A Review of the Effects of Two-Way Science Communication on Heat Protection for Refugees in Munich

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1. Introduction

Since 2008, implementation of heat-health action plans (HHAPs) has been recommended by the World Health Organization (WHO) European Region in response to increased prevalence of heatwaves (Matthies et al., 2008). Existing heat protection interventions in Germany consist largely of making resources available for the public to find, such as distributing information on heat protection via pamphlets or online resources. There are several online databases such as klima-mensch-gesundheit.de particularly useful for informing the public on heat protection strategies. See Appendix A for a more comprehensive review of municipal actions on heat protection.

Existing measures show that the German government has attempted to raise awareness about heat protection to their target audience, but a specific curriculum that engages the public in heat protection skills has yet to be developed in the face of rising heatwaves. In addition, according to the WHO one of the core elements that HHAPs should consider is “particular care for vulnerable population groups” (Matthies et al., 2008, p. 8). While resources focused on heat protection for certain vulnerable demographics such as children and elderly people can be found, there are few resources available that detail specific interventions for the refugee community in the event of a heatwave. Oftentimes, traditional heat protection measures are not applicable to people living in refugee accommodations, e.g. they may not have room for a fan or AC unit. This means that advice given to refugees must often be adapted compared to what is given to the general public. Refugee accommodation is usually built quickly and rarely considers the need to protect its inhabitants from rising temperatures (Conzatti et al., 2022). As a result, the inhabitants of refugee accommodation have a further increased risk of heat health complications. To further compound this problem, refugees often miss out on the distribution of public heat health advice. Oftentimes, pamphlets and brochures are not made available in their native language, meaning that even if they are given this information, they may not be able to understand it. In this way, the refugee demographic is uniquely vulnerable to worse health outcomes during heatwaves, and general heat protection interventions in Germany prove insufficient for this demographic.

In addition to language and housing constraints, we postulate that the refugee community of Munich faces substantial differences in knowledge needs than the general population, making a separate curriculum geared towards this demographic necessary. First, many refugees come from hotter climates than Western Europe and as a result are already familiar with basic heat protection measures that the general Munich public may have yet to learn. Furthermore, being

relatively new to the city of Munich and oftentimes lacking effective communication strategies, this demographic is likely to lack locality-specific heat protection knowledge that the wider public is familiar with, such as the locations of public water fountains and buildings with air conditioning (AC).

Taking into account the limits of existing heat protection interventions for Munich refugees, this report details the learning outcomes of designing and implementing three heat protection workshops targeting a range of refugee demographics in Munich and structured using two-way science communication. These workshops aimed to investigate how the WHO's recommendation for consideration towards vulnerable groups in HHAPs could be fulfilled for the refugee demographic by building a workshop curriculum targeting this demographic. It describes how each workshop was tailored to the refugee community, how the scientific and healthcare spaces can be made accessible for this demographic, identifies present heat protection interventions as well as their shortcomings, and provides policy recommendations for heat protection informed by input received directly from workshop participants.

2. A New Heat Protection Workshop Targeted for the Refugee Demographic of Munich

2.1 Workshop Design Context and Pedagogical Theory

The heat protection workshops of this report, referred to as Workshop 1, Workshop 2, and Workshop 3, were carried out as a sister project to the Munich Science Communication Lab's (MSCL's) heat protection workshop for general city and suburban audiences. Project workshops consisted of participants from four different refugee shelters. Workshop 1, carried out on 31 July, 2024, had 12 participants, all of whom were refugees from Turkey residing at a newly built shelter in Aubing. While most were women, there were also some men and children. Workshop 2, carried out on 7 August, 2024, had approximately 20 refugees from Ukraine, consisting of a mix of genders and ages. 19 of them lived in an old nursing home that had recently been converted into a shelter, while one participant lived in a shelter converted from a hotel. Workshop 3, carried out on 13 August, 2024, had 10 refugees from various African countries, including seven men, two women, and one child all living in container-based housing.

In an effort to consider the specific needs of the refugee population, this project utilized two-way science communication to develop a workshop curriculum to increase awareness and self-efficacy of refugees regarding heat protection. Two-way science communication may be

better equipped to fulfill these objectives than traditional methods of science communication by emphasizing “interactive communication and mutual understanding between two parties,” highlighting a collaborative interaction that is increasingly necessary in the effective and persuasive messaging of scientific concepts and interventions (Yuan et al., 2017, p. 2). Burns, O’Connor, and Stocklmayer (2003) note that under this model, public understanding serves as both knowledge creation for the audience as well as the science communicators, where “ethical and political” (p. 190) considerations are relevant in addition to the scientific topic. Considering the sociopolitical context of the audience in heat protection workshops necessitates a bi-directional flow of knowledge, meaning that communicators reach out to the audience for input regarding workshop content and heat protection viewpoints. This grants science communicators direct insight into the perspectives and needs of their target group, increasing the ability to create relevant and effective messaging. In addition, Yuan et. al (2017) suggest that two-way science communication may increase trust between the public and science communicators, and we postulate that this trust-building may increase conviction in workshop curriculums and thus increase participants’ understanding and self-efficacy regarding heat protection interventions.

To this end, two broad categories of heat protection interventions for the refugee community were established for this project. First were interventions that could be made by the individuals within the refugee community. Though they may have limited effectiveness, individual interventions have the advantage of increasing self-efficacy, defined by the American Psychological Association (APA, 2009) as “an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments.” Second were interventions that could be made by the city and the accommodation providers. While these changes may be more impactful, they often face monetary and time constraints. Recommended interventions of the first category were presented to participants, and input regarding both intervention types were collected from participants as well.

2.2 Workshop Objectives

The objectives of the three workshops and their evaluation are listed as follows:

To raise awareness among Munich refugees about the necessity of heat protection measures in Munich and to encourage self-efficacy regarding such measures, by:

Providing the refugee community with information about rising temperatures, climate change, and the urban heat island effect in Europe, specifically the city of Munich.

Providing the refugee community with a comprehensive education on heat protection measures specifically on the topics of heat health, Munich-specific heat protection measures, and how to look after vulnerable groups in the heat.

Providing the refugee community with portable resources they can take out of the workshop containing information about heat protection and heat health

To learn from the refugees about what could be done by both the city of Munich and their accommodation centers to help them deal with rising temperatures, and to use this information to inform policy recommendations shared with accommodation providers and the city of Munich.

To collect feedback from the participants about the workshop's communication strategy and curriculum to learn which communication tactics are most effective and tailor workshop content to that which is most relevant for the Munich refugee population.

