Climate Change Influence on Health Domains, a Public Perception from a District in South India – A Cross-sectional Study

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Abstract

Background: The effects of climate change have been evident throughout all domains of health such as physical, social, environmental, and mental. However, the lack of perception made it a grey topic among the public. The aim of the study was to determine the perception of climate change on physical, environmental, and mental domains of health and to find the association between the physical, environmental, and mental effects of climate change and its basic characteristics. **Materials and Methods:** This study was conducted in a cross-sectional design among the general population above 30 years in the field practice area [urban and rural] of tertiary care hospital Perambalur for a period of three months. The data were collected using a semi-structured questionnaire and the interviewer method, which includes sociodemographic characteristics along with questions on the perception of climate change effects on mental, physical, and environmental aspects. The regression models were used to analyze the odds of perception among the subjects with respect to the various domains of characteristics. **Results:** The study included 877 participants, where the majority of subjects perceived the effects of climate change on physical, mental, and environmental domains of health. The odds of having a higher perception were significant in regression analysis among people with higher/school education, agriculture occupation, and rural residence ($P < 0.05$). **Conclusion:** Most of the study participants had an increased perception of climate change effects, making the subjects better candidates to impart adaptive strategies. Community-based programs have to be promoted to develop better comprehension and factual perception of climate change.

Keywords: Climate change, cross-sectional study, global warming, health domains, perception

Introduction

The greatest threat to humanity now is climate change, which jeopardizes both our civilization's survival and our natural resources. It can be considered a slow pandemic that inevitably contacts human beings. Climate change refers "to long-term shifts in temperature and weather patterns."[1] Climate change is defined "as a shift in an area's climate brought on by anthropogenic and natural disturbances such as ozone layer loss and greenhouse gas emissions."[2]

Climate change influences health as well as the economy and various other interrelated sectors. The effects of climate change on health are multidimensional with effects on physical, mental, social, and environmental domains. The interrelated pathways between health, economy, and food production would influence children's nutrition in an indirect manner and put them at risk for malnutrition, including stunting, wasting, and undernutrition.[3] Climate change poses mental health conditions such as depression and anxiety, chronic conditions such as cancer and kidney failure, and an immediate and long-term threat to human health around the world like heatstroke, fatigue, nose bleeding, and reproductive health issues such as infertility among population. There is also an increase in food-, water-, and vector-borne diseases, zoonosis, and mental health issues.[4–6] According to a World Health

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Organization (WHO) report, between 2030 and 2050, climate change is predicted to result in an additional 2,50,000 deaths per year from diseases like malaria, diarrhea, and heat stress.[7] Mental health is affected directly through post-traumatic events related to climate change and indirectly by a variety of social, political, and economic factors that influence mental health, including housing, employment, and poverty.[8]

The measure to tackle any impending disaster in a public manner is to explore the awareness regarding it and assess the perceptions regarding it. This information can be used as a paving stone for further mitigation measures against the problem. The lower perception of the problem can be a barrier to various adaptation efforts.[9] Various studies have been conducted among multiple groups of people to assess their attitudes and perceptions regarding climate change.[10–14] A study from Egypt has provided that more than 70% of the study participants had the knowledge and more than two-thirds have acknowledged that using public transport more frequently can assist to lessen the effects of climate change and global warming.[15] A study done in India has shown the presence of a lack of understanding about the health impact of climate change.[16]

There are very limited studies regarding the perception of climate change with respect to domains of health in South India. The study setting we have selected for the study belongs to a semi-arid region with frequent alterations in temperature and hence it is essential to identify the perception of the people in this region for their better adaptive behavior.

Objective

1. To evaluate the perception of climate change on domains of health among the general population in the rural district in South India.
2. To determine the association and regression between the physical, environmental, and mental effects of climate change with the baseline sociodemographic factors.

METHODOLOGY

Study design and study setting
The study was conducted as an analytical cross-sectional study among the field practice area of tertiary care medical college hospital Perambalur, Tamil Nadu. The study was conducted from November 2022 to March 2023.

Study population
The study population selected was adults over the age of 30 years from the rural and urban regions of the district.

