



(RESEARCH ARTICLE)



## Understanding the impact of climate change on human health: A cross-sectional study in Danao City, Cebu, Philippines

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### Abstract

This cross-sectional study in Danao City investigated the impact of climate change on human health, emphasizing the urgent need to address the health risks associated with rising temperatures and shifting weather patterns. The research aimed to establish a local understanding of how climate-related factors influence human health outcomes in the city. Findings revealed a high level of awareness among residents regarding the health risks linked to climate change, highlighting the importance of proactive measures to mitigate adverse effects. Recommendations include community education and awareness programs, climate resilience planning, healthcare capacity building, and ongoing research and monitoring efforts. By following these recommendations, Danao City can enhance its resilience to climate-related health challenges and protect the well-being of its population. This study contributes valuable insights to the intersection of climate change and human health at the local level, emphasizing the importance of specific actions to address health risks in vulnerable areas like Danao City. These actions are essential for building a healthier and more resilient community in the face of climate change impacts.

**Keywords:** Climate change; Human health; Awareness; Resilience

### 1. Introduction

Rising temperatures and shifting weather patterns, hallmarks of climate change, significantly impact human health. Climate change refers to long-term alterations in temperatures and weather patterns, leading to changes in local, regional, and global climates. It has been identified as a major factor affecting human health, with heat exposure reducing work capacity and causing various health problems (Vicedo-Cabrera et al.) [21]. The urgency of addressing these issues is underscored by the burden of heat-related mortality attributed to recent human-induced climate change.

The United Nations describes climate change as a transformation in average conditions, including temperature and rainfall, over an extended period in a specific region. This differs from weather, which pertains to short-term atmospheric conditions observed at a particular moment (NASA Kids Climate) [14]. Climate change poses significant challenges to human health worldwide, affecting air quality, water resources, food security, and mental well-being (World Health Organization) [23].

The Philippines, identified as one of the most vulnerable nations to climate change, faces significant health challenges exacerbated by climate-related factors (Cruz et al.) [8]. Low- and middle-income countries like the Philippines bear a disproportionate burden of adverse health effects from climate change, with heightened vulnerability among women, children, ethnic minorities, poor communities, migrants, older populations, and those with underlying health conditions. Extreme weather events such as typhoons, floods, and droughts have increased in frequency and intensity, resulting in widespread displacement, injury, loss of life, and heightened health risks (Asian Development Bank) [3].

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Additionally, rising temperatures and changing rainfall patterns affect water and food security, vector-borne diseases, and heat-related illnesses, further exacerbating health problems (Asian Development Bank) [3].

Danao City in Cebu, Philippines, exemplifies these broader patterns. Positioned in a coastal zone, it is vulnerable to sea-level rise and coastal flooding, posing risks to public health infrastructure and sanitation systems. Its reliance on agriculture exposes the population to food insecurity amid changing weather conditions. Despite these vulnerabilities, there is limited empirical research on the specific health effects of climate change in Danao City. Conducting local studies in Danao City is crucial to gain an in-depth understanding of the specific health challenges linked to climate change in this vulnerable area. Local data is essential for identifying the unique health risks faced by the population and tailoring interventions to effectively address them.

To address this information gap and provide valuable insights into the intersection of climate change and human health at the local level, this study aims to investigate the specific health consequences brought about by climate change in Danao City. This cross-sectional study seeks to establish a local understanding of the effects of climate-related factors on human health outcomes in Danao City.

## 2. Materials and Methods

A quantitative cross-sectional study was conducted to examine the impact of climate change on human health in Danao City. Data collection involved selecting 385 respondents from the city's population using the Krejcie and Morgan method. Surveys were administered online via Google Forms, with the questionnaire structured based on QuestionPro [4] guidelines. The survey covered demographic profiles, perceptions of climate change impacts on health and safety, awareness of health risks associated with climate change, awareness of climate change policies, and agreement on global warming/climate change issues. The survey relied on descriptive statistics like frequency tables and percentages to understand the prevalence of various perceptions and awareness levels among residents. Data analysis utilized the weighted mean average method to compute scores for survey responses. This method involved multiplying the frequency of each rating by its corresponding numerical value, summing these products, and dividing by the total number of respondents. The study aimed to investigate the specific health consequences of climate change in Danao City, aiming to establish a local understanding of the impact between climate-related factors and human health outcomes in the area.

