Heatwave preparedness in urban Georgia: A street survey in three cities

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ABSTRACT

Background: The frequency and intensity of heatwaves are expected to increase in the coming years. To promote resilient cities, it is key to have insights in populations with low preparedness levels. This study investigated personal characteristics associated with heatwave-protective knowledge, and preferred information channels and sources on this topic in cities in Georgia.

Methods: We undertook a street survey among three large cities in Georgia, including the capital Tbilisi. We collected demographic, socio-economic, medical and behavioural characteristics as potential risk factors for reduced heatwave-protective knowledge. Furthermore, we asked respondents about information channels and sources they use and prefer to obtain information on heatwave-protective measures.

Results: Being male, parent of children under the age of 12 and having a lower educational level are risk factors for lower knowledge levels on heatwave protection. Being homemakers, retiree, having fasted and using medication are protective factors. Television and internet are the channels more often used for obtaining information on heatwave-protective measures, and people prefer to receive information on this topic from health authorities.

Conclusion: Our findings identified characteristics that make people more vulnerable to heatwaves, due to a reduced knowledge level on heatwave protection. Targeted communication towards these groups, using information sources and media specifically aimed at this target audience, could improve this.

1. Background

1.1. Heatwave occurrence and impact

Most countries are already experiencing consequences of climate change, or will experience them in the coming years (Climate Change, 2013). This is also the case for Georgia, which experienced on average 1.7 heatwaves per year over the period 1961–2010, with an average duration of 5.5 days, using heatwave indices developed by the World Meteorological Organization (Keggenhoff, Elizbarashvili, & King, 2015b). Over this same period, the number, intensity and duration of heatwaves has increased by 0.4 days/decade, 1.1 °C/decade and 0.9 days/decade, respectively (Keggenhoff, Elizbarashvili, & King, 2015a; Keggenhoff et al., 2015b). This increase was particularly felt in Tbilisi, the capital and largest urban area of the country (Keggenhoff et al., 2015b). A particularly severe heatwave hit Tbilisi in 2011, reaching temperatures of over 41 °C (Barry, 2011). It is expected that there will be a further increase in the number of very warm, hot and very hot days in Tbilisi in the period 2020–2049, compared to the baseline period 1990–2007 (Westphal, Mehtiyev, Shvangiradze, & Tonoyan, 2011). The timing, duration and frequency of heatwaves contribute to their human impact, and heatwaves can in addition lead to an increase in air pollution, particularly ozone, which further exacerbates their harmful effects (Kalisa, Fadlallah, Amani, Nahayo, & Habyariremye, 2018). We identified only one source that described the effects of heatwaves on health of the Georgian population, in which they showed an increase in cardiovascular hospital admissions, particularly in Tbilisi (Georgia’s Third National Communication to the UNFCCC, 2015). This is in line with a 2019 literature review, which highlighted a research gap in studies on the impact of heatwaves in low- and middle-income countries (Green et al., 2019). However, previous research in other settings has clearly demonstrated negative consequences of high temperatures on human

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health, such as an increase in mortality (Benmarhnia, Deguen, Kaufman, & Smargiassi, 2015; Gasparrini & Armstrong, 2011) and an increase in emergency room admissions, specifically for respiratory, heat-related and infectious diseases (Ragettli, Vicedo-Cabrera, Fluckiger, & Roosli, 2019; van Loenhout et al., 2018).

1.2. Urban heatwave mitigation

Although there is no universally accepted definition for heatwaves, they are generally considered to be periods of unusually hot weather, lasting for at least several days, and having a negative impact on human health (Heat & health in the WHO European Region: updated evidence for effective prevention, 2021). Also, in Georgia, no formal definition for a heatwave exists. Instead, historical data have been used to develop a heat index, which takes both temperature and relative humidity into consideration, and is an indicator of thermal comfort of the population (Kiseliova, Fandoeva, & Sikharulidze, 2014). Heatwaves are known to be especially problematic in cities, partly due to the positive relationship between population density and perceived heat stress (Zander, Cadag, Escarcha, & Garnett, 2018), and partly due to the urban heat island effect, which is prevalent in areas with high settlement density and sparse vegetation (Arnfeld, 2003). This effect is amplified during extremely warm days (Ramamurthy & Sangobanwo, 2016). More people will be impacted by urban heatwaves in the future, as the proportion of the world population living in cities will increase from 55 % in 2018 to 68 % in 2050 (The world population projected to live in urban areas, 2018). In Georgia specifically, 53 % of the population is living in cities, of which more than half in the capital Tbilisi (Westphal et al., 2011). Different actions can be taken to reduce the impact of heatwaves on urban settings, targeted towards urban planners and designers, and various services and tools exist that translate scientific knowledge into actionable knowledge (Keramitsoglou et al., 2017). This includes the use of high albedo materials in building surfaces and urban inland water (O’Malley, Piroozfar, Farr, & Pompomni, 2015). Provision of urban green space also helps in reducing the heat island effect (Ronchi, Salata, & Arcidiacono, 2020), and further contributes to relaxation and recreation of residents in a relatively cool environment during heatwaves. However, the spaces need to adhere to certain standards in order to be effectively used by residents (Wlodarczyk-Marciniak, Sikorska, & Krause, 2020), such as presence of vegetation and water, and usage of cool materials. Several barriers can exist that prevent use of urban green space, especially among low-income ethnic families, such as lack of knowledge on where to go and fear of antisocial behaviour (Croinin-de-Chavez, Islam, & McEachan, 2019). Furthermore, studies that specifically investigated the impact of urban green spaces on human health are very scarce, and there is no concluding evidence yet that they have a positive impact on health (Kondo, Fluhr, McKeon, & Branas, 2018). Overall, modifications in urban design are only effective and sustainable if inhabitants have sufficient knowledge and awareness on how to properly use urban green spaces during heatwaves.

