 819–837. doi: 10.1175/JAS-D-23-0072.
7. Lo E, Vicedo-Cabrera AM, Mitchell D, et al. Is heat stress more indicative of summer mortality than temperature alone?. EGU General Assembly 2022; 2022.
8. Watts N, Amann M, Arnell N, et al. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. The Lancet. 2019; 394(10211): 1836-1878. doi: 10.1016/S0140-6736(19)32596-6
9. APA. 8th National Communication to the United Nations Framework Convention on Climate Change. Portuguese Environment Agency; 2022.
10. Korançe F. The Growing Relation between Environment and Public Health. SciMedicine Journal. 2021; 3(2): 100-115. doi: 10.28991/SCIMEDJ-2021-0302-3
11. Rani P. A Multidimensional Exploration of the Interplay between Human Health and Environmental Factors. Shodh Sari. 2024; 3(3): 225-237. doi: 10.59231/sari7730
12. Mendez MA. Assessing local climate action plans for public health co-benefits in environmental justice communities. Local Environment. 2015; 20(6): 637-663. doi: 10.1080/13549839.2015.1038227
13. Watts N, Adger WN, Agnolucci P, et al. Health and climate change: policy responses to protect public health. The Lancet. 2015; 386(10006): 1861–1914. doi: 10.1016/s0140-6736(15)60854-6
14. Siegfried GA. Environmental and Climate Justice. In: Elgar Encyclopedia of Climate Policy. Elgar online; 2024.
15. Gallagher CL, Holloway T. Integrating Air Quality and Public Health Benefits in U.S. Decarbonization Strategies. Frontiers in Public Health. 2020; 8. doi: 10.3389/FPUBH.2020.563358
16. Kyrychenko O. Health Benefits of Air Pollution Reduction: Evidence From Economic Slowdown in India. Economics and Human Biology. 2024; 55: 101437-101437. doi: 10.1016/j.ehb.2024.101437
17. Rauner S, Hilaire J, Klein D, et al. Air quality co-benefits of ratcheting up the NDCs. Climatic Change. 2020; 163(3): 1481-

1500. doi: 10.1007/s10584-020-02699-1
18. Omeye FI. The Impact of Climate Change on Public Health. Newport International Journal of Research in Medical Sciences. 2024; 5(3): 34-37. doi: 10.59298/nijrms/2024/5.3.3437
19. HEI. State of Global Air 2020. Health Effects Institute; 2020.
20. Luber G, Knowlton K, Balbus J, et al. Ch. 9: Human Health. Climate change impacts in the United States: The Third National Climate Assessment. Environmental Science; 2014.
21. WHO. State of World Sanitation: An urgent call to transform sanitation for better health, environments, economy, and society. World Health Organization; 2020
22. Suryasa IW, Rodríguez-Gámez M, Koldoris T, et al. Climate change and its impact on health. International journal of health sciences. 2024; 8(2): vi-x. doi: 10.53730/ijhs.v8n2.15065
23. Hoegh-Guldberg O, Jacob D, Taylor M, et al. Impacts of 1.5 ℃ Global Warming on Natural and Human Systems. In: Masson-Delmotte V, Zhai P, Pörtner HO, et al. (editors). Global Warming of 1.5 ℃. IPCC; 2018.
24. Pereira J, Pecoraro L, Neto H, et al. Impact of Climate Change on Public Health: Integrative Review (Portuguese). Electronic Journal Collection Health. 2020; 12(11): e4720. doi: 10.25248/reas.e4720.2020
25. Arszulowicz M. Sustainable Development. In: Governance Strategies for Effective Sustainable Development. IGI Global; 2024.
