Predictors of Knowledge, Attitudes and Practice about Heat Waves: An Exploratory Cross-Sectional Study in Greece

Ioannis Moisoglou *, Aglaia Katsiroumpa, Antigoni Kolisiati, Maria Tsiachri, Olympia Konstantakopoulou, Parisis Gallos, Petros Galanis

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Article

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Ioannis Moisoglou [1,*], Aglaia Katsiroumpa [2], Antigoni Kolisiati [3], Maria Tsiachri [4], Olympia Konstantakopoulou [5], Parisis Gallos [2] and Petros Galanis [2]

[1] Faculty of Nursing, University of Thessaly, 41500, Larissa, Greece; iomoysoglou@uth.gr
[2] Clinical Epidemiology Laboratory, Faculty of Nursing, National and Kapodistrian University of Athens, 11527, Athens, Greece; aglaiakat@nurs.uoa.gr (A.K.), parisgallos@nurs.uoa.gr (P.G.); pegalan@nurs.uoa.gr (P.G.)
[3] Department of Endocrinology and Diabetes Center, General Hospital "G. Gennimatas", 11527, Athens, Greece; antigonikol@outlook.com
[4] Primary Education Directorate of Fthiotida, Fthiotida, 35131, Lamia, Greece; mtsiachri@gmail.com
[5] Center for Health Services Management and Evaluation, Faculty of Nursing, National and Kapodistrian University of Athens, 11527, Athens, Greece; olykonstant@nurs.uoa.gr
* Correspondence: iomoysoglou@uth.gr; Tel.: +30 2231029188

Abstract: Heat waves are a significant consequence of climate change threatening public health by increased morbidity and mortality. The aim of this study was to estimate individuals' knowledge, attitudes and practice related to heat waves. We conducted an exploratory cross-sectional study in Greece during September 2023. We employed a convenience sample of 1055 participants. We used the heat wave knowledge, awareness, practice and behavior scale (HWKAPBS) to measure our outcome. We measured several socio-demographic variables, such as gender, age, educational level, etc. as potential determinants. Mean scores for the knowledge, awareness, practice and behavior factors were 12.5, 22.7, 22.2 and 12.1 respectively. Females had higher scores on the four factors compared with males. We found a positive relationship between self-perceived health status and awareness, practice and behavior about heat waves. Similarly, we identified a positive relationship between self-perceived financial status and awareness and behavior about heat waves. Increased age was associated with increased practice score, while increased educational level was associated with increased knowledge score. Additionally, behavior score was higher among participants in urban areas than those in rural areas. We found statistically significant positive correlations between the four factors. Levels of knowledge, awareness, practice and behavior about heat waves were high in our sample. Several socio-demographic variables affect participants' knowledge, awareness, practice and behavior concerning heat waves.

Keywords: heat waves; climate change; knowledge; attitudes; practice; behavior

1. Introduction

Climate change can be defined as long-term changes in temperatures and weather patterns [1]. The main cause of climate change has been identified as greenhouse gas emissions. There are two sources of greenhouse gas emissions. These are natural systems and human activity. Natural systems include forest fires, earthquakes, oceans, permafrost, wetlands, mud volcanoes and volcanoes [2]. According the human activity, the fossil fuel energy consumption remains the primary source of greenhouse gas emissions [3]. CO2 produced by human activities is the main contributor to global warming. In 2020, its concentration in the atmosphere was 48% higher than its pre-industrial level (before 1750) [4]. The consequences of climate change affect the natural world, while climate change poses risks to social threats and business activities. The consequences of climate change affect the natural world, while climate change poses risks to social threats and business activities. In particular, with regard to the natural world, some of the most significant impacts of climate change include an

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increase in the average global temperature, an increase in the frequency, intensity and duration of droughts, an increase in precipitation in many areas, rising sea levels and changes in biodiversity [5]. Regarding societal changes and risks to business, these may include deaths from very high or very low temperatures and natural disasters (e.g. foods, storms and droughts), emerging and re-emerging animal diseases that increase animal and human health challenges, significant impacts on agricultural production and tourism [5–8].

Global warming is one of the most important consequences of climate change. The year 2022 was the 6th warmest year in the history of global temperature records, which began in 1880. Moreover, the last nine years (2014-2022) ranked as the nine warmest years on record [9]. Even a small increase in global warming is associated with the occurrence of a heat wave, which, depending on the increase in global warming, has a longer duration, intensity and shorter recurrence intervals [10]. The Mediterranean is one of the world regions where increased heatwave days, maximum heatwave duration, average heat wave intensity and cumulative heat have been recorded over time [11].