3. Overview of Munich Refugee Demographic and Accommodations

Stadtverwaltung Landeshauptstadt München (2024) cites that by the end of June 2024 data was reported for 9,167 refugees in Munich. 78% of this population come from the following eight countries - Ukraine, Afghanistan, Nigeria, Turkey, Somalia, Sierra Leone, Syria, and Yemen. It also notes that due to the Ukraine War, the number of female refugees has risen, and men now make up only 57% of all refugees compared to 75% in pre-war times. Housing conditions for this group vary greatly, from shipping containers to repurposed old buildings to newly built residences. Participants in Workshop 1 gave a tour of their accommodations. The following insights were collected from the rooms they showed, which provided initial insights into what could be done to better protect from rising temperatures. Rooms were cramped and small, leading to heat trapping. There were usually three to five people sharing a single room (Fig.1, 2).

Fig. 1: Inner room of accommodations

Fig. 2: Bunk beds for families

Space constraints and old electronics made cooling strategies such as unplugging electronics difficult. Each room had only one narrow window, causing ventilation challenges even when cool air was available. To avoid direct sunlight, some refugees covered their windows with a towel or cloth (Fig. 3, 4).

Fig. 3: Room with original curtain

Fig. 4: Insect net across yard door

While some rooms had refrigerators, others did not. Additionally, leftover food was often stored outside refrigerators without any covering, usually due to lack of individual storage spaces. Participants complained about the smell and lack of hygiene associated with these practices, factors that are exacerbated by increased temperatures during heatwaves (Fig. 5, 6).

Fig. 5: Onions, potatoes, garlic stored in spare trash bin

Fig. 6: Tables piled with food and supplies

Participants from Workshop 3 also shared insight into their accommodations, which houses two people per room. Due to the design of the accommodation, the buildings on the outermost edges are particularly vulnerable to sunlight. Additionally, there are few trees in the accommodation itself, meaning there is little natural shade. Refugees also resorted to covering their windows with a towel or cloth to avoid direct sunlight. See Appendix B for health outcome challenges of this demographic.

With respect to language competencies, participants in Workshop 1 had begun to learn German, but they were not yet at a stage where they could communicate in this language, roughly A1 level. Additionally, none of the participants spoke English. Without the help of two translators, we would have struggled to conduct the workshop. Many of the participants in Workshop 2 could speak and understand English fluently, but they were more comfortable speaking Ukrainian. An English-Ukrainian translator was also included in Workshop 2 to effectively carry out project goals. For both Workshop 1 and Workshop 2, written information was translated into participants' native language as well where possible. All the participants in Workshop 3 spoke English fluently, which eliminated language barriers and allowed the workshop to run more effectively.

4. Workshop Design

4.1 Preparations for Initial Design

Research for this project prioritized effective communication to the refugee demographic, with the pre-design stage consisting of a literature review and a diverse set of stakeholder consultations organized by MSCL. Hansen et al. (2014) suggest that refugees should be provided with information about heat health and heat protection as part of their orientation in a new country in their native language and in multiple forms, e.g. both spoken and written communication. They further recommend that heat warnings are distributed in a multilingual format through multiple channels.

Dr. Zeliha Öcek, a public health research associate at Ludwig Maximilian University, informed communication strategies for vulnerable groups, specifically refugees, highlighting an avoidance of re-traumatization and emphasis on consent, the ability to terminate sessions, and the use of workshop learnings. MSCL members Sarah Stiller and Jule Schmitz provided an overview of previous heat protection workshops conducted and preliminary adaptations to the target group, which gave us the opportunity to look at what a generalized version of this workshop would look like. Additionally, Sarah Pritchard, a MSCL volunteer and international school teacher shared workshop design adaptations in the face of language barriers, providing insight into how to use pictorial representations and interactive activities to engage and inform an audience.

In order to gain a better sense of refugee accommodations and heat protection strategies that were already in place, social worker Birgitta Mair from the Condrob's Women's Shelter was consulted, and the shelter was toured. It featured dorm-style housing, consisting of double rooms and a shared kitchen and bathroom. Heat protection barriers and interventions were observed, such as the lack of AC and window blinds but the existence of window shutters which sometimes functioned properly. In addition, strategies for gaining participant interest and building an effective communicator-audience relationship was consulted. A main takeaway was that motivation might be a challenge for workshop participants, as heat stress may not be a priority in their everyday lives. Similarly, we met with volunteers and staff members at the cultural center Bellevue di Monaco to further understand how best to communicate and engage with the refugee community and ask about the merits of holding a workshop there. Additionally, the city of Munich provides funding for refugee accommodations as well as heat protection amenities, playing a vital role overcoming structural challenges to refugee heat protection. Thus, to inform the scope of policy recommendations, city council member Barbara Likus was consulted. Likus' background working

with refugees provided insight into tension areas between the needs of refugees and the city's capabilities.

Lastly, refugees were directly consulted at a summer party at the Condrob's Women's Shelter, noting what they were interested in learning, what would motivate them to attend such a workshop, and prior knowledge. The aim was to maintain cultural awareness and avoid a workshop perceived as condescending or overly simple. From these meetings, we learned that the community was aware of common heat protection measures such as staying hydrated and in the shade. They also showed interest in learning from each other, generating ideas for discussion-based elements in the workshops.

Ultimately, three workshops were scheduled with four shelters run by Arbeiterwohlfahrt München (AWO), a non-profit involved with a range of sociopolitical initiatives. Meetings with the managers of several AWO refugee shelters provided information on the participants including their type of accommodation, nationality, gender, and languages spoken. This allowed the content of the workshop to be tailored to each set of participants. MSCL provided funding, resources, and materials for each workshop. Workshop findings aim to provide lasting insights on how to execute heat-health action plans targeting specific populations and what effective strategies can be employed for science communication within the refugee community.

4.2 Initial Workshop Design

The initial workshop design, carried out in Workshop 1, consisted of a PowerPoint slideshow in English and German with several discussion activities aimed at fostering two-way science communication. The workshop was designed for a duration of one hour and run by three workshop leaders. Two leaders presented the slideshow while a third took notes for qualitative data analysis. The workshop was additionally facilitated by two Turkish translators. Free snacks and beverages were included for participants. The PowerPoint began with an introduction which gave an overview of the rising temperatures across Europe, including pictures and emojis for communication without language. Three heat protection input sections followed.

Section 1, "Healthy in the Heat," aimed to give general actionable steps for personal heat health. It began with information on heat health conditions, then moved into an interactive activity by presenting the participants with a number of drinks (water, iced tea, coke and an isotonic sports drink). Participants were asked to select the one they felt was most suitable for a hot day and explain why. After they answered, the correct answer of water, with iced tea and sports drink after excessive sweating, were revealed followed by a focus on electrolyte intake. A demonstration of

how to use electrolyte mix and a home electrolyte recipe were also given. Lastly, sunscreen and sunburn were discussed.