1.3. Vulnerability, exposure and adaptive capacity

Two categories of populations vulnerable to heatwaves have been identified. First, those who are at an increased risk for experiencing negative health effects or even death, such as the elderly (Hajat, Kovats, & Lachowycz, 2007), small children (Knowlton et al., 2009), people with chronic conditions (Schifano, Cappai, Sario, Bargagli, & Michelozzi, 2013) and people belonging to a lower income group (Lopez-Bueno et al., 2020). Second, those who are more exposed to heatwaves, such as people with a lower socio-economic status and ethnic minorities, who are more likely to live in urban heat islands with high settlement density and sparse vegetation (Harlan, Bazel, Prashad, Stefanov, & Larsen, 2006). A study on exposure to land surface temperature in the Netherlands showed that especially immigrants and women are overexposed (Mashhoodi, 2021). In addition, there is large variation in indoor temperature between residences due to differences in housing characteristics such as building materials used, age of the dwelling and position of the windows (White-Newsome et al., 2012; Zuurier et al., 2021). Indoor temperatures are further exacerbated in buildings with low thermal comfort, which are common in historical cities such as Tbilisi (Caro & Sendra, 2020). This difference in building heat resistance and consequently indoor heat exposure also affects the extent to which inhabitants report heat-related health symptoms (Hatvani-Kovacs, Belusko, Skinner, Pockett, & Boland, 2016; van Loenhout et al., 2016). Besides sensitivity and exposure, climate vulnerability is also determined by adaptive capacity (Thomas et al., 2019). A definition of adaptive capacity in disaster resilience is “the arrangements and processes that enable adjustment through learning, adaptation and transformation” (Parsons et al., 2016). By increasing knowledge on disaster protection, the adaptive capacity of citizens grows, which in turn leads to higher levels of household and community preparedness (Thomas, Leander-Griffith, Harp, & Cioffi, 2015). However, knowledge levels on disaster protection vary between different groups. For example, previous studies undertaken in Europe showed that people with a lower education (van Loenhout & Guha-Sapir, 2016) and those with a foreign nationality (Gil Cuesta, van Loenhout, Colaco, & Guha-Sapir, 2017) were less familiar with identifying groups at risk for heatwaves and measures to protect themselves from negative heat impacts. This uneven distribution of vulnerability and risk makes this an important climate justice issue. Although interest in social inequalities and climate change is growing, little is known about the potential link between climate justice and adaptation policy (Yang, Lee, & Juhola, 2021). A comprehensive overview of factors that determine vulnerability in terms of adaptive capacity and disaster preparedness is currently lacking.

1.4. National heat health action plans

It has been shown that providing information on the severity of a hazard increases information-seeking behaviour of the population, and in turn improves willingness to undertake actions for protection against the hazard (Newnham, Dunwoody, & Griffin, 2000). Knowledge levels on heatwave protection and individual preparedness for heatwaves can be improved by means of specific government activities. In various countries, National Heat Health Actions Plans (NHHAPs) exist, that among other purposes aim to improve knowledge on and awareness regarding heatwaves in the general population, and in particular among vulnerable groups (Lowe, Ebi, & Forsberg, 2011). Plans differ between countries in terms of stakeholders and how messages are communicated to the public (Casasueva et al., 2019). However, whether a NHHAP is successful in protecting the general public and vulnerable populations depends on the extent to which communicated messages reach targeted audiences, and on whether people trust the information and act upon it. Previous studies have shown that the general public is often unfamiliar with their country’s NHHAP (Gil Cuesta et al., 2017; van Loenhout & Guha-Sapir, 2016). Furthermore, trust in government institutions regarding climate change communication can be very low, especially among low socio-economic groups, since climate change is a highly
politicised issue (Palmer, Bowd, & Griffiths, 2017). However, trust in authorities and experts has been identified as one of the main factors to influence risk perceptions with respect to natural hazards (Wachinger, Renn, Begg, & Kuhlicke, 2013). A study describing and analysing attitude of the public towards local governments in Georgia showed that local populations have a relatively high level of trust in local governments and believe that these stakeholders should be primarily concerned with the well-being of citizens (Swianiewicz, 2011). To improve the effectiveness of NHHAPs, it is important to better understand through which channels people would prefer to receive information about heatwave occurrence and preparedness measures, which sources they consider reliable, and from which sources they would prefer to receive such information.

1.5. Study objectives

There is currently no official NHHAP in place in Georgia. Nonetheless, the country is interested in implementing one as part of its National Environmental Health Action Plan. To enhance the effectiveness of this NHHAP, they aim to incorporate citizen-based insights during the development of the plan. This will ensure alignment with the local situation to the extent possible. Within this study, we assessed which personal characteristics are risk or protective factors for the level of knowledge on heatwave-protective measures, and hence for having a lower level of preparedness and being more vulnerable to the impacts of heatwaves. This offers important insights in groups that are particularly affected by climate injustice and require extra attention in communication on heatwaves and protection measures. Furthermore, we assessed from which sources people expect to receive information regarding heatwave-protective measures.