The impacts of the heat wave are multifaceted, affecting the natural environment, the animal kingdom and people. The heat wave has resulted in a significant loss of cropland, which in Europe has tripled in recent decades [12], an increase in electricity demand and damage to urban infrastructure [13], devastating impacts on marine ecosystems with a reduction in abundance of habitat-forming seaweeds and an increased mortality of several marine species [14]. In humans, as high temperatures affect almost all organs and systems, the risk of morbidity and mortality is increased, especially for patients with chronic diseases [15]. Other population groups that are vulnerable in the event of a heat wave are the elderly, females, persons with lower educational attainment and individuals within the low socioeconomic status [16,17]. Infants, particularly neonates, outdoor workers, those who use alcohol, medications, and illegal narcotics are at high risk of heat wave mortality [15].

Although, the role of public awareness in health-protective behaviors is fundamental to reducing the risks of heat waves [18], the existence of studies using a validated tool to assess citizens' knowledge and attitudes towards heat waves is very limited. Therefore, it is necessary to recognize the factors that influence general public's knowledge, attitudes and practice about heat waves. Recently, two valid instruments are developed to measure knowledge, attitudes and practice about heat waves in the general population [19,20]. However, according to our knowledge, there are no studies that investigate predictors of knowledge, attitudes and practice towards heat waves by using valid instruments.

Thus, the objectives of our study were to: (a) assess participants' knowledge, attitudes and practice related to heat waves, (b) identify predictors of knowledge, attitudes and practice about heat waves by using a valid tool.

2. Materials and Methods

2.1. Study design

Since our knowledge regarding the determinants of individuals' knowledge, attitudes and practice related to heat waves is limited, we conducted an exploratory cross-sectional study in Greece. We collected our data during September 2023, after one of the hottest summers in the human history since an intense and prolonged series of heat waves have reported in summer of 2023 in Europe [21]. According to a recent estimate, Greece was amongst the European countries with the highest summer heat-related mortality rate between June and August 2022 [22]. In general, the highest heat-related mortality rates were found in Mediterranean countries, i.e. Greece, Italy, Spain and Portugal. Moreover, mean temperature in Greece during 2021 was among the fourth highest values in European countries [23].

We used several sources to collect our data. In particular, we created an on-line form of the study questionnaire using Google forms and we posted it in social media (Facebook, Instagram, LinkedIn, Viber and WhatsApp). Moreover, we sent the questionnaire to our e-mail contacts asking from recipients to forward it to their contacts. In that case, snowball sampling method was applied.

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Applying these on-line methods, we collected data from residents in several regions throughout the country. Additionally, we approached individuals in person requesting them to fill our questionnaire. In particular, we approached individuals in public areas in Athens, such as squares and churches. Athens is the capital and the biggest city of Greece. Overall, a convenience sample was obtained.

Our eligibility criteria were age ≥18 years, understanding of the Greek language since the study questionnaire was in Greek, and a written acceptance to participate in our study.

Considering a low effect size (f2=0.02) of each socio-demographic variable on each construct score, the number of predictors (n=10), level of alpha error as 5%, level of power as 95%, and a two tailed test, we needed 652 participants to perform multivariable linear regression analysis. We decided to increase our sample to reduce random error.

2.2. Measures

We used the heat wave knowledge, awareness, practice and behavior scale (HWKAPBS) that is created from Sayili et al. in Turkey [19]. Another similar tool is created by scholars in Malaysia [20]. We decided to use the HWKAPBS for two reasons: (a) Turkey is a Mediterranean country near Greece and so climate conditions are similar, (b) the tool has already been validated in Greek [24] and is proven to be valid and reliable. The HWKAPBS measured knowledge about heat waves (15 items), awareness (five items), practice (five items), and behavior (three items). Correct answers take a value of 1, while wrong answers take a value of 0. Thus, an overall knowledge score is estimated with values from 0 to 15. Answers on awareness, practice and behavior factors are on a five-point Likert scale: strongly disagree (1), disagree (2), not sure (3), agree (4), strongly agree (5). We calculated an overal score for each factor by adding answers. Thus, awareness and practice score ranges from 5 to 25, while behavior score ranges from 3 to 15. Higher values in the four factors of the HWKAPBS indicate higher level of knowledge, awareness, practice and behavior about heat waves. In our study, Cronbach's alpha for the knowledge, awareness, practice and behavior factors were 0.72, 0.95, 0.90 and 0.80 respectively.