Section 2, “Staying Cool Around Munich,” focused on heat protection interventions specific to Munich. Starting with an overview of Munich summer conditions, a digital Munich shade map was introduced as well as a list of cool spots near the shelter. Access and use of this resource was explained. Advice on staying hydrated in the area was also included, such as using water fountains and refilling water bottles at cafes. Afterwards, to facilitate two-way communication, participants were asked for their tips and tricks for staying cool in Munich on a hot day. They were additionally asked what they thought the city of Munich and their accommodations could do to make it easier to deal with the heat.

Section 3, “Caring for Others,” listed three groups particularly vulnerable to extreme heat: elderly people, kids and those with chronic illnesses. Before providing interventions for each group, participants were asked what they would do to help take care of these people during a heatwave. After that, specific information on how to take care of each group was given.

Table 1 below summarizes the approximate time spent for each section in Workshop 1. To reference specific slides, see Appendix C for a Google Drive link to workshop materials, including the PowerPoint presentation for Workshop 1.

Section Name	Description and Slide Numbers	Approximate Time Spent	Additional Notes
Introduction	Sides 1-6	8-10 min	Most time in this section was spent on slides 3 (“Climate Change”), 4 (“Cities are Warmer”) and 5 (“Problem for People”)
Section 1: “Healthy in the Heat”	Informational Introduction; Slides 7-8	3 min	
	Beverage Activity; Slide 9	3 min	
	Informational Slides; Slides 10-12	9-10 min	A whiteboard was used to explain visually the basic biology behind the principle of isotonic drinks (e.g. they are the same concentration

			as the fluids in a body on Slide 10)
Section 2: "Staying Cool Around Munich"	Informational Slides; Slides 13-16	7-10 min	Technical difficulties impeded ability to show online resources on the projector; instead, they were shown on a laptop screen which made it harder for all participants to see
	Discussion Questions; Slide 17	5-8 min	
Section 3: "Caring for Others"	Informational Introduction; Slides 18-19	2 min	
	Discussion Question; Slide 20	2-3 min	
	Informational Slides; Slides 21-23	5 min	
Extra Slide: "Cool at Home"	Slide 27	2-3 min	
Feedback	Slides 24-26	3-5 min	

Table 1: Workshop 1 PowerPoint and Input Phase Breakdown

Back-up material consisting of information and discussion for how to stay cool at home, what to do in the event of heat stroke, and activities about how to exercise and eat on a hot day was prepared in the event of extra time. The workshop ended with thanking the participants and asking for feedback to improve the content and the structure of the workshop. Free food and drinks were provided, and participants stayed to chat with workshop leaders and among each other. See Appendix C for a manual and checklist for running the workshops. Additionally, as mentioned in Section 4.1, a Google Drive link with all 3 workshop presentations and supplementary materials are included.

Supplemental take-home pamphlets summarizing some of the interventions were also included in Workshop 1, with adaptations made for the specific language needs of the refugees. First, custom-designed heat health pamphlets written in English were provided, as the majority of the refugees spoke more English than German. In addition, they were heavily picture-based to

decrease communication gaps across a language barrier. LMU Klinikum brochures in the native language of the refugees were also included, detailing infection control methods in the heat and taking care of the elderly. Finally, a page with QR codes linking to different heat protection resources was supplied, with descriptions in English and German. This prevented information overload as the participants only had to scan the resources that interested and applied them. Given that these QR codes would show up on their phone, they could be automatically translated to participants' native language.

To conclude, parting gifts of origami birds and suns were given to workshop participants, courtesy of one Japanese workshop leader. In addition, participants were provided with instructions for how to make the origami bird themselves, in both English and their native language. In Japan, origami is an important cultural tradition with a long history. By folding a single sheet of paper, one can create representations of animals, plants, objects, and more. As a creative activity that enhances dexterity, origami has been enjoyed by children from an early age. Moreover, there are no fixed rules for folding origami, allowing individuals to freely express their thoughts and emotions through their creations. By experimenting with different folds and designs, people can shape their joy, wishes, and heartfelt sentiments, as seen in the tradition of folding a thousand cranes as a symbol of prayer and hope. In addition to its cultural significance, origami is also a valuable educational tool, helping to develop spatial awareness and geometric understanding. In modern times, its applications extend beyond art and education into fields such as mathematics, engineering, and medicine. In this way, origami is not only a key part of Japanese culture but also a versatile medium for personal expression and innovation. Thus, this portion was added to end the workshop on an upbeat note as well as to thank participants for attendance. It also served to give participants something to remember the workshop by, and it was a way to engage young children in cases where they were present.

4.3 Workshop Design Effectiveness: Methodological Overview

A number of different methodologies were used to determine whether the workshop goals were achieved with the initial design. First, at the end of each workshop, verbal feedback from participants was solicited as a group. Initial feedback questions consisted of 1) if participants found the workshop useful, 2) what they learned during the session, and 3) what could have been done better. In order to gather more honest opinions, anonymous feedback was incorporated at the end of the second workshop. This was done by writing scales from one to ten on the board and asking participants to rate how useful they found the workshop, as shown below (Fig. 7, 8).

Effectiveness of this method was also questionable, however, as all participants rated the workshop ten out of ten with no further elaboration.

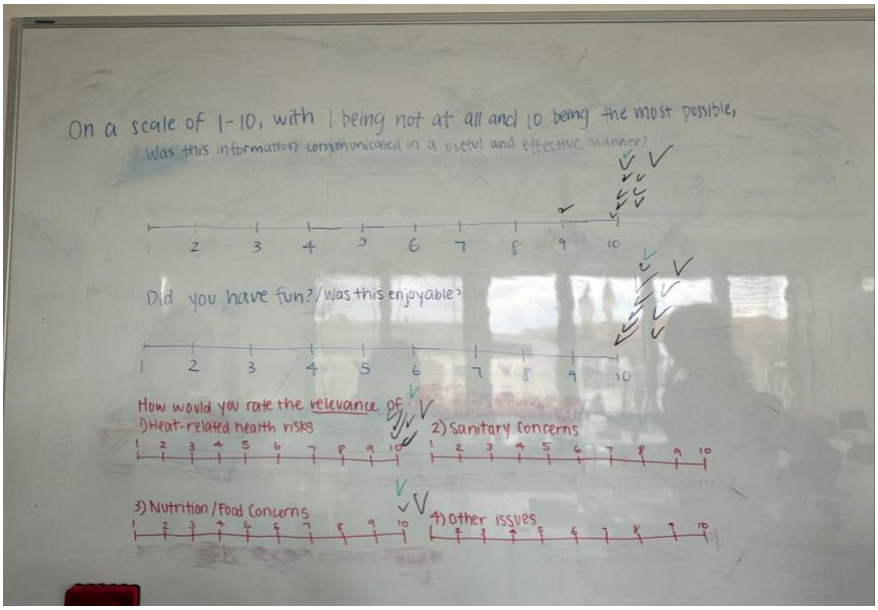

Fig. 7: Scale ratings of Workshop 2 effectives. All participants who gave feedback indicated a score of 10/10.