2. Methods

2.1. Study setting

Georgia is a country in the South Caucasus region, and has a surface area of 69,700 km² (Georgia, 2021). The west side of Georgia consists of the Black Sea coastal band. The geography of Georgia is characterized by vertical zoning, and two-thirds of the country are mountainous (Rukhadze, Vachiberidze, & Fandoeva, 2014). Despite the country’s relatively small size, it contains contrasting ecosystems, such as semi-desserts in the east and forests that are almost sub-tropical in the west (Nakhutsrishvili, 2013). Georgia’s geography also has an impact on its climate: the west of the country experiences relatively mild winters and hot summers and the east of the country has a more continental climate, while the mountain region is the coldest. July is on average the warmest month of the year, and the average-high temperature is 29.9 °C. The average heat index estimated in that month is 31.4 °C (Monthly weather forecast & climate for Tbilisi, 2021).

Georgia has a population of 3.7 million people, a population density of 53.1 persons/km², and an average life expectancy of 77.0 years (CIA: Central Intelligence Agency, 2020). The proportion of women is 52.1 %. With a Gross Domestic Product of USD 4,786 per capita in 2019, Georgia is considered an upper-middle income country (The World Bank in Georgia, 2021). More than half of Georgians reside in urban areas (53 %), in particular in the capital Tbilisi (Westphal et al., 2011). However, to obtain a more diverse sample of urban residents in our study, we selected three cities from which residents could participate in our study, namely Tbilisi, Batumi and Telavi. These cities have populations of 1,184,282; 204,156 and 19,629, respectively, making it the 1st, 2nd and 14th biggest cities of the country. The unemployment rates of the

![Fig. 1. Cities selected for our study, namely Tbilisi (1), Telavi (2) and Batumi (3).](image-url)
regions where the three cities are located (Tbilisi, Adjara and Kakheti, respectively) were 16.3 %, 17.6 % and 13.5 % in 2019 (Geostat, 2021). Tbilisi and Telavi are located in the east and have a continental climate, while Batumi is located in the west (Fig. 1). Batumi has invested in heatwave resilience in recent years by implementing several measures, including a Heat Wave Action Plan (East, 2017).

2.2. Questionnaire development

The questionnaire in our study was based on one that was previously used by the first author in similar studies in four European countries, namely Netherlands, Belgium, Spain and Portugal (Gil Cuesta et al., 2017; van Loenhout & Guha-Sapir, 2016). However, the questionnaire in this study collected more in-depth information on risk and protective factors, as well as on items that reflect heatwave-protective knowledge. It included demographic (age, gender) and socio-economic (educational level, employment status) questions, as potential risk or protective factors for the level of heatwave-protective knowledge. In addition, we also asked medical (using daily medication for a chronic disease) and behavioural (participating in a fast) information, as this can also influence vulnerability to heatwaves. We asked respondents whether they considered themselves well-informed about heatwaves. We included an open question on channels that people consulted regarding heatwave-protective measures, and an open question on sources that respondents considered themselves well-informed about heatwaves. We asked respondents whether they preferred to receive information from on this topic. Finally, we included four questions on heatwave-protective knowledge of respondents. For this, we distinguished four categories of knowledge, which combined we consider key in protecting oneself and others from heatwave impact. We followed the Protection Motivation Theory, and included two knowledge items linked to threat appraisal (vulnerability), and two linked to coping appraisal (protective and mitigation actions) (Rogers, 1975), all of which strengthens adaptive capacity of individuals to heatwaves:

1) Symptoms that people can develop due to heatwaves (threat appraisal): knowledge on this allows people to recognise whether they or others are potentially suffering from heat-related illness;
2) Risk groups for an increased negative impact from heatwaves (threat appraisal): this knowledge is important, in order to check up on or give special emphasis to those particularly vulnerable for heatwave impacts;
3) Heatwave-related protective measures (coping appraisal): this allows people to take appropriate actions in order to prevent heat illness for themselves and others
4) Actions to take in case of overheating (coping appraisal): this type of knowledge allows people to undertake appropriate action in case someone in their direct environment is suffering from heat-related illness;

The respondents’ level of knowledge was investigated for each category, by first asking them whether they knew any, for example, symptoms people can develop due to a heatwave. Next, if they replied yes, they were asked to list every symptom they knew in an open question. Some of the answers that we were expecting respondents to give more frequently were included in the questionnaire, but were only visible to enumerators.

The English version of the survey was translated into Georgian, and a back-translation was conducted to ensure the accuracy. The questionnaire can be found in Appendix A.

2.3. Sample size calculation

We obtained a sample of respondents among citizens of the study cities, while ensuring variation in terms of age, gender and educational level. We calculated the required sample size using Cochran’s sample size formula:

\[ n_0 = \frac{Z^2 * p * (1-p)}{e^2} \]

We used a margin of error (e) of 5%, a confidence interval of 95% (Z = 1.96). The component ‘p’ is the proportion of the population that has the attribute in question. Since we did not have information on this, we used a value of 50%, the most conservative estimate. We found that the minimal required sample size was 385 for the three cities combined. To ensure a sufficiently large sample, in case some questionnaires could eventually not be used, we decided to include a small margin and include at least 30 respondents extra. The sample size per city was calculated based on the relative size of the population in relation to the overall country’s population.

2.4. Data collection

The data were collected in September 2019 by undertaking a street survey among residents of Tbilisi, Batumi and Telavi. In each city, different locations were selected based on the presence of a relatively large number of passer-by’s (e.g. markets, malls, shopping streets). However, we avoided locations where people would be in a hurry, such as train or bus stations, and locations that would have a relatively low proportion of locals, such as touristic spots. In addition, we ensured variation in the selected locations per city in terms of socio-economic backgrounds, i.e. high, low and mixed. The number of locations was 7, 5 and 3 in Tbilisi, Batumi and Telavi, respectively (following the difference in size between the cities).