Sample size and sampling technique
The sample size calculation was done with the proportion of subjects knowing something about climate change (71.4%)[16] and calculated using the formula, $n = Z^2_{1-\alpha/2} pq/d^2$ [$Z_{1-\alpha/2} = 1.96$, $p = 71.4$, $q = 28.6$, d, absolute precision = 3]. The final sample size came up to 872.[16] We have collected a total sample size of 877. The study participants are selected from the study setting via multi-phase sampling.

The line list of the households from field practicing areas [urban and rural] of tertiary care hospitals was collected, which consisted of 17 villages in rural areas and 16 wards in urban areas. Based on the sample size and proportion of households, we have selected the number of households by population proportion to size sampling. This was then followed by systematic random sampling. In each village and ward, every eighth house was taken for data until the number was reached. The next house was selected if the sample was not present at the time of the visit.

Study tool
The objective was assessed using a questionnaire (semi-structured) and was pretested by a pilot study and redefined with the specialist. The internal consistency of the domain questions was assessed by Cronbach's alpha, which came to 0.71.

The questionnaire consisted of sociodemographic and basic details such as age (years), sex, education, occupation, residence, and family type. The questionnaire also contained domain-based questions.

- Perception of effect on physical domain: The domain included questions to which the respondents must clearly agree/disagree or stay neutral. The questions were related to physical health in terms of heat-induced dehydration, infections, water-related diseases, respiratory diseases, road traffic accidents, and systemic disease. The final scores were calculated by adding the responses assigning, 3 – agree, 2 – disagree, and 1 – neutral. The minimum value is 16 and the maximum value is 48. The scores were categorized into low, medium, and high based on the quartiles such as <25th, 25–75th, and >75th, respectively.
- Perception of effect on the environmental domain: The domain included questions to which the respondents must clearly agree/disagree or stay neutral. The questions were related to air pollution and global warming, insect/mosquito predominance, and water scarcity/excess. The final scores were calculated by adding the responses assigning, 3 – agree, 2 – disagree, and 1 – neutral. The minimum value is six and the maximum value is 18. The scores were categorized into low, medium, and high based on the quartiles such as <25th, 25–75th, and >75th, respectively.
- Perception of effect on mental domain: Subjects were asked to respond to a single question, "Does climate change affect your mental health?" The responses were marked as yes or no.

Attitudes were assessed by asking a few questions related to nature conservation solutions like recycling, organic/pesticide-free food habits, energy saving, and using public facilities. The responses were collected for convenience, habit, preserving environment, health benefits, etc.

Data collection
The questionnaire was administered through face-to-face interviews in the households by the investigators. From each

household, one member was selected, and if the members of the house were not present, then the consecutive house was taken for the data collection. If more than one member is present within the inclusion criteria, the elder member was taken for the interview.

Statistical analysis

The data were collected using Google Forms and imported to Microsoft Excel, and analyzed using Statistical Package for the Social Sciences (SPSS) version 26 [IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.]. Descriptive statistics – categorical variables were described with frequencies and percentages, and continuous variables were described using mean with the standard deviation (SD). The association of dichotomous categorized dependent variables was analyzed using the Chi-square test. The continuous dependent variables were analyzed using an independent *t*-test and an ANOVA test. Odds ratios (OR) with a 95% confidence interval (CI) were used to evaluate the strength of connections between variables, and multivariate logistic regression and binary logistic regression were employed to reveal the decisive predictor factors. Statistics were judged significant at a *P*-value <0.05.

Ethical clearance and informed consent

Ethics committee approval was obtained from the institution ethics committee of Dhanalakshmi Srinivasan Medical College and Hospital [IECHS/IRCHS/DSMCH/NO 288] before the start of our study. Informed written consent was acquired from the participants before the study by explaining the risks, objectives, and benefits of our study.

RESULTS

In the study, the mean age was 48.33 ± 13.07 years, among which the majority (55.8%) were females and the majority (52.4%) were agriculturists. Most of the study participants [378 (43.2%)] have completed their schooling. In the study, 643 (73.4%) of the participants reside in rural areas and 684 (78.1%) participants belong to nuclear type of family [Table 1]. The effects of climate change perception on the physical, environmental, and mental domains were categorized in the study. The mean ± SD scores of physical and environmental domain effects are 30.116 ± 7.77 and 14.393 ± 2.83, respectively. In the study, most of the participants perceived medium perception in both physical (454) (51.8%) and environmental domains. [Supplemental Figure]. In the study, 561 (64%) subjects were perceived to have an effect on the mental domain due to climate change.