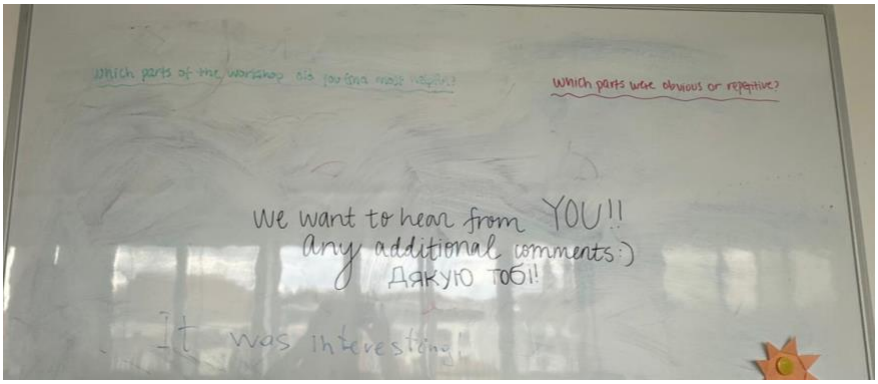

Fig. 8: Board used to collect qualitative feedback from participants after Workshop 2, though no additional comments were given.

As mentioned above, one workshop leader took notes at all times, observing and recording participant behavior. Body language was monitored using a number of positive and negative indicators to determine participant engagement. Positive indicators included taking notes and/or photos of the slides, actively engaging in group discussions, approving body language e.g., thumbs up and nodding, spontaneous expressions of opinions e.g., commenting outside of a group discussion, examining objects brought in for demonstrations such as electrolyte packets, learning from each other, and asking questions. Negative indicators included fidgeting and appearing restless in their seats, looking at their phone, talking and/or whispering to others about areas unrelated to the workshop, appearing tired, yawning, and leaving the room. The notetaker

recorded energy level fluctuations throughout each section, and this was used as a basis to make changes throughout iterations of the workshop. We also noted how long the group discussions lasted in order to determine engagement levels.

Finally, we kept track of the number of participants present as the workshop progressed. This number changed over the course of each workshop, and it was a good metric for measuring how engaged and motivated participants were to learn about the topic of heat protection.

4.4 Feedback and Design Change

After consulting feedback, a number of changes were implemented for Workshop 2. First, the presentation was adapted from English and German to English and Ukrainian to meet the needs of the new audience consisting entirely of Ukrainian refugees. Questions were asked throughout the workshop instead of only at the end to create a more natural, conversational atmosphere. It also allowed for more effective identification of knowledge gaps in participants.

For Section 1, a separate slide was dedicated to isotonic drinks and how to access them based on positive engagement indicators and a perceived knowledge gap in Workshop 1. Along similar veins, information that electrolyte sachets could only be accessed from a pharmacy was added in response to a Workshop 1 question.1 Two additional slides were also included on sunscreen advice, as questions about the best type of sunscreen and suitable SPF values arose in Workshop 1. Furthermore, when informed that workshop data would be compiled in a report, participants seemed much more eager to share their experiences in Workshop 1. Thus, this fact was shared at the start of all of the following workshops. Finally, resources for public water fountains were added to Section 2. Supplemental resources in the form of the QR code handout and LMU Klinikum pamphlets were still distributed but adapted to Ukrainian or Russian languages.

Feedback gathering was also added to in Workshop 2 to receive more detailed responses. In order to learn what was most engaging, participants were asked what they would say to a friend to convince them to come to the workshop. They were also asked who they thought the workshop would be helpful for and if they'd be interested in connecting with refugees from different shelters in the future. Last, participants were asked to rate the workshop from a scale of one-to-ten on a white board.

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[1] This was later discovered to not be true. Electrolyte sachets can also be found in the health sections of drugstores such as DM, Müller, and Rossmann.

For the third iteration of the workshop, discussion sections were reformatted after noting that Workshop 2 contained a long period throughout Section 1 and Section 2 of the presentation with no discussion element followed by lots of consecutive discussions at the end of Section 2 and Section 3. Given that Workshop 2 saw the least amount of engagement, it was hypothesized that uneven staggering of discussion questions may have been a contributor. After re-formatting, Section 1 started with a group discussion about tips and tricks for staying cool in the heat, using Mentimeter, an online, real-time anonymous survey tool, to record participants' responses in the event that they felt more comfortable providing anonymous discussion points than conversing with the others in person. In the information slides that followed, the main change from the previous workshop was the addition of some content in the section on isotonic drinks. The discussion on Munich city and accommodations improvements were also moved from the end to the beginning of Section 2 to more evenly spread discussions. Additionally, to combat the drop in engagement in Section 3 discussions, this section was made more interactive by restructuring it as a trivia style multiple choice section followed by two informational slides. The text of the third presentation was in English and German. The supplemental information sections weren't changed, except to all be in English and German.

4.5 End Design and Further Improvement

Workshop 3 was by far the most successful of all three iterations. Participants showed higher levels of engagement and gave more positive feedback. They also suggested fewer changes and gave less negative feedback compared to previous iterations. While workshop 3 had the lowest number of participants at the start, the number of participants grew throughout the workshop, and it was the only workshop where no participant left. Overall, the workshop was effective at providing the refugee community with new, tailored information with regards to heat protection. The participants of Workshop 3 estimated that about 70% of the material covered was new to them.

Several factors could have contributed to the higher success rate of Workshop 3. First, as mentioned previously, it is possible that restructuring the workshop with regularly spaced discussions increased engagement by repeatedly refocusing the group throughout the presentation. A second factor could be that after multiple rounds of content editing, the information included in Workshop 3 was what was most relevant and interesting to the refugee community. Since these edits were based on the observed engagement levels and direct feedback of participants, it is likely that the information of the workshops became more relevant to the needs of the community with each iteration.

The areas that the participants found to be most beneficial were the sections on isotonic drinks and electrolytes, sunscreen, Munich specific interventions, and advice on looking after children during heatwave. Almost all the participants thought that water rather than an isotonic sports drink was the best beverage to take when sweating on a hot day. Therefore, it was important to correct this idea. Additionally, participants engaged with the QR code-based handout of sources, suggesting there is a lack of pamphlets and brochures targeted at the refugee community. Participants were also shocked to hear about how extreme rising temperatures were getting in Europe. They were aware that temperatures were increasing but didn't know that the rise was so dramatic.