The survey team, consisting of one data manager and six enumerators, collected the data in each location, using paper surveys. All of them had been previously trained in undertaking the survey in a standardised way (e.g. asking questions as literal as possible, and making sure to know which questions had to be asked in an open way). Random passer-by’s were asked to participate, namely each fifth individual, to avoid inclusion of clusters of people from the same group (e.g. husband and wife). The survey started with a brief description of the study, after which the passer-by was asked for oral informed consent to participate. Only adults (≥ 18 years) living in the city of interest were eligible to participate. On average, it took 10 min to complete the survey. The data manager kept track of the number of completed surveys, assessed when the target number of surveys was reached and decided when the team could move to the next location. The target number of surveys was 40 per location in Tbilisi, and 20 in Batumi and Telavi, although small adjustments were made in case the number of potential respondents in a certain location was low. The maximum temperature in the three cities varied between 20 and 28 °C, with one day reaching 30 °C in Tbilisi. The number of respondents in our study was 420. One questionnaire was stopped early on, which made it unfit for use in the analyses. This brings the final sample of total usable questionnaires to 419.

2.5. Data description

The open answers to the questions on heatwave-protective knowledge were partly categorised during the data collection by including predefined answer options in the questionnaire, only visible to
enumerators. They were further categorised by the research team into different groups based on their similarity (e.g. the symptoms ‘excessive sweating’ and ‘fever’ were both listed under ‘thermoregulation-related problems’). The predefined categories were based on insights from previous research (Gil Cuesta et al., 2017; van Loenhout & Guha-Sapir, 2016), and other groups were iteratively added during the analysis based on responses. The final groups were decided through a process that ensured inter-rater reliability between two researchers. Each researcher categorised the answers according to his/her best assessment, after which they were discussed and a final agreement was made on the groups, as well as the answers belonging to them. For the groups related to heatwave-related symptoms, we obtained additional input from a medical doctor. In addition, we determined for each question which groups reflected ‘correct’ answers, and which ones were ‘incorrect’. Incorrect in this case means that the answer is not supported by current insights or literature, e.g. men as a risk group for heatwaves. All correct answers were summed, to come up with a total number of correct answers per respondent, for the four categories combined, based on the four open questions in the survey. This continuous variable was used as a proxy for respondents’ overall heatwave-protective knowledge.

Educational level was reclassified into three levels, namely high, medium and low. For the question on whether respondents considered themselves informed about heatwaves, we grouped ‘very well informed’ and ‘somewhat informed’ into the category ‘informed’, and we grouped ‘not very well informed’ and ‘not at all informed’ in the category ‘uninformed’. Answers to the questions on information sources were partly informed that they could end the questionnaire at any moment. We did not collect any personal identifiers in this study (e.g. name, address).

2.6. Data analysis

We carried out all analyses using IBM SPSS Statistics 25. We used Pearson’s chi-square tests and Analysis of Variance (ANOVA) to test for differences in socio-demographic characteristics between the study cities, for categorical and continuous variables, respectively. We used univariate linear regression to identify characteristics associated with heatwave-protective knowledge. Those characteristics which were statistically significant were included in a multivariate model. We removed characteristics that did not show statistical significance in the multivariate model using a backwards analysis, which led to the final multivariate model. We used chi-square tests to assess differences in the extent to which respondents considered themselves informed about heatwaves, for those groups identified in the regression model as lacking knowledge. In all analyses, a p-value of < .05 was considered to be statistically significant, based on two-sided tests.

2.7. Ethics

We obtained ethical clearance from Institutional Review Boards from the Georgian National Center for Disease Control and Public Health in Georgia (ref. no. 2019-014). All respondents provided oral informed consent prior to their participation in the study. Respondents were informed that they could end the questionnaire at any moment. We did not collect any personal identifiers in this study (e.g. name, address).

3. Results

3.1. Descriptive statistics

A breakdown in terms of demographic and socio-economic characteristics of our sample by study city is presented in Table 1. The numbers of male and female respondents were fairly equal, representing the gender distribution among the overall Georgian population (52.1 %). The average age was almost 50, and was highest in Telavi and lowest in Batumi. Educational level differed between the cities as well, and respondents in Batumi had on average a lower education than in the other two cities. The proportion of employed respondents was a bit lower in Batumi than in the other two cities, and the proportion of students was higher. The unemployment rates in our sample were lower than the regional averages where each city was located (16.3 vs. 7.2 %, 17.6 vs. 9.4 % and 13.5 vs. 8.7 %). Respondents in Tbilisi worked more often outdoors than in the other two cities, and respondents in Telavi took

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Descriptive overview of study participants.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal characteristic</td>
<td>Tbilisi</td>
</tr>
<tr>
<td>Male gender</td>
<td>N = 265</td>
</tr>
<tr>
<td>Mean age (sd)</td>
<td>49.1 (17.6)</td>
</tr>
<tr>
<td>Low</td>
<td>118 (44.5)</td>
</tr>
<tr>
<td>Medium</td>
<td>92 (34.7)</td>
</tr>
<tr>
<td>High</td>
<td>29 (10.9)</td>
</tr>
<tr>
<td>Children below 12</td>
<td>75 (28.3)</td>
</tr>
<tr>
<td>Student</td>
<td>14 (5.3)</td>
</tr>
<tr>
<td>Employed / self-employed</td>
<td>191 (72.1)</td>
</tr>
<tr>
<td>Work mainly outdoors</td>
<td>107 (56.0)</td>
</tr>
<tr>
<td>Work taking care of others</td>
<td>21 (11.0)</td>
</tr>
<tr>
<td>Participated in (religious) fast</td>
<td>103 (38.9)</td>
</tr>
<tr>
<td>Medication for chronic disease</td>
<td>108 (40.8)</td>
</tr>
</tbody>
</table>

- Low educational level consists of: None, Primary education, Secondary education; medium educational level consists of: Vocational/Professional education; high educational level consists of: College/University.
- In the questionnaire, the term ‘housewife’ was used, which was a term that respondents were more familiar with. All homemakers that participated in our study were female.
- The questions on ‘working mainly outdoors’ and ‘work consists of taking care of others’ were only addressed to respondents who were employed/self-employed. The sample sizes were 191, 54 and 47 in Tbilisi, Batumi and Telavi, respectively.
medication for a chronic disease more often.