We collected data on the following socio-demographic variables: gender (females or males), age (continuous variable), educational level (elementary school, high school, university degree, MSc/PhD diploma), living conditions (alone or with others), residence area (urban or rural), workers (no or yes), air-conditioner ownership (no or yes), voluntary activities (no or yes), self-perceived health status, and self-perceived financial status. We used a 5-point Likert scale to measure self-perceived health status and financial status: very poor (1), poor (2), moderate (3), good (4), very good (5). We considered these socio-demographic variables as potential predictors of knowledge, awareness, practice and behavior about heat waves.

2.3. Ethical issues

We took an approval of the Ethics Committee of the Faculty of Nursing, National and Kapodistrian University of Athens to perform our study (reference number; 459, September 2023). Additionally, we applied the guidelines of the Declaration of Helsinki in our study [25]. Also, participants gave their written consent to participate in our study, while we did not collect personal data.

2.4. Statistical analysis

We present categorical variables with numbers and percentages. Moreover, we present continuous variables with mean, standard deviation (SD), median, minimum value and maximum value. We employed Kolmogorov-Smirnov test and Q-Q plots to identify the distribution of continuous variables. We found that continuous variables followed normal distribution. Since knowledge, awareness, practice and behavior scores followed normal distribution, we performed linear regression analysis to estimate the independent effect of socio-demographic characteristics. First, we performed univariate linear regression analysis and then we constructed multivariable

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linear regression models to eliminate confounding. In regression analyses, socio-demographic characteristics were the independent variables, while knowledge, awareness, practice and behavior scores were the dependent variables. We present unadjusted and adjusted coefficient betas, 95% confidence intervals (CI), p-values, and coefficients of determination (R2). We considered p-values less than 0.05 as statistically significant. We used IBM SPSS 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) to perform our statistical analysis

3. Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

3.1. Socio-demographic characteristics

Study population included 1055 participants. Mean age was 35.9 years (SD: 12.2). The majority of participants were females (78.6%), had a university degree (86.1%), working (83.1%), and living with others (82.8%) in urban areas (87.6%). Nine out of ten participants owned an air-conditioner (89.7%). Among our participants, 14.1% have participated in voluntary activities. Only 3.5% considered their health status as poor/very poor, while 84.0% considered it as good/very good. Regarding financial status, 50.9% reported a good/very good status, 43.4% reported a moderate level, and 5.7% reported poor/very poor status. Detailed socio-demographic characteristics of our sample are shown in Table 1.

Table 1. Socio-demographic characteristics of our sample (N=1055).

Characteristics	N	%
Gender		
Females	829	78.6
Males	226	21.4
Age[a]	35.9	12.2
Educational level		
High school	147	13.9
University degree	406	38.5
MSc diploma	405	38.4
PhD diploma	97	9.2
Living		
Alone	181	17.2
With others	874	82.8
Residence area		
Rural	131	12.4
Urban	924	87.6
Workers		
No	178	16.9
Yes	877	83.1
Air-conditioner ownership		
No	109	10.3
Yes	946	89.7
Voluntary activities		
No	906	85.9
Yes	149	14.1
Self-perceived health status		
Very poor	25	2.4
Poor	12	1.1

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Moderate	132	12.5
Good	407	38.6
Very good	479	45.4
Self-perceived financial status		
Very poor	8	0.8
Poor	52	4.9
Moderate	458	43.4
Good	472	44.7
Very good	65	6.2

[a] mean, standard deviation.

3.2. Study scales

Descriptive statistics for the knowledge, awareness, practice and behavior factors are shown in Table 2. Mean knowledge score was 12.5 (SD: 1.9) indicating a high knowledge level in our sample. Moreover, level of awareness about heat waves was high since the mean score was 22.7 (SD: 4.2). Participants' practices to deal with heat waves were very good with a mean practice score of 22.2 (SD: 4.3). High mean behavior score (12.1, SD: 2.9) indicated that participants are alert towards heat waves. We found statistically significant positive correlations between the four factors (Table 3). Correlation between knowledge and other factors was weak since correlation coefficients ranged from 0.082 to 0.144. Moreover, correlations between awareness, practice, and behaviors were strong ranging from 0.647 to 0.738.