Figure 1 shows the attitude toward nature conservation solutions, where about 56.7% of the study participants preferred recycling to preserve the environment. More than half of the study participants preferred to use public transport to save money rather than to preserve the environment.

The study showed a higher mean age for subjects with low environmental domain perception [53.83 ± 11.94] in

Table 1: Sociodemographic details of the study participants (*n*=877)

Variables	*n* (%)
Age	
Mean±SD	48.33±13.068
Gender	
Male	387 (44.2%)
Female	489 (55.8%)
Education	
Higher	272 (31.1%)
Schooling	378 (43.2%)
No formal education	226 (25.8%)
Occupation	
Agriculture	459 (52.4%)
Non-agricultural	299 (34.1%)
Unemployed	118 (13.5%)
Residence	
Rural	643 (73.4%)
Urban	233 (26.6%)
Family type	
Joint family	192 (21.9%)
Nuclear family	684 (78.1%)

comparison to those with medium [48.32 ± 12.59] and high perception [46.89 ± 13.64]. Among subjects with high physical domain effect perception, 94 (41.96%) had higher education, whereas the participants who had completed schooling had a high environment domain effect perception of 196 (43.17%) and a high mental domain effect perception of 247 (44.03%) (*P* < 0.001). The subjects who are practicing agriculture as their occupation had significantly high perception in physical 101 (45.1%), environmental 159 (47.6%), and mental domains 387 (69%) [*P* < 0.05]. Those participants who reside in rural areas have significantly high perceptions in physical 121 (54%), environmental 214 (64.1%), and mental domain 387 (69%) (*P* < 0.001). The participants who belong to the nuclear family had significantly high perception in the physical domain 162 (72.3%) (*P* < 0.001) [Table 2].

A multivariate logistic regression evaluated the prediction of the physical domain perception of climate change categories (high, medium, and low). The reference group in the model has a low perception of the physical effect of climate change. Analyses of good model fit (discrimination among groups) based on education, occupation, residence, and type of family were, $\chi^2 = 100.178$, $P = 0.08$. The significant factors were analyzed by using multivariate logistic regression, where in education, the participants who have completed higher education have 1.29 times the odds of having a higher perception than participants with no formal education. The study participants who were agriculturists were 57% less likely to have low perception in comparison to unemployed subjects. Subjects residing in rural areas with medium perception were 57% less likely to have low perception, and those with high perception were 85% less likely to have low perception in comparison to urban areas. Among the study participants who

Table 2: Association between perception of effect on health domains with basic characteristics (*n*=877)