3.2. Risk and protective factors for level of heatwave-protective knowledge

For each of the four questions on heatwave-protective knowledge (symptoms, risk groups, protective measures, heat actions), we present the number of respondents who provided a certain correct answer in Fig. 2. This figure only contains correct responses, as these contribute to the respondents’ overall knowledge level with respect to heatwave preparedness. When we plot the number of overall correct answers provided to the proportion of respondents who provided that number, we find that the proportion is highest for those who participate in religious activities and lowest for those who work mainly outdoors.

Table 2

Personal characteristics associated with heatwave-protective knowledge.

<table>
<thead>
<tr>
<th>Personal characteristic</th>
<th>Univariate b-value (CI)</th>
<th>p-value</th>
<th>Multivariate b-value (CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intercept</strong></td>
<td></td>
<td></td>
<td></td>
<td>.011</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-0.7 (-1.2 to -0.2)</td>
<td>.011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Ref</td>
<td>Ref</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td>.645</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>1.0 (0.4 to 1.5)</td>
<td>.001</td>
<td>0.9 (0.3 to 1.5)</td>
<td>.003</td>
</tr>
<tr>
<td>Medium</td>
<td>1.4 (0.5 to 2.2)</td>
<td>.001</td>
<td>1.4 (0.6 to 2.3)</td>
<td>.001</td>
</tr>
<tr>
<td>Low</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td><strong>Children below 12</strong></td>
<td>-0.6 (-1.2 to -0.4)</td>
<td>.037</td>
<td>-0.8 (-1.3 to -0.2)</td>
<td>.010</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
<td>.001</td>
<td></td>
<td>.003</td>
</tr>
<tr>
<td>Student</td>
<td>0.9 (-0.2 to 1.9)</td>
<td>.106</td>
<td>1.0 (-0.1 to 2.1)</td>
<td>.064</td>
</tr>
<tr>
<td>Unemployed</td>
<td>-0.2 (-1.2 to 0.7)</td>
<td>.644</td>
<td>-0.2 (-1.2 to 0.7)</td>
<td>.620</td>
</tr>
<tr>
<td>Retired</td>
<td>1.0 (0.2 to 1.9)</td>
<td>.018</td>
<td>0.7 (-0.1 to 1.6)</td>
<td>.087</td>
</tr>
<tr>
<td>Homemaker</td>
<td>2.4 (1.3 to 3.6)</td>
<td>&lt;.001</td>
<td>2.0 (0.9 to 3.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>-0.6 (-4.3 to 3.1)</td>
<td>.748</td>
<td>-0.7 (-4.3 to 3.0)</td>
<td>.719</td>
</tr>
<tr>
<td>Employed / self-employed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work mainly outdoors</td>
<td>-0.3 (-0.9 to 0.3)</td>
<td>.333</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work taking care of others</td>
<td>0.5 (-0.5 to 1.5)</td>
<td>.351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participated in (religious) fast</td>
<td>0.8 (0.3 to 1.4)</td>
<td>.003</td>
<td>0.7 (0.2 to 1.2)</td>
<td>.011</td>
</tr>
<tr>
<td>Medication for chronic disease</td>
<td>0.6 (0.1 to 1.1)</td>
<td>.026</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R² = .113 (Adjusted R² = .094).

a) p-values of characteristics with a statistically significant contribution are hatched in grey.
Using univariate models, several personal characteristics were significantly associated with knowledge level, as presented in Table 2. The data follow a normal distribution (Appendix B). Women had on average a significantly higher knowledge level than men. There was no significant association with age. Respondents with a high or medium educational level were on average more knowledgeable than those with a low educational level. Respondents with children below the age of 12 had less knowledge than those without children or children above the age of 12. The employment categories with the highest knowledge levels were the retired and homemakers. People who had participated in a religious fast in the same year had on average higher knowledge levels than those who had not participated, and people who use medication daily for a chronic disease had more knowledge than those who do not use medication.

In the multivariate model, the characteristics that remained statistically significant were educational level, having children below 12, employment status, and having participated in a religious fast (Table 2). The directions were the same as within the univariate models. The R² of the model was .113.

For the groups of respondents who were found to be less knowledgeable in the regression analyses, i.e. men, those with a low education, and those with children under the age of 12, we assessed whether they also considered themselves less informed. Men considered themselves more often uninformed than women (p = .012). Those with a low education considered themselves more often uninformed than those with a high education, but similar to those with a medium education (p = .001). There was no difference in respondents with or without children under the age of 12 (p = .819).

3.3. Information sources on heatwave-protective measures

The most common information channel that respondents used to obtain information on heatwave-protective measures was television (38 %). This was followed by the internet, in-person information from a doctor or other health professional, social media, and information from relatives or friends (Table 3). Almost one fourth of respondents indicated that they did not consult any channel, and more than 10 % did not know which channel they consulted. We checked whether there were notable differences between all respondents and the groups identified to have fewer knowledge in the linear regression (i.e. men, those with low education, those with kids under the age of 12), but the results were similar. Men and those with kids under the age of 12 indicated slightly more often than average that they did not consult any channel (27 and 30 %, respectively).