Table 2. Descriptive statistics for the knowledge, awareness, practice and behavior factors (N=1055).

Factor	Mean	Standard deviation	Median	Minimum value	Maximum value
Knowledge	12.5	1.9	13	3	15
Awareness	22.7	4.2	24	5	25
Practice	22.2	4.3	24	5	25
Behavior	12.1	2.9	13	3	15

Table 3. Pearsons' correlation coefficients between the knowledge, awareness, practice and behavior factors (N=1055).

Factor	2	3	4
1. Knowledge	0.144*	0.082**	0.086**
2. Awareness		0.738*	0.647*
3. Practice			0.725*
4. Behavior			

* p-value < 0.001; ** p-value < 0.01.

3.3. Regression analysis

Females (adjusted beta: 0.43, 95% CI: 0.14 to 0.71) and owners of an air-conditioner (adjusted beta: 0.71, 95% CI: 0.33 to 1.10) had more knowledge about heat waves (Table 4). Moreover, we found a positive relationship between educational level and knowledge score. In particular, participants with a university degree (adjusted beta: 0.44, 95% CI: 0.08 to 0.80), or a MSc diploma (adjusted beta: 0.74, 95% CI: 0.37 to 1.12), or a PhD diploma (adjusted beta: 0.88, 95% CI: 0.37 to 1.40) had more knowledge than high school graduates. Additionally, knowledge score was higher among participants with good/very good self-perceived health status compared with those with poor/very poor health status (adjusted beta: 0.69, 95% CI: 0.04 to 1.34).

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Table 4. Linear regression analysis with knowledge score as the dependent variable (N=1055).

Independent variables	Univariate model		Multivariable model	
	Unadjusted coefficient beta (95% CI)	P-value	Adjusted coefficient beta (95% CI)	P-value
Females vs. males	0.36 (0.08 to 0.64)	0.013	0.43 (0.14 to 0.71)	0.003
Age	-0.0001 (-0.01 to 0.01)	0.976	-0.006 (-0.02 to 0.004)	0.250
Educational level				
University degree vs. high school	-0.13 (-0.37 to 0.11)	0.277	0.44 (0.08 to 0.80)	0.018
MSc diploma vs. high school	0.37 (0.13 to 0.61)	0.002	0.74 (0.37 to 1.12)	<0.001
PhD diploma vs. high school	0.30 (-0.10 to 0.70)	0.144	0.88 (0.37 to 1.40)	0.001
Living with other	-0.04 (-0.35 to 0.27)	0.799	0.06 (-0.25 to 0.36)	0.728
Urban vs. rural residence area	0.21 (-0.14 to 0.56)	0.246	0.05 (-0.31 to 0.41)	0.792
Workers	0.25 (-0.06 to 0.56)	0.119	0.07 (-0.27 to 0.41)	0.671
Air-conditioner ownership	0.73 (0.35 to 1.11)	<0.001	0.71 (0.33 to 1.10)	<0.001
Voluntary activities	0.17 (-0.17 to 0.50)	0.326	0.10 (-0.23 to 0.44)	0.544
Self-perceived health status				
Moderate to poor/very poor	-0.15 (-0.50 to 0.20)	0.400	0.50 (-0.20 to 1.20)	0.161
Good/very good to poor/very poor	0.29 (-0.03 to 0.61)	0.072	0.69 (0.04 to 1.34)	0.037
Self-perceived financial status				
Moderate to poor/very poor	0.10 (-0.13 to 0.34)	0.386	0.25 (-0.28 to 0.78)	0.348
Good/very good to poor/very poor	-0.01 (-0.24 to 0.23)	0.947	0.11 (-0.43 to 0.65)	0.689

CI: confidence interval; Adjusted R^2 for the model=3.4%; p-value for ANOVA<0.001.

Linear regression analysis with awareness score as the dependent variable is shown in Table 5. Mean awareness score was higher among females compared with males (adjusted beta: 2.07, 95% CI: 1.47 to 2.66). Moreover, better health status and financial status were associated with increased awareness score. In particular, participants with moderate (adjusted beta: 4.56, 95% CI: 3.08 to 6.03) or good/very good health status (adjusted beta: 4.68, 95% CI: 3.31 to 6.05) had higher awareness score compared to those with poor/very poor health status. Additionally, levels of awareness were higher among participants with moderate (adjusted beta: 1.12, 95% CI: 0.003 to 2.23) or good/very good financial status (adjusted beta: 2.03, 95% CI: 0.89 to 3.16).