Basic Characteristics	Physical effect perception			Environmental effect perception			Mental effect perception	
	Low	Medium	High	Low	Medium	High	No	Yes
Age								
Mean	47.79±10.50	48.26±13.03	48.96±1.01	53.83±11.94	48.32±12.59	46.89±13.64	48.09±12.98	48.75±13.24
P		0.65			< 0.001*			0.48
Gender								
Male	94 (24.3%)	185 (47.8%)	108 (27.9%)	36 (9.3%)	196 (50.6%)	155 (40.1%)	131 (33.9%)	256 (66.1%)
Female	104 (21.3%)	269 (55%)	116 (23.7%)	52 (10.6%)	258 (52.8%)	179 (36.6%)	184 (37.6%)	305 (62.4%)
P		0.10			0.54			0.26
Education								
Higher	37 (18.69%)	141 (31.06%)	94 (41.96%)	12 (13.63%)	126 (27.75%)	134 (40.12%)	81 (25.71%)	191 (34.05%)
School	111 (56.06%)	183 (40.31%)	84 (37.5%)	35 (39.77%)	196 (43.17%)	147 (44.01%)	131 (41.59%)	247 (44.03%)
No formal education	50 (25.25%)	130 (28.63%)	46 (20.54%)	41 (46.59%)	132 (29.07%)	53 (15.87%)	103 (32.7%)	123 (21.92%)
P		< 0.001*			< 0.001*			0.001*
Occupation								
Agriculture	132 (66.7%)	226 (49.8%)	101 (45.1%)	51 (11.1%_	249 (54.8%)	159 (47.6%)	163 (51.7%)	296 (52.8%)
Non-agriculture	53 (26.8%)	158 (34.8%)	88 (39.3%)	21 (23.9%)	144 (31.7%0	134 (40.1%)	98 (31.1%)	201 (35.8%)
Unemployed	13 (6.6%)	70 (15.4%)	35 (15.6%)	16 (18.2%)	61 (13.4%)	41 (12.3%)	54 (17.1%)	64 (11.4%)
P		< 0.001*			0.023*			0.043*
Residence								
Rural	180 (90.9%)	342 (75.3%)	121 (54%)	75 (85.2%)	354 (78%)	214 (64.1%)	256 (81.3%)	387 (69%)
Urban	18 (9.1%)	112 (24.7%)	103 (46%)	13 (14.8%)	100 (22%)	120 (35.9%)	59 (18.7%)	174 (31%)
P		< 0.001*			< 0.001*			< 0.001*
Family type								
Joint family	24 (12.1%)	106 (23.3%)	62 (27.7%)	22 (25%)	96 (21.1%)	74 (22.2%)	75 (23.8%	117 (20.9%)
Nuclear family	174 (87.9%)	348 (76.7%)	162 (72.3%)	66 (75%)	358 (78.9%)	260 (77.8%)	240 (76.2%)	444 (79.1%)
P		< 0.001*			0.720			0.309

Age: physical and environmental perception – ANOVA [represented as mean±SD], mental perception – independent t-test [represented as mean±SD], other variables – Chi-square test [represented as frequency (%)], *P*<0.05 considered significant
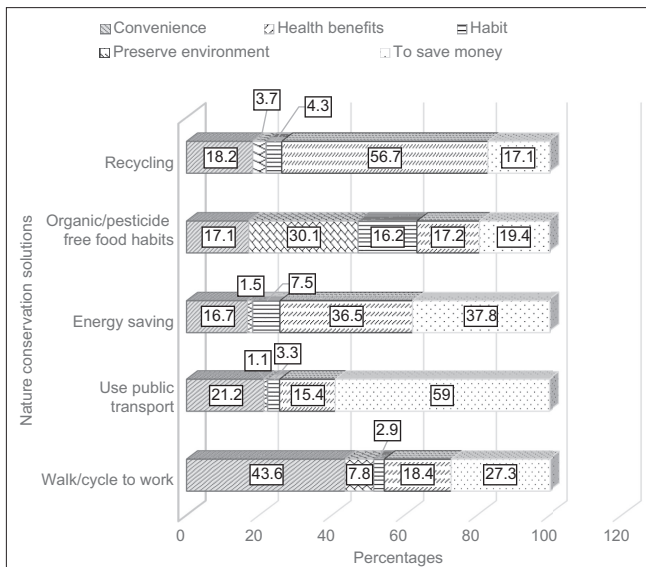

Figure 1: Attitudes towards nature conservation solutions (*n*=877)

belong to the nuclear family type with medium perception were 42% less likely to have a low perception of physical effects in comparison with joint family [Table 3].

A multivariate logistic regression evaluated the prediction of environmental domain perception of climate change categories (high, medium, and low). The reference group in the model has a low perception of the environmental effect of climate change. Analyses revealed a good model fit (discrimination among groups) based on age, education, occupation, and residence, $\chi^2 = 69.33$, $P = 0.179$. The significant factors were analyzed by using multivariate logistic regression, where decreasing age has increasing odds of having a medium perception of climate change effects. Participants who have completed higher education have 5.12 times the odds of having higher perception and participants who have completed schooling have 2.75 times the odds of having higher perception than participants with no formal education. The study participants who are agriculturists have 2.33 times the odds of having a higher perception than those who are unemployed. Subjects residing in rural areas with high perception were 53% less likely to have a low perception of environmental effects in comparison to urban areas [Table 3].