When we asked respondents from whom they expect information, over one third indicated a health authority (Table 3). Other notable stakeholders were healthcare professionals, the meteorological agency, an environmental agency, and the media. A small proportion of respondents (4%) did not have a preference, and 3% of respondents mentioned they did not need information. Around 10 % answered they did not know. We did not see notable differences between all respondents and the groups less informed subgroups identified in the linear regression analyses, although people with a low education and those with children under the age of 12 slightly more often indicated that they did not know who to expect information from (15 and 14 %, respectively).

4. Discussion

This study is the first to describe heatwave-protective knowledge, and particularly risk factors for poor knowledge, among urban residents in Georgia. As the frequency, the duration, and intensity of heatwaves in the South Caucasus region is set to increase in the coming decades (Jincharadze & Simonett, 2013), information on residents particularly at risk is vital to improve their adaptive capacity against heatwaves and hence reduce climate injustice. Policy makers can use such findings when developing national and local heatwave health adaptation plans, aimed at making cities more socially resilient.

Our study identified several characteristics that were associated with a lower knowledge level for heatwave protection. Several of those were statistically significant in both the univariate and multivariate models, for which we consider the evidence to be strongest. Since having (access to) adequate heatwave-protective knowledge is an indicator for adaptive capacity of citizens, these characteristics can also be seen as risk factors for climate injustice. A risk factor that only showed statistical significance in the univariate regression model was being male. This difference between genders was also visible when respondents were asked whether they considered themselves informed about heatwaves, where women scored higher as well. Previous research has shown that women express greater risk perception about climate change and related issues than men (Pearson, Ballew, Naiman, & Schuld, 2017). In addition, women are often overexposed to severe land surface temperatures (Mashhoodi, 2021). The higher level of concern and higher exposure could be a reason why women tend to inform themselves better. The finding that people with a low educational level had less heatwave-protective knowledge than those with medium or high level is also supported by a previous study in Belgium and the Netherlands (van Loenhout & Guha-Sapir, 2016). Nonetheless, this emphasizes the fact that more attention should be given to increasing the knowledge on heat health risks and protective measures of those with a low education, through sources and channels that they indicate to use for this type of information. We also found that respondents with children under the age of 12 had a lower knowledge level than those without children in that age group. Young children, particularly those within the age range 0–4 years, are considered a vulnerable group, and they have a higher chance of being admitted to the hospital for heat-related illnesses (Knowlton et al., 2009; Smith et al., 2016), which makes this a worrisome finding. In addition, parents of young children do not seem to be sufficiently aware of their lower knowledge level, as there was no significant difference in how informed people felt between respondents with and without children under the age of 12. A study among parents of elementary school children in South Korea also found that almost three
out of four scored not or minimally prepared when it comes to disaster preparedness (Jung, Kim, & Choi, 2020). In another study, lack of knowledge was reported as the main disaster preparedness barrier (Najafi, Ardalan, Akbarisari, Noorbala, & Elmi, 2017). To avoid adverse heat health impacts in children, it is important to increase the knowledge on protection against the impact of heatwaves for those responsible for the well-being of young children.

Apart from risk factors, we also identified several characteristics that showed a protective effect. Among the different employment categories, homemakers had by far the largest heatwave-protective knowledge levels. This can partly be explained by the fact that all of them were female, and women were more knowledgeable than men were, as described above. However, the impact for homemakers is stronger than for gender (expressed as regression coefficient and significance level), which implies that gender is not the only factor that determines knowledge of this group. Our finding is in contrast with a study after Hurricane Ike in the United States, which found that homemakers were less prepared because they had less access to disaster preparedness information (Chen, Banerjee, & Liu, 2012). A lower level of disaster preparedness of homemakers was also reported by a 2019 review article (Torani, Majd, Maroufi, Dowlati, & Sheikhi, 2019). One potential explanation for the high level of knowledge among homemakers in our study is that, since they spend more time at home, they might be more likely to come into contact with any awareness raising material, either through paper or other media. The same applies to the group of retirees, who also were more knowledgeable than the reference group of employed/self-employed, albeit only in the univariate analyses. Another protective factor was having participated in a (religious) fast during the same year. As fasting increases the risk of dehydration (Cherif, Roelands, Meeusen, & Chamari, 2016), especially during heatwaves, it is a positive finding that this group had more knowledge than average on heatwave protection. The last protective factor, which was only significant in the univariate analysis, was using daily medication for a chronic disease. People with a chronic disease are also particularly vulnerable to heatwaves, and have a larger risk of dying due to heat-related illnesses (Schifano et al., 2013). Because people in this group use medication every day, they are reminded on a daily basis of their own overall vulnerability, which might be a trigger for them to stay informed on different risks, including heatwaves.

The channels that were most often mentioned for obtaining information on heatwave-protective measures were television and the internet. Should Georgia move forward in developing a NHHAP, other communication methods could be investigated for use by the government as well, such as dissemination of printed materials, organization of public meetings, and communication through social media (Awareness campaigns for behavioural change, 2015), as well as communication by medical professionals, either directly or indirectly by disseminating printed communication materials. Different frameworks for NHHAPs exist that could be used as a starting point, including a framework from the World Health Organization (Matthes, Bickler, Cardenosa Marín, & Hales, 2008). When asked about the actor that respondents expect to receive information from regarding what to do during a heatwave, the largest share indicated a health authority. As the communicated information for a large part relates to protecting health of individuals, this would make a health authority indeed the most qualified and credible actor to take the lead in the communication. Also, the sustainability of a NHHAP will improve if citizens are actively involved in its development. Engagement for climate change adaptation can for example be fostered by undertaking community risk assessments (van Aalst, Cannon, & Burton, 2008). As such, we recommend the involvement of citizen groups or representatives as part of discussions on NHHAP establishments. It is essential that the groups identified as at risk to climate injustice in this study are represented in this. This trend to involve vulnerable groups, such as the elderly, in adaptation plans is also observed in Europe (Yang et al., 2021).