Table 5. Linear regression analysis with awareness score as the dependent variable (N=1055).

Independent variables	Univariate model		Multivariable model	
	Unadjusted coefficient beta (95% CI)	P-value	Adjusted coefficient beta (95% CI)	P-value
Females vs. males	1.80 (1.19 to 2.41)	<0.001	2.07 (1.47 to 2.66)	<0.001
Age	-0.02 (-0.04 to 0.0005)	0.055	-0.02 (-0.04 to 0.0001)	0.051
Educational level				
University degree vs. high school	-0.51 (-1.03 to 0.01)	0.055	-0.26 (-1.02 to 0.50)	0.506
MSc diploma vs. high school	0.49 (-0.03 to 1.02)	0.065	0.56 (-0.23 to 1.35)	0.165
PhD diploma vs. high school	0.49 (-0.39 to 1.38)	0.271	0.99 (-0.09 to 2.07)	0.072
Living with other	-0.11 (-0.78 to 0.57)	0.760	-0.002 (-0.65 to 0.65)	0.996
Urban vs. rural residence area	0.33 (-0.44 to 1.10)	0.399	0.43 (-0.32 to 1.19)	0.260
Workers	-0.38 (-1.06 to 0.30)	0.277	-0.60 (-1.31 to 0.12)	0.102
Air-conditioner ownership	0.70 (-0.14 to 1.54)	0.100	0.78 (-0.03 to 1.60)	0.059
Voluntary activities	-0.16 (-0.89 to 0.57)	0.659	-0.28 (-0.99 to 0.42)	0.431
Self-perceived health status				
Moderate to poor/very poor	-0.30 (-1.07 to 0.47)	0.443	4.56 (3.08 to 6.03)	<0.001
Good/very good to poor/very poor	1.51 (0.82 to 2.20)	<0.001	4.68 (3.31 to 6.05)	<0.001
Self-perceived financial status				

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Moderate to poor/very poor	-0.69 (-1.20 to -0.18)	0.008	1.12 (0.003 to 2.23)	0.049
Good/very good to poor/very poor	1.19 (0.69 to 1.70)	<0.001	2.03 (0.89 to 3.16)	<0.001

CI: confidence interval; Adjusted R^2 for the model=10.9%; p-value for ANOVA<0.001.

Table 6 shows the results of the linear regression analysis with practice score as the dependent variable. Practice score was higher among females (adjusted beta: 2.03, 95% CI: 1.42 to 2.65) compared with males. Additionally, participants with moderate (adjusted beta: 5.08, 95% CI: 3.57 to 6.58) or good/very good health status (adjusted beta: 5.22, 95% CI: 3.82 to 6.61) had higher practice score compared to those with poor/very poor health status. Moreover, we found a positive relationship between age and practice score (adjusted beta: 0.04, 95% CI: 0.02 to 0.06).

Table 6. Linear regression analysis with practice score as the dependent variable (N=1055).

Independent variables	Univariate model		Multivariable model	
	Unadjusted coefficient beta (95% CI)	P-value	Adjusted coefficient beta (95% CI)	P-value
Females vs. males	1.75 (1.12 to 2.37)	<0.001	2.03 (1.42 to 2.65)	<0.001
Age	0.03 (0.01 τo 0.06)	0.001	0.04 (0.02 to 0.06)	0.001
Educational level				
University degree vs. high school	-0.88 (-1.41 to -0.35)	0.001	-0.26 (-1.03 to 0.52)	0.518
MSc diploma vs. high school	1.04 (0.51 to 1.57)	<0.001	0.82 (-0.01 to 1.63)	0.052
PhD diploma vs. high school	0.23 (-0.67 to 1.13)	0.616	0.46 (-0.64 to 1.57)	0.410
Living with other	-0.22 (-0.90 to 0.47)	0.537	-0.22 (-0.88 to 0.45)	0.524
Urban vs. rural residence area	0.16 (-0.62 to 0.95)	0.683	0.23 (-0.54 to 1.003)	0.552
Workers	0.15 (-0.54 to 0.85)	0.662	-0.68 (-1.41 to 0.05)	0.066
Air-conditioner ownership	0.79 (-0.06 to 1.64)	0.067	0.83 (-0.0005 to 1.66)	0.050
Voluntary activities	-0.34 (-1.08 to 0.41)	0.375	-0.49 (-1.21 to 0.23)	0.183
Self-perceived health status				
Moderate to poor/very poor	-0.04 (-0.82 to 0.75)	0.930	5.08 (3.57 to 6.58)	<0.001
Good/very good to poor/very poor	1.28 (0.58 to 1.98)	<0.001	5.22 (3.82 to 6.61)	<0.001
Self-perceived financial status				
Moderate to poor/very poor	-0.35 (-0.87 to 0.17)	0.189	0.65 (-0.49 to 1.79)	0.261
Good/very good to poor/very poor	0.76 (0.24 to 1.27)	0.004	1.04 (-0.12 to 2.20)	0.080