26. Beck U. World Risk Society - In Search of Lost Security (Portuguese). Coimbra: Editores 70; 2015.
27. Lujala P, Lein H, Rød JK. Climate change, natural hazards, and risk perception: the role of proximity and personal experience. Local Environment. 2014; 20(4): 489-509. doi: 10.1080/13549839.2014.887666
28. Niemeyer S, Petts J, Hobson K. Rapid Climate Change and Society: Assessing Responses and Thresholds. Risk Analysis. 2005; 25(6): 1443–1456. doi: 10.1111/j.1539-6924.2005.00691.x
29. Eyles J, Wilson K, Mu L, et al. What people think about the environment and its relationship to their health: perceptions of health at different scales of the environment in Hamilton, Ontario. Local Environment. 2009; 14(10): 981–998. doi: 10.1080/13549830903277409
30. Slovic P. The Perception of Risk. In: Sternberg RJ, Fiske ST, Foss DJ, eds. Scientists Making a Difference: One Hundred Eminent Behavioral and Brain Scientists Talk about Their Most Important Contributions. Cambridge University Press; 2016:179-182. doi10.1017/CBO9781316422250.040
31. Delicado A, Gonçalves ME. The Portuguese and the new risks: results of a survey (Portuguese). Social Analysis. 2007; 42(184): 687-71. doi: 10.31447/AS00032573.2007184.01
32. Ebi KL, Semenza JC. Community-based adaptation to the health impacts of climate change. American Journal of Preventive Medicine. 2008; 35(5): 501-507. doi: 10.1016/j.amepre.2008.08.018
33. Lucas CH. Climate friction: How climate change communication produces resistance to concern. Geographical Research. 2021; 60(3): 371-382. doi: 10.1111/1745-5871.12514
34. O'Neill S, Nicholson-Cole S. Fear Won't Do It" Promoting Positive Engagement With Climate Change Through Visual and Iconic Representations. Science Communication. 2009; 30(3): 355-379. doi: 10.1177/1075547008329201
35. Maibach EW, Nisbet M, Baldwin P, et al. Reframing climate change as a public health issue: an exploratory study of public reactions. BMC Public Health. 2010; 10(299). doi: 10.1186/1471-2458-10-299
36. Menatti L, Bich L, Saborido C. Health and environment from adaptation to adaptivity: a situated relational account. History and Philosophy of The Life Sciences. 2022; 44(3). doi: 10.1007/s40656-022-00515-w
37. Anguelovski I, Eric C, Carmin J. Variations in approaches to urban climate adaptation: Experiences and experimentation from the global South. Global Environmental Change. 2014; 27: 156–167. doi: 10.1016/j.gloenvcha.2014.05.010
38. Ramalho M, Ferreira JC, Santos CJ. Climate Change Adaptation Strategies at a Local Scale: The Portuguese Case Study. International Journal of Environmental Research and Public Health. 2022; 19(24): 16687. doi: 10.3390/ijerph192416687
39. Molina T, Abadal E. Enhancing Strategies and Actions to Elevate Public Awareness and Optimize Decision-Making. EMS Annual Meeting; 2024.
40. Huijts NMA, Molin EJE, Steg L. Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. Renewable and sustainable energy reviews. 2012; 16(1): 525-531. doi: 10.1016/j.rser.2011.08.018
41. Hallegatte S, Rentschler J, Rozenberg J. Lifelines: The Resilient Infrastructure Opportunity. Sustainable Infrastructure, World Bank; 2019.

42. Hallegatte S, Maruyama Rentschler JE, Walsh BJ. Building back better: Achieving resilience through stronger, faster, and more inclusive post-disaster reconstruction. World Bank; 2018.
43. Bulkeley H, Betsill M. Rethinking sustainable cities: Multilevel governance and the "urban" politics of climate change". Environmental Politics. 2005; 14(1): 42-63. doi: 10.1080/0964401042000310178
44. Farr D. Sustainable urbanism: Urban design with nature. John Wiley and Sons; 2008.
45. WHO. Raising awareness on climate change and health. World Health Organization; 2023.
46. Schmidt L, Delicado A. Environment, Climate Change, Food and Energy: The Opinion of the Portuguese in a European Context (Portuguese). Lisbon: Social Sciences Press; 2013.