A binary logistic regression evaluated the prediction of mental effect perception of climate change categories (yes/no). The reference group in the model has no perception of the mental effects of climate change. Analyses revealed a good model fit (discrimination among groups) on the basis of education, occupation, and residence, $\chi^2 = 35.36$, $P = 0.42$. The significant factors were analyzed by using binary logistic regression,

Table 3: Multivariate logistic regression differentiating low perception of physical and environmental effects due to climate change from medium and high perception

	Physical perception					
Categories	**Medium perception**			**High perception**		
	Adjusted OR	**95% CI**		**Adjusted OR**	**95% CI**	
		Lower	**Upper**		**Lower**	**Upper**
Education						
Higher	0.92	0.53	1.62	1.29	0.68	2.48
School	0.70	0.47	1.06	0.95	0.57	1.57
Occupation						
Agriculture	0.43*	0.22	0.83	0.60	0.28	1.26
Non-agriculture	0.53	0.26	1.03	0.49	0.23	1.03
Residence						
Rural	0.43*	0.24	0.78	0.15*	0.08	0.28
Family						
Nuclear	0.58	0.36	0.96	0.58	0.33	1.00
	Environment perception					
Categories	**Medium perception**			**High perception**		
	Adjusted OR	**95% CI**		**Adjusted OR**	**95% CI**	
		Lower	**Upper**		**Lower**	**Upper**
Age	0.98*	0.96	0.10	0.98	0.96	1.00
Education						
Higher	2.23	0.96	5.18	5.12*	2.12	12.35
School	1.41	0.83	2.40	2.75*	1.54	4.91
Occupation						
Agriculture	1.79	0.91	3.50	2.33*	1.11	4.87
Non-agriculture	1.71	0.81	3.62	2.08	0.94	4.59
Residence						
Rural	0.85	0.41	1.70	0.47*	0.22	0.96

For physical and environmental perception: reference variable – low perception category. OR=odds ratio, 95% CI=95% confidence interval, *indicates $P<0.05$ is significant. Reference categories: education=no formal education, occupation=unemployed, residence=urban, family=joint family. For environment perception: reference categories: education=no formal education, occupation=unemployed, residence=urban. OR=odds ratio, 95% CI=95% confidence interval, *indicates $P<0.05$ is significant

where in education the participants who have completed higher education have 1.80 times the odds of having mental effects of climate change perception and the participants who have completed schooling have 1.57 times the odds of having mental effects of climate change perception compared to participants with no formal education. The study participants who practice agriculture have 2.14 times the odds of having mental effects of climate change perception than the unemployed. Subjects residing in rural areas were 52% more likely to have perception of the mental effect of climate change in comparison to urban areas [Table 4].

DISCUSSION

In our study, most of the participants perceived medium perception in both physical 454 (51.8%) and environmental perception effects 454 (51.8%). In the study, 561 (64%) reported having mental effects due to climate change. The study has highlighted that the education, occupation, and residence of the participants have significant associations with the perception of climate change effects in all health domains.

Subjects with a higher perception of the physical domain effect due to climate change had higher education, with agriculture as the occupation basis of education, rural residing, and belonged to nuclear family. In a study done in central and North India, the subjects could not connect the physical changes including disease with that due to climate change.[16] A study conducted in Canada by Casson *et al.*[17] shows that the higher the education, the higher the perception of the biophysical impact of climate change. The study also concluded that females have a high perception regarding the biophysical impact of climate change, whereas in our study, gender is not statistically significant. The increased participation of subjects from rural areas with similar education may be a reason for the absence of gender disparity in perception. Another study by Van Wijk *et al.*[18] found that while subjects from the general population had similar levels of knowledge about climate change, they did not have the same level of understanding of infectious diseases or the impact of climate change on those diseases as participants with a background in natural sciences. A cross-sectional study conducted in Madhya Pradesh, Jammu and Kashmir by Tripathi

Table 4: Binary logistic regression analysis between mental perception and significant variables

Categories	Mental effect perception		
	Adjusted OR	95% CI	
		Lower	Upper
Education			
Higher	1.80*	1.17	2.76
School	1.57*	1.11	2.20
Occupation			
Agriculture	2.14*	1.36	3.37
Non-agriculture	1.53	0.97	2.39
Residence			
Rural	0.48*	0.32	0.71

Reference variable: no mental effect perception. OR=odds ratio, 95% CI=95% confidence interval, *indicates *P*<0.05 is significant. Reference categories: education=no formal education, occupation=unemployed, residence=urban

has shown the study participants have a lack of comprehension about the health impacts of climate change but have sound knowledge about seasonal diseases.[16] A study was done in Bangladesh by Kabir *et al.*[11] also shows that the level of education plays an influential factor in understanding climate change effects and depicts that educational qualification, age, monthly income, and occupation were significantly related to climate change knowledge including both environmental factors and physical impact of climate change. In our study considering the nature of the occupation, the results show that the agriculturists have a high perception of climate change effects when compared to other occupation-practicing subjects and unemployed.