CI: confidence interval; Adjusted R^2 for the model=10.5%; p-value for ANOVA<0.001.

We present the results of the linear regression analysis with behavior score as the dependent variable in Table 7. We found that females had better behavior towards heat waves than males (adjusted beta: 1.17, 95% CI: 0.74 to 1.60). Additionally, behavior score was higher among participants in urban areas than those in rural areas (adjusted beta: 0.62, 95% CI: 0.08 to 1.16). Moreover, increased health status and financial status were associated with increased behavior score. In particular, participants with moderate (adjusted beta: 2.38, 95% CI: 1.33 to 3.44) or good/very good health status (adjusted beta: 1.78, 95% CI: 0.80 to 2.76) had higher behavior score compared to those with poor/very poor health status. Also, participants with moderate (adjusted beta: 0.90, 95% CI: 0.10 to 1.70) or good/very good financial status (adjusted beta: 1.70, 95% CI: 0.89 to 2.51) had higher behavior score compared to those with poor/very poor health status.

Table 7. Linear regression analysis with behavior score as the dependent variable (N=1055).

Independent variables	Univariate model		Multivariable model	
	Unadjusted coefficient beta (95% CI)	P-value	Adjusted coefficient beta (95% CI)	P-value
Females vs. males	1.02 (0.59 to 1.44)	<0.001	1.17 (0.74 to 1.60)	<0.001
Age	0.001 (-0.01 τo 0.02)	0.934	0.001 (-0.02 to 0.02)	0.923
Educational level				

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University degree vs. high school	-0.11 (-0.48 to 0.25)	0.544	-0.17 (-0.71 to 0.37)	0.543
MSc diploma vs. high school	0.08 (-0.29 to 0.44)	0.683	-0.05 (-0.61 to 0.52)	0.872
PhD diploma vs. high school	0.20 (-0.41 to 0.82)	0.519	0.10 (-0.68 to 0.87)	0.807
Living with other	-0.04 (-0.51 to 0.43)	0.864	-0.02 (-0.48 to 0.45)	0.944
Urban vs. rural residence area	0.50 (-0.04 to 1.04)	0.067	0.62 (0.08 to 1.16)	0.024
Workers	-0.13 (-0.61 to 0.34)	0.584	-0.18 (-0.70 to 0.33)	0.479
Air-conditioner ownership	0.11 (-0.47 to 0.69)	0.711	0.04 (-0.54 to 0.63)	0.882
Voluntary activities	-0.25 (-0.76 to 0.26)	0.339	-0.29 (-0.80 to 0.21)	0.253
Self-perceived health status				
Moderate to poor/very poor	0.38 (-0.15 to 0.92)	0.160	2.38 (1.33 to 3.44)	<0.001
Good/very good to poor/very poor	0.24 (-0.25 to 0.72)	0.341	1.78 (0.80 to 2.76)	<0.001
Self-perceived financial status				
Moderate to poor/very poor	-0.52 (-0.88 to -0.16)	0.004	0.90 (0.10 to 1.70)	0.027
Good/very good to poor/very poor	0.82 (0.47 to 1.17)	<0.001	1.70 (0.89 to 2.51)	<0.001

CI: confidence interval; Adjusted R^2 for the model=6.2%; p-value for ANOVA<0.001.

4. Discussion

The present study assessed participants' knowledge, attitudes, practice and behavior related to heat waves and investigated predictors of these variables. According to the results, the participants were found to have a high level of knowledge, attitudes, behavior and practice about heat waves, as they scored high in all subscales. Greece is located in the Mediterranean region, where heat waves of particularly high intensity, frequency and duration are common [11]. The experiences of residents, combined with the information provided by the state, may have contributed to improving the level of knowledge and public awareness in health-protective behaviors in case of heat waves. A study in the United States showed that residents living in the hottest states had high heat-risk perceptions [26].