Our study had several strengths. By undertaking the survey in three different cities, it gives a good representation of urban citizens in Georgia. We included diverse neighbourhoods, to ensure diversity in demographic and socio-economic background of the respondents. Furthermore, we ensured that the sample size was large enough to undertake the analyses presented in this paper. We purposefully undertook the survey in September, just after the summer period, to avoid a recall bias as much as possible.

A limitation of our study was our outcome measure for heatwave-protective knowledge level. Although we feel confident about the components that constitute a good knowledge on heatwave protection, this compiled measure has not been used in previous studies that we are aware of and it only considers correct answers, not incorrect answers, which can also be an indicator of poor knowledge. Another limitation is that there might have been differences in the responses between enumerators due to small differences in how the enumerators asked the questions. We tried to reduce the impact of this by providing a training in which all enumerators participated, before the start of data collection. Furthermore, the choice for a street survey might have excluded individuals with limited mobility, who are less likely to be present on the street during a given time. Nonetheless, we feel that this was the most appropriate method to reach a diverse group of urban Georgian residents. Finally, there might have been a social desirability bias, related to the question on whether people consider themselves informed about heatwaves.

5. Conclusion

Our findings offer important insights in risk factors for climate injustice in Georgia, which was expressed in our study as having a reduced knowledge level on heatwave protection. This particularly concerns those with a low education, those with children under the age of 12, and men. However, demographic, socio-economic and cultural characteristics are rarely considered in heat emergency planning (Yardley, Sigal, & Kenny, 2011). Targeted communication towards these groups, using information sources and media specifically aimed at the target audience in question, would be a good approach to improve knowledge levels and hence preparedness of these vulnerable groups. Also, actively involving representatives of these groups in adaptation strategies is an important step forward in reducing climate injustice. It would further be of interest to observe potential resilience mechanisms taking place during a heatwave, which would be of interest for a follow-up study.

In a recent publication, the World Health Organization iterates the importance for countries to strengthen their capacity and to develop health-focused interventions to protect the population from climate change (Kendrovski & Schnoll, 2019). Developing a NHHAP, which incorporates a targeted communication campaign to inform the general population and vulnerable groups on heatwave preparedness, should help in improving the level of heatwave-protective knowledge in Georgia. However, a NHHAP needs to developed in a way that ensures
flexibility to adapt to changing circumstances, which is especially the case in cities. This study is part of an ongoing project, named SCORCH, on improving heatwave preparedness in the European Neighbourhood, with Georgia as one of the target countries. We will use these unique field-based findings in the next stage of the project, in which we plan to organise a co-constructive workshop in Georgia, aimed at designing a NHHAP. The Georgian National Center for Disease Control and Public Health will, as a national health authority, take this forward. The involvement of a national institute is essential in ensuring sustainability of the NHHAP.

Funding

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Questionnaire used to survey urban residents in Georgia

SURVEY
INTRODUCTION

Good morning / afternoon.

My name is ….. and I work for NCDC. We are currently working on a research project in which we aim to improve health services with respect to heatwaves in Georgia. A heatwave is a period in which temperatures are extremely warm for multiple consecutive days. For this purpose, we need to better understand the awareness of the public about heat waves and their health impact, which is why we are conducting a survey.

The survey takes about 10 min to complete. All your answers are completely anonymous. We will ask you about your knowledge regarding heatwaves and their health impact, your sources of information and your behavior during heatwaves.

Do you agree to participate in the survey? YES / NO

If yes: Do you have any further questions before we get started?

A. DEMOGRAPHY

1. Do you currently live in CITY?
   □ No  →  If no, not eligible for this study!  □ Yes
   →  If yes: Have you lived here for over 5 years?
   □ No  □ Yes

2. What is your age?
   □ If under 18 → not eligible for this study

3. Gender
   □ Male  □ Female  □ Other

4. What is your educational level?
   □ None
   □ Completed primary education (I – IX grades)
   □ Completed secondary education (X – XII grades)
   □ Completed vocational or professional education
   □ Completed college or university studies

5. Do you have children aged 12 years or under?
   □ No  □ Yes

6. What is your current employment status?
   □ Student
   □ Employed or self-employed
   □ Unemployed
   □ Retired
   □ Housewife
   □ Other

6a.  →  If “employed or self-employed”: Does your job require you to work mainly outdoors between 10 AM and 3 PM?
   □ No  □ Yes

6b.  →  If “employed or self-employed”: Does your job include taking care of other people? (e.g. nursery, school or elderly care centre)
   □ No  □ Yes

7. Have you participated in a fast that lasted multiple, consecutive days between May and September (e.g. religious fast or diet)?
   □ No  □ Yes
8. Do you take a medication every day for a chronic disease? (e.g. high blood pressure, diabetes, asthma)
   □ No □ Yes

B. AWARENESS ABOUT OCCURRENCE OF HEATWAVES

9. Do you know when the last heatwave took place in your city?
   □ No □ Yes, in year: ______________________

10. Do you consider heatwaves/extreme temperatures a problem in your city?
    □ No □ Yes □ I do not know

11. Do you believe that heatwaves will occur more frequently in your city in the future?
    □ No □ Yes □ I do not know

C. AWARENESS ABOUT HEALTH IMPACT OF HEATWAVES

12. Can you name some of the symptoms people may experience due to a heatwave? (open question and multiple answers possible, do NOT present answers to respondent)
    □ I don’t know
    □ Headache
    □ Dehydration
    □ Sunburn
    □ Exhaustion
    □ Extreme thirst
    □ Excessive sweating
    □ Accelerated pulse
    □ Muscle cramps
    □ Other: ______________________