### 2.1. Scoring Procedure

**Table 1** Scoring Procedure for Resident Perception of Health and Safety Threats and Air Quality

Category	Value	Range	Description
Very Likely	5	5.00-4.21	Residents affirmed a strong perception that climate change constitutes a significant threat to their personal health and safety, and/or believe it has a considerable impact on air quality in their area.
Somewhat Likely	4	4.20-3.41	Residents affirmed a moderate perception that climate change poses a potential threat to their health and safety and/or air quality, although not to an extreme extent.
Neutral	3	3.40-2.61	Residents affirmed a neutral perception regarding the impact of climate change on health, safety, and air quality.
Somewhat Unlikely	2	2.60-1.81	Residents affirmed a moderate perception that climate change is unlikely to significantly threaten their health, safety, and air quality.
Very Unlikely	1	1.80-1.00	Residents affirmed a strong perception that climate change is highly unlikely to pose a threat to their health and safety or air quality.

**Table 2** Scoring Procedure for Resident Awareness of Health Risks Associated with Climate Change

Category	Value	Range	Description
Always	5	5.00-4.21	Residents always demonstrate a high level of awareness and understanding of health risks associated with climate change.
Often	4	4.20-3.41	Residents often demonstrate a high level of awareness and understanding of health risks associated with climate change.
Sometimes	3	3.40-2.61	Residents sometimes demonstrate a high level of awareness and understanding of health risks associated with climate change.
Rarely	2	2.60-1.81	Residents rarely demonstrate a high level of awareness and understanding of health risks associated with climate change.
Never	1	1.80-1.00	Residents never demonstrate a high level of awareness and understanding of health risks associated with climate change.

**Table 3** Scoring Procedure for Resident Awareness of Climate Change Policies in Danao City

Category	Value	Range	Description
Completely Aware	5	5.00-4.21	Residents affirmed complete awareness of Danao City's climate change policies, covering global and national initiatives.
Slightly Aware	4	4.20-3.41	Residents affirmed partial awareness of Danao City's climate change policies, with some understanding of global and national initiatives.
Neutral	3	3.40-2.61	Residents affirmed neutral awareness of Danao City's climate change policies, with moderate knowledge of global and national initiatives.
Slightly Not Aware	2	2.60-1.81	Residents affirmed limited awareness of Danao City's climate change policies, with slight understanding of global and national initiatives.
Completely Not Aware	1	1.80-1.00	Residents affirmed complete lack of awareness of Danao City's climate change policies, lacking knowledge of global and national initiatives.

**Table 4** Scoring Procedure for Resident Agreement on Global Warming/Climate Change

Category	Value	Range	Description
Completely Agree	5	5.00-4.21	Residents affirmed complete agreement with global warming/climate change, its causes, and the need for action.
Somewhat Agree	4	4.20-3.41	Residents affirmed somewhat agreement with global warming/climate change, its causes, and the need for action.
Neutral	3	3.40-2.61	Residents affirmed neutral agreement with global warming/climate change, its causes, and the need for action.
Somewhat Disagree	2	2.60-1.81	Residents affirmed somewhat disagreement with global warming/climate change, its causes, and the need for action.
Completely Disagree	1	1.80-1.00	Residents affirmed complete disagreement with global warming/climate change, its causes, and the need for action.