We found that females had a better level of knowledge and attitudes compared to males. This finding is consistent with study findings where females were found to be more engaged in health-protective behavior in relation to heat waves than males [18]. Females seem to exhibit more protective behavior than males when it comes to life-threatening situations. As in the case of the COVID-19 pandemic, where females were more likely to undergo rapid test and comply with government guidelines than males [27,28]. Participants with a higher educational level were found to have a better level of knowledge. This finding is in consistence with similar studies in the USA and Europe, where having a lower educational level was a predictor for lower knowledge levels on heat wave protective measures [29,30]. High educational attainment, also, plays a protective role by reducing the risk of heat wave mortality [31,32]. This finding can be explained by the fact that people with higher educational attainment may have better access to knowledge or information on heat wave health risks, the vulnerable groups and protective measures. It is also possible that educational level is related to the work of individuals, as those with a lower educational level may be working outdoors and therefore be at higher risk in the event of a heat wave.

The health status of the participants in this study was found to be a predictor of their level of knowledge, awareness, practice and behavior. Specifically, better health status was associated with increased score in all subscales. Similar findings with the present study in another one, where the self-rated health was significantly associated with awareness of heat wave alert and engaging in health-protective behaviors [18]. The advanced level of knowledge of the healthier participants, regarding heat waves, may be due to their general health attitudes towards issues that can negatively affect their health. They probably choose to be informed about health and public health issues and choose healthier behaviors and lifestyles. Although, citizens with a poor health status are vulnerable to heat waves [33], they are often unaware of this vulnerability and also are unaware of the effectiveness of important protective behaviors [34]. Therefore, the need for the state to intervene with targeted information programs on the risks of heat waves to vulnerable groups, such as citizens with chronic diseases and generally poor health status, is considered extremely important. The

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intervention programs contribute to education, awareness raising and the development of adaptive behaviors to deal with the risk of heat waves [35]. It is important to educate citizens, as their perceptions of heat waves and the risks arising from them can mediate individual behavioral intentions upon exposure to high ambient temperatures [36].

The economic status of the participants in our study was found to influence their awareness, practice and behaviors regarding heat waves, as the higher the economic status, the higher the score in these subscales. Our findings are confirmed by studies in the literature, where a study in New York found that low-income participants were less likely to be aware of heat warnings [37], in another study in China high-income participants had higher scores in the practice section [38] and study in Australia found that high-income participants were more likely to have good adaptive behaviors' during a heat wave [39]. It is likely that high-income citizens have better access to information sources, more free time to participate in information programs or that the communities they live in are more aware of public health issues such as heat wave protection.

Our study had several limitations. Since we obtained a convenience sample, we cannot generalize our results. Our sample was not representative of the source population. For example, most of our participants were highly educated females. Further studies with random and stratified samples can reduce our selection bias. Additionally, we conducted our study in a sample of Greek population. Thus, we should conduct more studies in different countries, cultures and settings to expand our conclusions. Although we investigated several socio-demographic predictors of individuals' knowledge and attitudes about heat waves, we cannot measure all potential predictors in our study. Future studies should expand our knowledge by investigating more predictors, e.g. job, psychosocial factors, personality traits, etc. Moreover, the cross-sectional design of our study did not allow us to estimate causal relationships between socio-demographic variables and participants' knowledge and attitudes about heat waves. Longitudinal studies can reduce this bias assessing also changes in people's behaviors through time. Finally, we used a self-reported scale to assess individuals' knowledge and attitudes about heat waves. Although our scale has proven to be valid and reliable in the Greek language, an information bias is probable in our study.

5. Conclusions

Climate change has affected the temperature of the planet, as it is increasing in every region of the world. Rising temperatures are associated with the occurrence of heat waves. As heat waves are becoming more frequent, intense and long-lasting, it is essential for the protection of public health that citizens are aware of the risks arising from this phenomenon, the vulnerable groups in the event of heat waves and the protective measures to be taken. It is also to these groups that the state should direct its information programs in order to reduce the impact of heat waves. This study has highlighted the high level of knowledge of citizens regarding heat waves, as well as the important predictors that influence citizens' knowledge and behavior. The data from the study can be used in terms of public health protection.

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