A final iteration of the workshop would mirror the third workshop in terms of content and structure. However, two changes are recommended in relation to the context and culture of the workshop. First, we would recommend running the workshop at a time of day that doesn't clash with the participant's working hours. Secondly, we would recommend having a social worker or shelter staff worker to hear directly from the refugees themselves about the issues that are facing them. Both of these recommendations came directly from participants.

5. Communication Structure Learnings

Communication structure learnings were informed by the verbal feedback received from participants post-workshop as well as observations of participation and willingness to engage during the workshop recorded by the note-taker. In many cases, the latter was more useful in determining workshop success, as participants were hesitant to give criticism even when engagement was low. Generally, Workshop 3 saw the most engagement and discussion, followed by Workshop 1 and lastly Workshop 2.

When working with groups with a language barrier, the pictorial-based presentation used in Workshops 1 and 2 allowed for increased understanding of the material and shifted the focus to what the presenter said instead of deciphering a language that participants couldn't understand. However, the presence of translation services was the biggest asset in these cases. Pictorial representations were often helpful for communicating ideas in instances of limited language proficiency, but nuanced explanations of the science behind heat protection interventions would not have been possible without translators in these cases.

Furthermore, the drop in engagement in Workshop 2 was a curious observation that may have been due to multiple factors. First, Workshop 2 was held at MSCL, an unfamiliar environment for the participants which may have contributed to a more formal or foreign atmosphere. Second, there were far more participants in Workshop 2 compared to 1 and 3 (20 vs 12 and 10 respectively), which may have decreased participant willingness to engage. Herman and Nilson (2018) note that in educational settings, though the effectiveness of small class size in terms of learning outcome is widely contested, a smaller group of participants has been noted to be beneficial for discussion specifically. Third, there were a higher number of adolescents in Workshop 2. This is a hard group to engage, and their attention seemed to drop the quickest, with some scrolling on their phones by the end of the workshop. This may have also distracted other participants, lowering the entire group's engagement. Another factor may have been that there were two female translators present in the first workshop compared to one male translator in the second. Since the first workshop consisted mainly of females, perhaps having a translator of the same gender increased participation. Workshop 2 was mixed in gender, but we saw roughly equal participation across all genders despite only having one male translator. Lastly, there may have been social and cultural differences between the Ukrainian refugees of Workshop 2 compared to the Turkish and African refugees of Workshop 1 and 3 in relation to group discussion, causing differences in engagement mannerisms.

Though the reworking of the presentation was a big contributor to increased engagement in Workshop 3, the lack of a language barrier also significantly influenced the favorable outcome. First, it deepened the ability of workshop leaders to understand and contribute to discussions. Due to the large amount of content covered in discussion, translations of discussions were limited when a language barrier existed. Oftentimes, translators had to be asked what participants were saying when they were conversing with each other, leading to communication gaps and lost knowledge between workshop conductors and participants. Secondly, a lack of language barrier also made it possible to cover scientific principles behind heat protection strategies more effectively, providing a deeper level of understanding that participants found to be more meaningful. For example, in the presentation introduction time stamps of each temperature recording were included, rather than simply stating "Earlier," "Now," and "Future". Furthermore, the context behind the temperature data was explained. Afterwards, when asked about what they would tell a friend to get them to come to the workshop, one participant noted that showing the history of how temperatures are rising was helpful. Explaining the science behind why certain medications may make users feel hotter also sparked interest. For a detailed comparison on heat protection knowledge across the three participant sets, see Appendix E.

Using a two-way science communication model was helpful in building trust and gaining insights into the perspectives of the refugee community. In two out of the three workshops, participants seemed to enjoy answering the discussion questions included to foster two-way learning, and the process of discussion generated conversation among participants and with workshop leaders. This allowed workshop leaders to learn new heat protection strategies from participants as well as what participants thought about the state of their accommodations and Munich writ large. For example, input from participants of Workshop 1 about moving work hours to times that avoid the hottest parts of the day is an example of a learning not currently utilized in Munich that could benefit not only the refugee community but the wider public as well. Moreover, asking for the participants' opinions fostered an open relationship between workshop leaders and participants. Participants were able to ask questions when confused, and based on participant engagement and input the workshop had enough built-in flexibility to focus on certain sections, such as the electrolyte segment, for longer. This dynamicity created a workshop structure that respected the knowledge levels and needs of participants, in turn fostering trust and goodwill amongst all parties involved. Participants seemed to engage with the new knowledge they were exposed to when that openness to new information was mirrored in the workshop leaders as well.

Lastly, an additional interesting observation for Workshop 2 was that though participation in the workshop was low, participants engaged with the origami bird thank you gifts after the workshop on a higher level than either of the other two workshops. Many participants, regardless of gender or age, showed interest in learning how to fold the origami birds themselves, and a workshop leader even led a live demonstration of the process afterwards. Even the teenagers were engaged for this process. This perhaps shows that though it may be hard to connect with some participants in a formal classroom-style setting, they can be engaged using other methods. The post-workshop period was less formal, and participants may have felt more comfortable then to engage with workshop leaders.

Based on the fluctuations of workshop engagement and multiple rounds of presentation revisions, the following learnings should be taken into consideration when tailoring a generic heat protection workshop to the refugee community of Munich:

In cases where refugees do not understand or speak the language of workshop presenters, translation services are strongly recommended. Having translations of presentation text in the participants' native languages is also helpful.

A one-hour workshop, compared to the longer time frame of MSCL's past workshops, was an effective period for optimized learning. Generally, it gave adequate time to cover all three heat protection sections while leaving room for translation pauses, questions, and feedback. Workshop

3 experienced longer discussions, which caused the workshop to run overtime despite having no need for translation work. However, the one-hour time limit was still a helpful goal to strive for, as many participants had to leave the workshop shortly afterwards for other obligations. Longer workshops, especially given language barriers and increased distractions such as the presence of children may be harder to facilitate focus.

Holding the workshop in the refugee shelter or another familiar location seemed to increase participation. Decreasing the formality of the workshop and surroundings seemed to foster discussion.

The incorporation of interactive learning activities such as live demonstrations and trivia questions, as well as regularly spaced discussion sections, increased participant engagement. It seemed to enhance participant learning by promoting interest and giving an outlet for participants to voice their own opinions and knowledge. Furthermore, this demonstrates the merits of two-way science communication for use in HHAPs.