47. Altschuler B, Brownlee M. Perceptions of climate change on the Island of Providencia. Local Environment. 2015; 21(5): 615-635. doi: 10.1080/13549839.2015.1004165
48. Perlaviciute G, Steg L. Contextual and psychological factors shaping evaluations and acceptability of energy alternatives: Integrated review and research agenda. Renewable and Sustainable Energy Reviews. 2014; 35: 361-381. doi: 10.1016/j.rser.2014.04.003
49. Kloprogge P, Van Der Sluijs JP. The inclusion of stakeholder knowledge and perspectives in the integrated assessment of climate change. Climatic Change. 2006; 75(3): 359–389. doi: 10.1007/s10584-006-0362-2
50. Hansen A, Bi P. Climate Change Adaptation: no one Size Fits All. The Lancet Planetary Health. 2017; 1(9): 353-354. doi: 10.1016/S2542-5196(17)30160-2
51. Galway LP. Perceptions of climate change in Thunder Bay, Ontario: towards a place-based understanding. Local Environment. 2019; 24(1): 68-88. doi: 10.1080/13549839.2018.1550743
52. Perry J. Climate change adaptation in the world's best places: A wicked problem in need of immediate attention. Landscape and Urban Planning. 2015; 133: 1–11. doi: 10.1016/j.landurbplan.2014.08.013
53. Taylor AL, Dessai S, Bruine de Bruin W. Public perception of climate risk and adaptation in the UK: A review of the literature. Climate Risk Management. 2014; 4-5: 1-16. doi: 10.1016/j.crm.2014.09.001
54. Schmidt L, Alves AF, Guerra J, Mourato J. Social perceptions and local strategies for adapting to climate change: the experience of the ClimAdaPT.Local project (Portuguese). In: Proceedings of the International Conference on the Environment in Portuguese (CIALP 2018); 2018.
55. Lebel L, Anderies JM, Campbell B, et al. Governance and capacity to manage resilience in regional social-ecological systems. Ecology and Society. 2006; 11(1): 19. doi: 10.5751/es-01606-110119
56. Santos FD. Climate change (Portuguese). Lisbon: Francisco Manuel dos Santos Foundation; 2021.
57. Kickbusch I, McQueen DV. Health governance: The health society. In: McQueen DV, Kickbusch I, Potvin L, et al. (editors). Health and modernity: The role of theory in health promotion. Springer; 2006.
58. Lázaro A, Cabecinhas R, Carvalho A. Perceptions of risk and responsibility in the face of climate change (Portuguese). University of Aveiro Center for Communication and Society Studies; 2007.
59. Rodrigues ML, Malheiros T, Fernandes V, Darós T. "Environmental Perception as a Support Tool for the Management and Formulation of Environmental Public Policies (Portuguese)." Health & Society. 2012; 21(3): 96-110. doi: 10.1590/S0104-12902012000700009
60. Polonsky MJ, Garma R, Grau SL. Western consumers' an understanding of carbon offsets and their relationship to behavior. Asia pacific journal of Marketing and Logistics. 2011; 23(5): 583-603. doi: 10.1108/13555851111183048
61. Diamantopoulos A, Schlegelmilch BB, Sinkovics RR, Bohlen GM. Can sociodemographics still play a role in profiling green consumers? A review of the evidence and empirical investigation. Journal of Business Research. 2003; 56(6): 465–480. doi: 10.1016/S0148-2963(01)00241-7
62. Schmidt L, Trüninger M, Guerra J, Prista P. First Major Sustainability Survey: Final Report (Portuguese). Lisbon: Observa; 2016.
63. Whitmarsh L, Mitev K. Public perceptions of climate change and their variation across audiences. In: The Routledge Handbook of Environment and Communication, 2nd ed. Routledge; 2022.
64. Petrescu-Mag RM, Burny P, Banatean-Dunea I, Petrescu DC. How Climate Change Science Is Reflected in People's Minds. A Cross-Country Study on People's Perceptions of Climate Change. International Journal of Environmental Research and Public Health. 2022; 19(7): 4280-4280. doi: 10.3390/ijerph19074280
65. Furlow NE, Knott C. Who is reading the label? Millennials' the use of environmental product labels. The Journal of Applied Business and Economics. 2009; 10(3): 1-12.

66. Seixas PC, Baptista L, Dias RC. Territorial sociometrics of citizen participation: Kernel maps as a tool to support municipal strategic planning (Portuguese). Urbe Brazilian Journal of Urban Management. 2020; 12. doi: 10.1590/2175-3369.012.e20190249