### 3. Results and Discussions

#### 3.1. Resident's Profile

**Table 5** Resident's demographic profile

Age Range	Male		Female	
	frequency	percentage	frequency	percentage
15-below	0	0%	1	0.26%
16-25	113	29.35%	192	49.87%
26-35	29	7.53%	37	9.61%
36-45	8	2.08%	1	0.26%
46 above	3	0.78%	1	0.26%
Total	153	39.74%	232	60.26%
Highest Educational Attainment	Male		Female	
	frequency	percentage	frequency	Percentage
Middle School Level	1	0.26%	0	0%
High School Level	53	13.77%	62	16.10%
College Level	81	21.04%	145	37.66%
Graduate	20	5.19%	23	5.97%
Total	155	40.26%	230	59.74%

The table presents the demographic profile of the residents surveyed in the study, showcasing the distribution of respondents by gender across different age ranges and educational attainment levels. Among the 385 total respondents, 153 were male (39.74%), while 232 were female (60.26%). In terms of age distribution, for range 15 and below there is 1 respondent which is female (0.26%) and 0 respondent for the male (0.26%), 112 respondents fell within the 16-25 age range, with 113 males (29.35%) and 192 females (49.87%). For the 26-35 age range, there were 29 males (7.53%) and 37 females (9.61%). In the 36-45 age range, 8 males (2.08%) and 1 female (0.26%) were represented. Additionally, in the 46 and above age range, 3 males (0.78%) and 1 female (0.26%) were included in the survey. Regarding educational attainment, the data showed that among those with a middle school level education, there was 1 male (0.26%) and 0 females (0%). For respondents with a high school level education, there were 53 males (13.77%) and 62 females (16.10%). In the college-level education category, there were 81 males (21.04%) and 145 females (37.66%). Lastly, in the graduate-level education group, there were 20 males (5.19%) and 23 females (5.97%).

The majority of respondents are young adults aged 16-25, with a significant female representation. The data indicates that the younger population, particularly females, are more engaged in the in the impact of climate change potentially reflecting higher awareness or concern about climate change among this group. This is supported by recently published research by Clayton, et al. [7] wherein there was a significant representation of young adults aged 16-25 in ten countries around the world expressed concern about climate change. Furthermore, the educational attainment levels suggest a well-educated respondent base, with a substantial portion having college level education, which may influence their understanding and awareness of climate change issues. This is supported by the research findings of Welsch [22] which indicates that higher levels of education are associated with a stronger identity-dependence of climate change cognitions.

### 3.2. Perception of health and safety threats and air quality

**Table 6** The weighted mean of the perception of health and safety threats and air quality

Statements	Weighted Mean	Description
Threat of personal health and safety	4.74	Residents affirmed a strong understanding that climate change constitutes a significant threat to their personal health and safety, and/or believe it has a considerable impact on air quality in their area.
Air quality in the area	3.70	Residents affirmed a moderate understanding that climate change constitutes a significant threat to their personal health and safety, and/or believe it has a considerable impact on air quality in their area.

The table presents residents' perceptions of health and safety threats and air quality. The data shows that residents affirmed a strong perception that climate change constitutes a significant threat to their personal health and safety, with a weighted mean of 4.74. Additionally, residents acknowledged a moderate perception that climate change poses a potential threat to their health and safety and/or air quality, with a weighted mean of 3.70. Climate change is inseparably linked to human health (Baal, et.al) [20]. Compared to the study from Sydney, Australia, our findings show a particularly high awareness and concern about personal health impacts. In Sydney, concerns about air quality varied significantly before and after events like the 2019/2020 bushfires and COVID-19 lockdowns, highlighting regional differences in perceptions based on direct experiences with climate impacts (Rj et. al) [17].

### 3.3. Resident awareness of health risks associated with climate change

**Table 7** The weighted mean of the residents' awareness of health risks associated with climate change

Statement	Weighted Mean	Description
Personal experience during heat events	3.99	Residents often affirmed demonstrating a high level of recognition and understanding of health risks associated with climate change.
Respiratory problems linked to air pollution	4.25	Residents always affirmed demonstrating a high level of recognition and understanding of health risks associated with climate change.
Potential increase of waterborne diseases	4.20	Residents always affirmed demonstrating a high level of recognition and understanding of health risks associated with climate change.
Climate change's impact on disease spread by mosquitoes and other insects	4.12	Residents often affirmed demonstrating a high level of recognition and understanding of health risks associated with climate change.