A multi-workshop program should be considered. Especially in Workshop 3, participants seemed eager for additional information. Covering topics of climate change, heatwaves, and heat protection strategies over multiple workshops by including more scientific context and data may be helpful for fostering a deeper understanding and stronger self-efficacy.

Cultural differences may need to be considered for increasing workshop engagement. Though this is speculative, it is possible that differences in Ukrainian culture compared to Turkish, African, or other cultures contributed to less communication in Workshop 2.

Workshop leaders should plan to remain available for questions and comments post-workshop. Participants may be more comfortable interacting with workshop leaders during this time such as what occurred after Workshop 2, and valuable learnings may also be gleaned then. For example, in Workshop 1 participants were eager to lead the workshop leaders around the shelter in a tour of their accommodations, including what their rooms looked like.

Childcare may be considered in cases where many children are present and parents are unable to abandon care. In Workshop 1, childcare needs interrupted the workshop multiple times, though discussion and interest did not seem to be hindered by this.

6. Self-Efficacy and Policy Intervention Learnings

6.1 Self-Efficacy Assessment

Overall, based on participant engagement and feedback, it seems that increased self-efficacy was achieved throughout the three workshops at least in terms of increased knowledge about heat protection strategies. The workshop participants, especially those of the first and third workshop, expressed interest in the heat protection strategies shared. In the first workshop, sunscreen and the electrolyte packets that were demonstrated were passed around, with some participants taking pictures of the labels. They also noted the “ISO” label of the sports drinks. The third workshop noted similar behavior especially for the electrolyte packets, as it seemed foreign to the participants. Furthermore, a long discussion about how to stay cool in the heat took place during the “tips and tricks” section, with participants driving the conversation by asking for strategies for keeping cool in their accommodations. The eagerness of the participants to learn about heat protection strategies indicates the presence of self-efficacy and a desire to learn about strategies they could themselves implement.

Even though the second workshop saw less participation and interest seemed to dip towards the end, taking pictures of the isotonic drinks was still observed. One participant even took out their own sunscreen to see if the SPF label was strong enough. Overall, this indicates that the information presented in the workshop was generally helpful, and participants presumably plan to use the conveyed information in a manner to better equip them against the heat in the future.

However, further research should be done to obtain more concrete measures of heat protection self-efficacy within this demographic. Our indicators were mostly qualitative, with the observations documented by the note-taker as well as post-workshop verbal feedback from participants serving as the primary measures of self-efficacy. Furthermore, the qualitative indicators of self-efficacy taken e.g. positive participation indicators and post-workshop verbal feedback, were not systematized or consistent across all three workshops. Quantifiable, scaled feedback was collected from workshop participants as documented in the methodological overview, but as mentioned, the public feedback boards in combination with the almost ubiquitous ratings of 10/10 warrant more investigation into participants’ true sentiments. To increase effectiveness of self-efficacy measures, we recommend more consistent measures of what qualifies as self-efficacy as well as more precise and confidential qualitative and qualitative data gathering of such measures. In addition, follow-up with workshop participants would be needed

in order to understand if knowledge acquired during the workshops produced lifestyle changes after the workshop itself.

6.2 Findings on Policy Interventions

Another distinct goal of the workshops was to investigate possible policy interventions that would increase heat health for the target demographic. While MSCL's original design only keeps in mind improving self-efficacy as a goal, it has been observed that the refugees of Munich are a unique demographic that necessitates more balance between what the self can do and what the municipality can do to ensure heat health. Due to the amount of heat protection measures that are out of the control of this demographic such as housing set-up, renovations, and location, policy interventions are especially needed to create effective heat protection plans. The following sections identify policy intervention learnings, informed by direct inputs from refugees during and after the workshops. They are separated into two categories, that which the refugee shelters themselves can initiate and those recommended for the municipality of Munich.

6.2.1 Action Steps for Refugee Shelters

Participants noted several simple solutions that could be enacted directly by shelters themselves. In Workshop 3, participants noted that simply bringing in a portable, inflatable pool for kids to swim in on hot days and allowing them play time there with water guns and other water toys would be helpful for staying cool. This would ensure that kids are not isolated to their individual rooms on hot days. The participants noted that this had been implemented in the past but had stopped occurring in recent years. More shade in outdoor areas, especially playgrounds, were noted, a sentiment that was shared by Birgitta Mair, the social worker that was consulted. Participants noted that currently, playgrounds and outdoor seating areas are not shaded, which prevent children from going outdoors. This is a barrier to children's growth, as regular exposure to the outdoors is a determinant of social and cognitive development in children, as well as a booster of mental and physical health (Larouche et al., 2023). Natural or artificial shade in the form of tree shade or a pavilion-style structure over playgrounds and outdoor seating areas would help foster social resilience in the heat.

Furthermore, participants of both Workshop 1 and 3 noted that the presence of mosquitoes, ticks, and other bugs around naturally shaded shelter areas was a barrier to accessing this shade. Participants of Workshop 1 seemed not to know how to access bug spray or which brands to buy, so perhaps the inclusion of a limited, shared supply of bug and tick repellent would then be an effective way to expose refugees to the correct sprays needed.

Including directions for how to buy these products themselves would foster self-efficacy among participants, who seemed eager to purchase these products if they knew where to find them.

For cooling inside the rooms, many participants asked for the addition of AC or fans. While the energy use of AC should be noted, for participants it seemed to be the most effective manner of cooling.

6.2.2 Action Steps for Munich City

Refugees identified several needs from the city of Munich to ensure adequate heat protection. First, the expansion of green space was noted as a large need for refugees. In Workshop 3, several participants pushed for the planting of more trees around their area, which would increase shade and help reduce the urban heat island effect. However, it is necessary to note a potential byproduct of this intervention would be an increase of mosquitoes, ticks, and other bugs, a challenge noted above.

Furthermore, refugees have little control over the design of their living spaces, where cramped quarters with little ventilation and no AC easily trap in heat. Keeping in mind current conditions, there are a few design elements that the city of Munich may consider for refugee housing:

The inclusion of window awnings or a larger window ledge: This would keep windows shaded from the outside while maintaining sufficient light into the room. Though refugees from Workshop 1 and 3 noted that they have blinds to prevent sunlight from streaming in during the hottest parts of the day, this was something the Condrob's Women Shelter did not have. There, large window shutters were used to shade windows, but they were sometimes unreliable in their ability to close. The challenge that both of these designs face, however, is that using them darkens rooms significantly during the day, which may prevent day-to-day activities in the room. Refugees of Workshop 3 noted that they were not allowed to change the outside of the shelter building, preventing any renovations that inhabitants themselves could install.

The use of awning windows for circulation: Chung et al. (2019) studies the effectiveness of awning windows for ventilation in bathrooms in Taiwan, which in addition to pulling in wind to keep the room cool has sanitary benefits.