Subjects with a high perception of the environmental domain effect due to climate change had higher/schooling education, agriculturists, and were residing in rural areas in our study.

A cross-sectional study conducted by Wang *et al.* in China[19] was conducted on primary school students where the students were found to have a good perception of the climate change effects and the adaptive behaviors which coincides with the results of our study where the participants who have completed schooling had a high perception on environmental effects of climate change. The results of our study related to occupation were equivalent to the studies conducted by Datta[20] which is a systematic study where the agriculturist perception were in line with the trends, especially the environmental perception. A study conducted in Bhutan by Chhogyel *et al.*[21] also provides the same result as our study, where the agriculturists were found to have a high perception than the non-agriculturists and the unemployed.

In our study, subjects who perceived the mental domain effect of climate change had higher education, agriculturists, and residing in rural areas. According to Talukder *et al.*,[22] the agriculturists face mental effects of climate change and also Berry *et al.*[6] conclude that agriculturists have mental effects of climate change. A study done in Bangladesh showed that climate change increased the probability of augmented drug, alcohol use, psychological health stressors, family stress, and sources for suicide ideation.[23]

Strength and recommendation
Our research has demonstrated how the general population perceives the impacts of climate change. We've evaluated perception across various dimensions, including physical, environmental, and mental aspects. This addresses a gap in existing studies, which often focus solely on environmental impacts. Regression models were used to enlist the predictor variables that impact the perception of the effects of climate change on health domains. The result can be used as a step for further longitudinal studies, where an impact can be assessed over a longer period. Also detailed qualitative research can offer solutions to the challenges individuals encounter in understanding climate change. Different groups/vulnerable groups can be studied individually to identify the barriers in perceiving the changes.

Limitations
In our study, we measured subjective perception of climate change, but they are not measured objectively. The presence of mental effect has been determined by a single question, not by means of any objective assessment. The perception is not of real-time data, which can induce a recall bias in the study. Also, the perception of climate change and its effects depends on many factors which need to be analyzed on an individual basis to assess the true perception of climate change.

CONCLUSION
From our study, we can conclude that more than 50% of the study participants have a perception on climate change effects, especially in the mental domain. Education, occupation, family type, and residence of the participants were significant predictor variables influencing the perception of the effect of climate change on various domains.

Financial support and sponsorship

## Conflicts of interest
There are no conflicts of interest.

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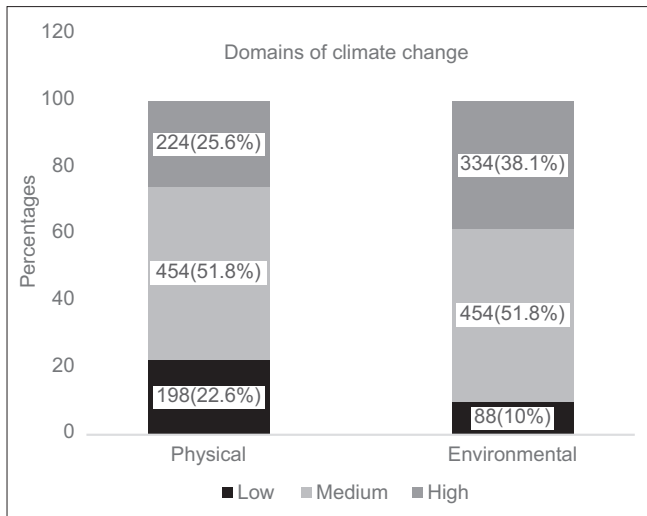
Supplemental Figure: Scores of Physical & Environmental domains (n=877)