The table shows residents' awareness of health risks associated with climate change. The data indicates that residents often affirmed demonstrating a high level of awareness and understanding of health risks associated with climate change. They showed understanding of personal experiences during heat events, with a weighted mean of 3.99, and respiratory problems linked to air pollution, with a weighted mean of 4.25. Takaro et. al [19] and Madrigano et. al [12] both highlight the significant impact of climate change on respiratory health. Mirabelli et al. [13] and Akerlof et. al [2] further explore the relationship between health conditions and awareness of air quality alerts, with Mirabelli et al. [13] finding that existing respiratory disease is associated with increased awareness. Compared to a study in Canada, our findings show a different pattern. In Canada, while there is substantial concern about health impacts of climate change, the level of awareness and specific concerns vary significantly across demographics and regions, with general concern about air quality, temperature-related morbidity, and infectious diseases being high (Casson et. al) [5]. This suggests that while both populations were aware of health risks, the specific concerns and levels of awareness differ, likely influenced by regional experiences and climate-related events.

### 3.4. Residents awareness regarding climate change policies

**Table 8** The weighted mean of the residents' awareness regarding climate change policies

Statement	Weighted Mean	Description
Global policies or initiatives aimed at reducing climate change	4.18	Residents often affirmed demonstrating a high level of recognition and understanding of health risks associated with climate change.
Environmental policies implemented	4.26	Residents always affirmed demonstrating a high level of recognition and understanding of health risks associated with climate change.

The table shows residents' awareness regarding climate change policies. The data indicates that residents often demonstrated a high level of awareness and understanding of global policies or initiatives aimed at reducing climate change Lenzholzer, et. al [11] with a weighted mean of 4.18. They also showed awareness of environmental policies implemented to address climate change, with a weighted mean of 4.26.

Residents show a high level of awareness of both global climate change policies and local environmental policies. Compared to a study conducted by European Commission in Europe, our findings show a similar pattern. In Europe, there is significant awareness of climate change initiatives and local policies, indicating effective information dissemination and public engagement (European Commission) [16]. This suggests that while both populations are well-informed about climate change policies, our residents exhibit slightly higher awareness levels, possibly due to more targeted communication strategies.

### 3.5. Resident agreement on global warming/climate change

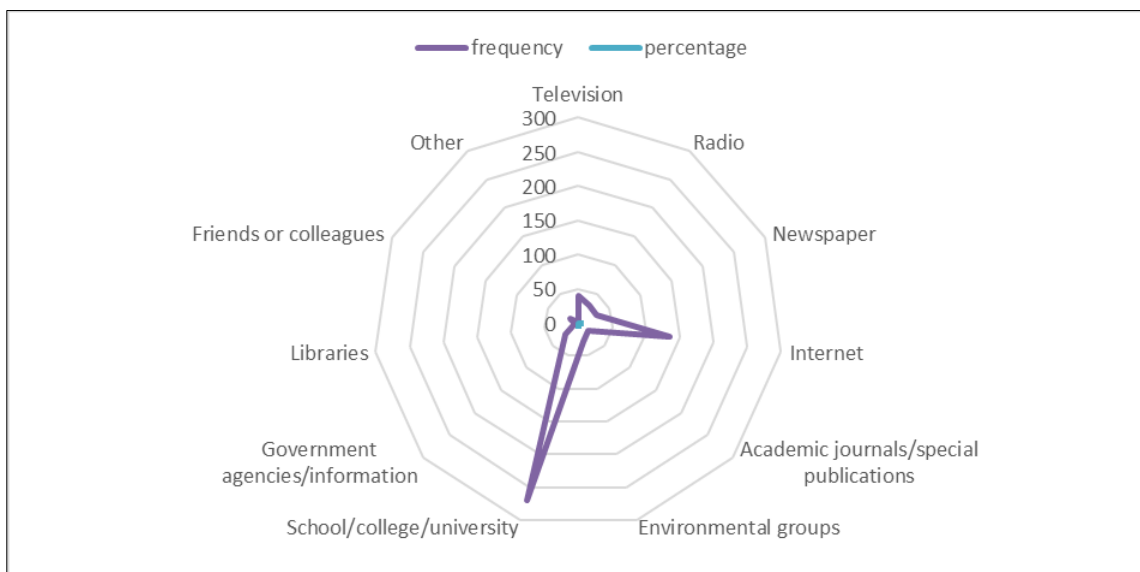
**Table 9** The weighted mean of the residents' agreement on global warming/climate change

Statement	Weighted Mean	Description
Seriousness as a global and personal threat	4.89	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Serious threat to the residents' family	4.56	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Caused by human activities	4.62	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Underestimation by news outlets	4.32	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Current occurrence	4.70	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Residents' understanding	4.76	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Evidence through global temperature changes	4.90	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Ability for individual mitigation	4.82	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Need for mandatory energy usage reduction	4.32	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Inevitability due to modern society	4.51	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.