The use of convective ventilation and conductive ventilation, which has been recommended by the Australian government in their Design for Climate model (YourHome, 2020). Not only does using natural air for ventilation decrease eliminate the energy demand of AC, but it also increases the quality of circulating air which improves inhabitant health. Participants of both

Workshop 1 and 3 noted that though AC is helpful, it often leads to dry skin, sore throats, and other health risks.

The incorporation of AC units: This was by far what workshop participants pushed for most in terms of room cooling, despite the health consequences noted above. However, it comes at an energy and environment cost that should be considered.

In terms of working hours, the city may also consider shifting work to avoid the hottest parts of the day, especially for outdoor work. Refugees from Workshop 1 shared that farmers in Turkey work the early mornings, late afternoons, and evenings during summertime to avoid the times of strongest heat. A work schedule centered around the outdoor temperature and which provides time to rest in cool spaces would improve heat health for not only refugees but the general Munich population as well.

7. Limitations and Further Research

Heat protection for Munich refugees is a complex and intersectional issue. Due to the short time frame of the research period (1 July 2024 – 23 August 2024), multiple limitations of the study are identified. First, all of the refugees we worked with lived in relatively secure buildings in contrast to the container or tent style living spaces of other refugees. These demographics likely need even more heat protection support, as their accommodations are more open to the elements and have very little cooling strategies. More research should be done as to their specific needs, and investigation into how much more drastic heat protection measures should be for these cases should be conducted. More generally, results should be taken with caution since the refugees that attended the workshops are not representative of all German refugees.

Additionally, though many ideas were included, the decisive rationale for why participation in Workshop 2 was lower than in Workshop 1 and 3 remains unclear. More research should be done into the communication styles of different refugee cultures, the ability of a familiar location to foster discussion, and the merits of an all-female workshop with a female translator for increasing engagement.

Lastly, further research into cooling mechanisms that do not involve AC should be investigated. Many of the tips provided in workshops weren't applicable due to the design of the room, space constraints, or lack of resources. Rooms designed to ventilate and cool are also a topic with benefits not limited to the refugee community of Munich. Most buildings in the city do not have AC, and naturally cooling building designs will be increasingly necessary in the future, especially when considering sustainable adaptations to climate change.

Ultimately, heat stress for refugees is only one challenge to refugee support that overlaps and interacts with many other negative health outcome contributors e.g. sanitation risks, overcrowding, social isolation, mental health triggers, etc. Bettering refugee health necessitates looking at these issues as interconnected and causal. Additional holistic research should be conducted on the condition of refugee health to inform self-efficacy initiatives and policy interventions. The utilization of a two-way science communication model for these efforts should be considered to more effectively transfer knowledge, improve the relationship between refugee and science communicators, and foster growth for both sides.

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9. Appendix A: Review of Existing and Past Heat Protection Measures

Cities have begun to implement more scoping heat protection measures as they have become more conscious of rising temperatures and the effect that this has on overall population health. Generally speaking, there are two types of heat protection measures: those that detect dangerous temperatures and those that work to mitigate the risk that these heatwaves pose (Mayrhuber et al., 2018). Heat mapping is used in cities to detect dangerously high temperatures. Heat alerts are then used either via display in public places or notification on an app to inform the public of an upcoming heatwave. By informing people in due time, residents can prepare to take individual heat protection measures (as outlined in the next paragraph). Cities can also employ public health measures to mitigate the risks posed by hot weather, such as water fountains to prevent dehydration, sunscreen dispensers, AC in public buildings, and programs to provide individuals in need with AC. Some cities have also extended the opening hours of public pools and buildings with AC in order to allow people to spend more time in cool places.

As heatwaves become more extreme, more intensive heat protection measures are necessary. For example, during the 2010 heatwave in Montreal municipality workers went door to door to distribute material on heat protection and to identify vulnerable individuals in need of assistance (Price, Perron, & King, 2013). In other cities (especially in the US) cooling centers have been opened to provide homeless people and people in accommodation which is unsuitable during heatwaves with a place to stay (Kovats and Kristie, 2006).

10. Appendix B: Sanitary and Education Challenges for Munich Refugees

In addition to heat stress, many of the participants in Workshop 1 complained about the lack of hygiene and sanitation measures in their accommodation. This seemed to be a significant challenge to favorable health outcomes, even possibly larger than heat stress. There were reports of children urinating on the floor and outside the toilet, and this not being cleaned up in a timely or effective manner. There have been a number of people who live in the shelter who have had to go to hospital for repeated infections.

In addition, access to education is sometimes a challenge. One of the Turkish refugee women from Workshop 1 who has been living in the camp with her 6-year-old son since last year has had trouble enrolling her son in school. The kindergarten says he is too old, but the primary school says that he must complete kindergarten first prior to enrolling, causing a gridlock. There are policies in place for refugee education in Germany. Children aged 1 to 6, including refugees, are entitled to early childhood education such as daycare, kindergarten, or preschool. This includes more than four hours of care per day if parents work. Children are screened at around 4.5 years old to support their integration. Programs like “Kita-Einstieg” aim to increase attendance among refugee children (Korntheuer & Ann-Christian, 2002). We believe that an increased awareness of these programs within the refugee community is necessary.

11. Appendix C: Recreating Our Workshop: Checklist and Manual

Workshop Setting Considerations:

- Hold workshops during an accessible time that doesn't conflict with refugee work times.
- Find an existing gathering time, such as during or after a weekly event if possible in order to increase participation. Consider partnering with a regular event to make this possible.
- Hold the workshop at the refugee shelter to increase engagement and participation. However, be mindful of Wi-Fi constraints. Download the presentation beforehand, and consider how to demonstrate website resource functions if Wi-Fi is not available.

Materials Needed for the Workshop

- Projector, HDMI cable and adapter, and laser pointer for presenting the PowerPoint slideshow. Ensure that the location of the workshop has a blank wall for projection. Otherwise, a workshop without a presentation needs to be developed, such as one which utilizes flipcharts and writing to illustrate workshop concepts.
- Supplementary material
    - Pamphlets with QR codes with links to important information slides, adding a description in the refugees' native language and German of what each QR code links to. The German/English version can be found here: https://docs.google.com/document/d/1pXs2pEHk7ftfAKouneSvsnv4BIquvcav/edit?usp=sharing&ouid=114384907359416024739&rtpof=true&sd=true
    - LMU Klinikum Infection Control In the Heat Brochure–multiple languages are available for the version of this pamphlet tailored for Staff in Health Professions (SHP), which is why we used it even though it is not directly pertaining to refugees. Found here: https://lmu-klinikum.de/klimawandel-bildung/projekte/coheat-hitzeschutz-in-zeiten-von-covid-19/420a46d71037bf3c
    - If the participants speak in English, custom-made heat health pamphlets. Found here: https://www.canva.com/design/DAGLMi67LWY/NMdpIG_abVC9sXE7bwu1kw/edit
- Elotrans electrolyte mix and water bottle to demonstrate how the powder is used.
- Sunscreen

- Aloe Vera cooling gel
- Water, sugar, salt, drinking glass, and stirring stick/spoon for demonstrating homemade electrolyte recipe.
- Sports Drink
- Water refilling sticker
- Food or snacks for participants, with cups and plates.