13. Can you name some groups of people who are at a higher risk to suffer from health effects due to a heatwave? (open question and multiple answers possible, do NOT present answers to respondent)
    □ I don’t know
    □ Elderly
    □ Babies and children under 12
    □ Pregnant women
    □ People who take certain kind of medication
    □ People who are physically ill
    □ People who are mentally ill
    □ Handicapped people or with mobility problems
    □ People who are socially isolated (homeless persons / migrants)
    □ People who perform a lot of physical efforts (sports / construction work)
    □ Other: ______________________

14. How concerned do you feel about the effects of heatwaves/extreme temperatures? (answers can be presented to respondent)
    □ Not at all concerned ➔ Go to Q16
    □ Somewhat concerned
    □ Very concerned
15. If you answered ‘somewhat’ or ‘very concerned’, what or who are you concerned about? (open question and multiple answers possible, do NOT present answers to respondent)

- I don’t know
- Personal health
- My children
- Elderly relatives
- People in my community or neighbors
- Personal comfort
- Financial aspects
- Temperature at work/school
- Pets
- Outdoor activities
- Other: __________

D. KNOWLEDGE ABOUT AND BEHAVIOUR FOR REDUCING HEALTH IMPACT OF HEATWAVES

16. Do you know what to do when someone suffers from a heat stroke/overheating? (open question and multiple answers possible, do NOT present answers to respondent)

- I don’t know
- Halt physical activities
- Hydrate
- Place in cool location
- Call emergency services
- Other: __________

17. Do you consider yourself sensitive to heat? (answers can be presented to respondent)

- Very much
- Somewhat
- Not at all

18. Do you adjust your behavior during a heatwave?

- Yes
- No

19. a) Are you familiar with some measures you can take to protect yourself from a heatwave? (open question and multiple answers possible, do NOT present answers to respondent)

b) After listing all measures, ask for each of the measures that were given as answers: did you implement this measure during the last summer?

<table>
<thead>
<tr>
<th>Measure</th>
<th>Used during last summer?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t know</td>
<td>investigative method</td>
</tr>
<tr>
<td>Increase consumption of fluids</td>
<td>Yes</td>
</tr>
<tr>
<td>Stay inside during the warmest times of the day</td>
<td>Yes</td>
</tr>
<tr>
<td>Keep windows closed</td>
<td>Yes</td>
</tr>
<tr>
<td>Adjust your clothing</td>
<td>Yes</td>
</tr>
<tr>
<td>Visit areas where you can be cooler</td>
<td>Yes</td>
</tr>
<tr>
<td>Cooling your body, e.g. by taking a shower</td>
<td>Yes</td>
</tr>
<tr>
<td>Adjust your medication</td>
<td>Yes</td>
</tr>
<tr>
<td>Using a fan or air conditioning at home</td>
<td>Yes</td>
</tr>
<tr>
<td>Avoid physical activity</td>
<td>Yes</td>
</tr>
<tr>
<td>Other: 1)</td>
<td>Yes</td>
</tr>
<tr>
<td>2)</td>
<td>Yes</td>
</tr>
<tr>
<td>3)</td>
<td>Yes</td>
</tr>
</tbody>
</table>
E. SOURCES FOR INFORMATION ON HEATWAVES AND MEASURES:

20. Do you consider yourself informed about heatwaves and extreme temperatures? (answers can be presented to respondent)
   [ ] Very well informed
   [ ] Somewhat informed
   [ ] Not very well informed
   [ ] Not at all informed

21. During the last heatwave, where did you look for information about the weather? (open question and multiple answers possible, do NOT present answers to respondent)
   [ ] I don’t know
   [ ] Government social media or website
   [ ] Government brochure or poster
   [ ] Television
   [ ] Social media
   [ ] Google
   [ ] Radio
   [ ] Newspaper or online news website
   [ ] Doctor or other health professional
   [ ] Relatives/friends
   [ ] I did not consult any source for information on protective measures
   [ ] Other:

22. Did the government or another organization personally notify you about the occurrence of the heatwave?
   [ ] No
   [ ] Yes, from:
       [ ] I do not know
       via [email, phone, ...]:

23. Would you prefer to get notified about the occurrence of a heatwave in the future?
   [ ] No
   [ ] Yes
   [ ] I do not know

24. Which of the following information sources did you consult during the past summer to look for information on measures to protect yourself from a heatwave? (open question and multiple answers possible, do NOT present answers to respondent)
   [ ] I don’t know
   [ ] Government social media or website
   [ ] Government brochure or poster
   [ ] Social media
   [ ] Google
   [ ] Television
   [ ] Radio
   [ ] Newspaper or online news website
   [ ] Doctor or other health professional
   [ ] Relatives/friends
   [ ] I did not consult any source for information on protective measures
   [ ] Other:
25. From whom do you expect information about what to do during the next heatwave? (open question and multiple answers possible, do NOT present answers to respondent)
   - I don’t know
   - Police/fire brigade
   - Health authority
   - Environmental agency
   - Meteorological agency
   - Health care professionals
   - Care institutions
   - Other: [ ]

**Closure**
Thank you very much for your participation. Please visit our website - www.ncdc.ge for more information or if you want to receive a short summary of our results, you can provide us with your email address. This will not be used for any other purpose.

Interviewer comments

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**Appendix B**