Natural occurrence beyond human control	4.12	Residents affirmed partial concurrence with global warming/climate change, its causes, and the need for action.
Necessity for government initiatives	3.36	Residents affirmed neutral concurrence with global warming/climate change, its causes, and the need for action.
Support for greener initiatives	4.57	Residents affirmed full concurrence with global warming/climate change, its causes, and the need for action.
Link to industrial pollution	4.18	Residents affirmed partial concurrence with global warming/climate change, its causes, and the need for action.
Recent global disasters	4.19	Residents affirmed partial concurrence with global warming/climate change, its causes, and the need for action.
Media exaggeration	2.13	Residents affirmed partial opposition with global warming/climate change, its causes, and the need for action.
Potential overshadowing by other issues	2.15	Residents affirmed partial opposition with global warming/climate change, its causes, and the need for action.
Impact on tree removal for infrastructure	1.92	Residents affirmed partial opposition with global warming/climate change, its causes, and the need for action.

The table shows the residents' agreement on global warming and climate change policies. The table indicates that residents often affirmed a high level of awareness and understanding of health risks associated with climate change, with a weighted mean of 4.18 for global policies or initiatives aimed at reducing climate change. Additionally, residents always affirmed a high level of awareness and understanding of health risks associated with climate change, as demonstrated by a weighted mean of 4.26 for environmental policies implemented. These results suggest that residents are actively engaged and informed about global warming and climate change policies Oliu-Barton [15], indicating a strong level of awareness and support for initiatives aimed at addressing environmental challenges. Compared to the findings of a Pew Research Center study in 2019, our data shows a similar strong agreement among residents about the reality and seriousness of global warming and climate change. Pew's survey revealed that a significant percentage of respondents across multiple countries acknowledged the urgency and importance of addressing climate change. Additionally, like our findings, the majority did not believe that climate change was exaggerated by the media or overshadowed by other issues (Budiman A.) [4].

### 3.6. Platforms through which residents heard about climate change



**Figure 1** The various platforms through which residents heard about climate change

The figure shows the platforms through which residents heard about climate change. The data shows that residents primarily received information about climate change from television, the internet, and environmental groups, with varying frequencies and percentages. Other sources included radio, newspapers, academic journals, government agencies, libraries, and interactions with friends or colleagues. Information sources play a crucial role in generating support for climate change mitigation efforts (Adetayo et. al) [1]. Compared to a study by the Yale Program on Climate Change Communication in 2020, which found that Americans also primarily rely on television and the internet for climate change information, our findings are consistent. The Yale study highlighted the role of media and online platforms in shaping public understanding and emphasized the need for a comprehensive approach to communication that includes both traditional and new media sources (Yale Program) [24].

### 3.7. Residents recommendation to a friend or colleague to promote activities

**Table 10** The frequency and percentage of the residents' recommendation to a friend or colleague to promote activities on climate change

	Frequency	percentage
yes	379	98.44%
no	6	1.56%
Total	385	100%

The table shows residents' recommendations to promote activities related to climate change. Out of the total 385 respondents, 379 (98.44%) indicated that they would recommend such activities to a friend or colleague, demonstrating a high level of engagement and willingness to advocate for climate change initiatives. Only 6 respondents (1.56%) stated that they would not recommend these activities. This high percentage of residents willing to promote climate change activities highlights a strong sense of awareness and commitment to addressing environmental issues within the community (Latkin et. al) [10]. Compared to a study by Saad BL [18] in 2019, which found a similar global consensus, our findings are consistent. Saad BL's [1] survey indicated that a significant majority of respondents globally acknowledge the seriousness of global warming and the need for urgent action. The study also showed low agreement with the idea that climate change is exaggerated by the media, reinforcing the perception that climate change is a critical issue compared to other concerns. These comparisons reinforce the global recognition of the importance and urgency of addressing climate change, highlighting the widespread public support for significant measures to combat this issue.