PowerPoint Presentation Key Content:

- Introduction
    - Context of the workshop, including that we are gathering input from refugees and learnings from the workshop are anonymous but will be used for science communication research at MSCL. If findings will be shared in a larger capacity e.g. shared with policy makers or the refugee shelter, mention this to ensure full disclosure. It may also increase engagement.
    - Emphasize that refugees can ask questions at any time during the presentation, take pictures of demonstrations and supplies, etc.
    - Overview of global warming, including temperatures from earlier, now, and projections for the future. If language is not a barrier, explain where these numbers came from, e.g. 10-year maximum temperature averages from the years X to Y.
    - Explain the Urban Heat Island Effect and the science behind it, including that this means everyone at the workshop is automatically a more vulnerable group.
    - Explain that excess heat causes health problems, hence why the workshop is taking place.
    - Overview of the sections of the presentation
- Staying Healthy in the Heat
    - Discussion Question: Ask refugees for their tips and tricks for staying cool in the heat.
    - What to Drink Activity
    - Electrolyte Segment, including homemade recipe
    - Isotonic Drinks
    - Importance of sunscreen for preventing sunburn and skin cancer
    - Significant of Hautarzt doctor for treating skin conditions, and home remedies treating sunburn

- Staying Cool Around Munich
    - Discussion Question: What can the city of Munich and their accommodations do to improve heat health?
    - Include the link to Shade Mapping Munich: https://hitzefrei-muenchen.de/
    - Include the link to a map of free water-filling stations in Munich: https://geoportal.muenchen.de/portal/trinkwasserbrunnen/
- Looking After Others
    - Ask participants if they can identify any heat stress vulnerable groups, then give a brief summary of suh vulnerable groups (the elderly, children, people who are ill or who have chronic illnesses, people who live in cities)
    - Include the following tips:
        - Breastfeed infants more, but don't give them water to prevent water poisoning.
        - Dress kids in light-colored, loose clothing.
        - Note the neck cooling necklace for children: "Warping a Neck Cooler, Portable Reusable Cooling Ring to make body cooler" (can also be substituted by a wet towel).
        - Store medications in a cool place.
        - Note that some medications can cause participants to feel hotter and explain the reasoning behind why and what to do in these circumstances.
        - Help the sick or elderly with outdoor tasks, and take them to the doctor if anything is wrong.
- Questions and Comments
- Feedback:
    - Draw a scale from one to ten for participants, asking, on a scale of one to ten, with on being not at all and ten being the most possible:
        - How would you rate the usefulness of this workshop?
        - Did you have fun?
        - How would you rank the importance of heat related health risks? Sanitary health risks? Nutrition shortages?
        - *Note that for refugees who don't speak English, this may be harder to execute unless the questions themselves are written in their native language

- If you had to convince your friend to come to this workshop, what would you tell them?
- Who do you think this workshop would be helpful for?
- Would you be interested in connecting with refugees from these different shelters in the future? If so, how?
- Included below is a Google Drive Link to our 3 workshop PowerPoints, with pdf and Google Slide version, as well as the notes taken after each workshop and the supplementary handouts that were given to participants: https://drive.google.com/drive/folders/128ke41KM8ALGUHkd0RcUT1ikFjF9W50N?usp=share_link

12. Appendix D: Specific Heat Protection Knowledge Comparisons Across 3 Participant Sets

Subject	Workshop 1	Workshop 2	Workshop 3
Answers to the What to Drink Activity	Iced Tea and Water	Iced Tea and Water	Water
Awareness of Isotonic drinks	None of them were aware of isotonic drinks.	A few knew that isotonic drinks were good on hot days.	None of them were aware of the benefits of isotonic drinks.
Electrolytes	None of them were aware of electrolytes; almost of all them showed interest in learning about them.	None of them were aware of electrolytes; some of them showed interest in learning about them.	None of them were aware of electrolytes; all of them showed interest in learning about them.
Sunscreen	Some of them knew about Sunscreen; participants were curious about the best type of sunscreen to use and what the different SPF numbers meant.	Almost all of them knew about sunscreen.	All except one of them knew about sunscreen; the one participant who did not know about sunscreen wanted to know where they could buy sunscreen.
Treatment for sunburn	None of them were aware of how to treat sunburn.	None of them were aware of how to treat sunburn.	None of them were aware of how to treat sunburn.
Using curtain to avoid direct sun	Some of them knew this already, and used white towels to cover their window.	Participants already knew about this.	Some of them knew this already, but they mentioned that they didn’t always have room to cover their windows from the inside and weren't allowed to cover their

			windows from the outside.
Wearing light-colored clothing to reflect sunlight	Already knew	Already knew	Already knew
Keeping infants hydrated with breast milk during hot weather and the prevalence of water poisoning	They already knew that infants may have to be breastfed more, but they weren't aware of water poisoning.	They already knew that infants may have to be breastfed more, but they weren't aware of water poisoning.	They already knew that infants may have to be breastfed more, but they weren't aware of water poisoning.
Storing medication in a cooler place	Already knew	Already knew	Already knew
Using AC	They already knew about it, but they don't have access to it in their rooms.	They already knew about it, but they don't have access to it in their rooms.	They already knew about it, but they don't have access to it in their rooms.
Using fans	They already knew about it, and some used them in their rooms.	They already knew about it.	They already knew about it, but not everyone was able to use it in their rooms.
Unplugging electronics	They already knew about it, but they couldn't unplug most devices because they are old models/the rooms were cramped.	They already knew about it, but they couldn't unplug most devices because they are old models/the rooms were cramped.	They already knew about it, but they couldn't unplug most devices because they are old models/the rooms were cramped.
Participant Input 1	Don't go outside until 4 or 5 pm when the worst of the heat has passed.	Take cold showers.	Take cold showers.
Participant Input 2	Wear light, loose clothing that covers	Wear wet towels around the neck.	Wear wet towels around the neck.

	the face, arm, and body.		
Participant Input 3	Covering head/hair with a headscarf.	Swim in public pools/the river Isar.	NA
Participant Input 4	Workplaces and other public buildings should have AC.	NA	NA