## 4. Conclusion

Based on the findings presented in the study conducted in Danao City on the impact of climate change on human health, it can be concluded that there is a high level of awareness among residents regarding the health risks associated with climate change. The research has successfully established a local understanding of the correlation between climate-related factors and human health outcomes in the city.

Residents have shown a strong understanding of climate change policies and global warming issues, indicating their support for initiatives aimed at addressing environmental challenges. The study has filled an information gap on the health impacts of climate change in Danao City, providing valuable insights for the implementation of targeted public health measures and interventions.

These findings emphasize the importance of proactive measures to mitigate the adverse effects of climate change on public health in the region. By recognizing the specific health consequences of climate change and raising awareness among residents, steps can be taken to address and adapt to the challenges posed by a changing climate.

### *Recommendation*

- Community Education and Awareness:

Suggestion for comprehensive educational programs and awareness campaigns aimed at informing residents about the health risks associated with climate change. Specific activities should include:

- Workshops and Seminars: Conduct regular workshops and seminars in local communities and schools to educate people on heatwave management, waterborne diseases, and preventive health measures.



- Information Sessions: Arrange information sessions on how to recognize symptoms of climate-related illnesses and first aid responses.
- Distribution of Educational Materials: Provide leaflets, brochures, and posters that highlight practical steps to mitigate health risks.
- Utilizing Local Media: Use local radio, newspapers, and social media to disseminate information effectively.

- Climate Resilience Planning:

Develop and implement local climate resilience strategies to mitigate the health impacts of climate change, which should include:

- Upgrading Drainage Systems: Improve existing drainage infrastructure to prevent flooding during heavy rains.
- Enhancing Water Storage: Develop and maintain water storage facilities to ensure a reliable supply of clean water during droughts.
- Early Warning Systems: Invest in technology and infrastructure to enhance early warning systems for extreme weather events. This includes setting up weather monitoring stations and establishing communication protocols to alert residents promptly.
- Sustainable Agricultural Practices: Promote techniques such as crop diversification, conservation tillage, and rainwater harvesting to enhance food security and reduce the impact of climate variability on agriculture.

- Collaboration and Partnerships:

Foster robust collaboration between various stakeholders to address climate-related health challenges effectively. This should involve:

- Joint Task Forces: Create task forces that include representatives from government agencies, NGOs, healthcare providers, and community leaders to coordinate climate resilience efforts.
- Resource Sharing: Facilitate the sharing of resources, such as medical supplies and expertise, between different organizations to strengthen response capabilities.
- Regular Workshops: Organize workshops and conferences to align strategies, share best practices, and review progress in climate resilience initiatives.

- Healthcare Capacity Building

Enhance the capacity of healthcare systems to respond to climate-related health emergencies by implementing the following measures:

- Training Programs: Conduct regular training sessions for healthcare workers on managing heat-related illnesses, vector-borne diseases, and other climate-related health issues.
- Medical Resources: Ensure healthcare facilities are equipped with adequate medical supplies and equipment, such as cooling devices for heatstroke patients and diagnostic tools for vector-borne diseases.
- Emergency Protocols: Develop and regularly update protocols for rapid response and treatment during extreme weather events, including heatwaves, floods, and outbreaks of climate-sensitive diseases.

- Research and Monitoring

Continue and expand research efforts to understand the health impacts of climate change in Danao City through:

- Health and Climate Monitoring: Implement systems for continuous monitoring of health indicators and climate data to detect emerging risks early.
- Longitudinal Studies: Conduct studies to track the long-term health impacts of climate change on different population groups, particularly vulnerable communities.
- Evidence-Based Decision Making: Utilize research findings to guide policy decisions and design targeted interventions that address specific health risks associated with climate change.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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