College of Health Solutions Student Heat and Health Research Challenge

Proposed Title:
SmartHeat Tracker: an integrative mHealth-AI tool to monitor and advise users on heat-related health risks

Student Investigators:

Name	College	Program	Signature
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Mentors:

Name	College	Title	Signature
(1) Floris Wardenaar	College of Health Solutions	Assistant Professor	Floris Wardenaar
(2) Jennifer Vanos	School of Sustainability, College of Global Futures	Associate Professor	Jennifer Vanos
(3) Megha Budruk	School of Community Resources & Development (CRD) Watts College of Public Service & Community Solutions	Associate Dean for Faculty Affairs & Associate Professor	Megha Budruk

(Dr. Vanos is currently on maternity leave until the beginning of August. During her absence, Dr. Budruk will assume the role of project mentor)

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(1) Project Vision

Excessive heat exposure stands as the foremost preventable cause of weather-related deaths in the United States.[1] High temperatures (e.g., over 100°F) are particularly common in the Southwest, notably in Arizona, where the current challenge is unprecedented.[2] In the summer of 2024, Arizona is anticipating both record-breaking heat and delayed onset of the monsoon season, with excessive heat warnings spanning every county and Phoenix bracing for an incredibly historic summer.[3] In 2023, Maricopa County, the state's most populous, reported 645 heat-associated deaths, a 50% increase from the previous year.[4] The health repercussions of extreme heat are 'just the tip of the iceberg' and represent only a fraction of the broader consequences.[5] Despite these consequences, it's crucial to acknowledge that morbidity and mortality resulting from excessive heat exposure can still be prevented.[6,7]

Phoenix is known for its uncountable hiking trails over the desert, attracting tourists and enthusiasts to explore the hiking trails during the summer.[8] However, while often uneventful, hiking carries inherent risks, particularly during intense heat conditions.[9] This is due to the risk of exertional heat illness (EHI), caused by individual and environmental heat stress during physical activities such as hiking.[9] EHI ranges from mild conditions like heat edema and cramps to severe cases like heat stroke.[10] Several incidents have been reported in the Grand Canyon National Park,[11] as well as within the Phoenix metropolitan area,[12] most of which were attributed to heat-related illness encounters during hiking. This highlights the need for interventions to address the health risks associated with extended exposure to heat during hiking excursions.

Several studies have evaluated the impact of heat on mountain hikers' performance [9,13] and a few interventions to enhance hiker safety on trails.[14] Prior research shows that among several factors, the duration of exposure to a hot environment and the type of activity performed play significant roles in determining the health risks for individuals exposed to heat. These risks range from mere discomfort, associated with short periods and low-intensity activities (e.g., 30-90 minutes), to more severe conditions such as cramps, dehydration, heat exhaustion, heat stroke, and even death, which are linked with prolonged periods and moderate to intense activities (e.g., over 90 minutes).[15] Therefore, it is imperative to develop individual-level interventions that influence human behavior, leveraging technological advancements to mitigate the effects of heat. These pragmatic solutions should involve real-time monitoring and alerting populations at risk.

Mobile health (mHealth) technologies have emerged in recent years as a promising approach at the individual level to guide, motivate, and remind individuals to engage in physical activity and/or exercise.[16,17] Similarly, mHealth tools can be applied in the context of heat exposure and health risk research. For instance, Wireless Emergency Alerts sent by the National Weather Service (NWS) through the Federal Emergency Management Agency (FEMA) have been able to alert the public about climatic events such as heat waves, sand storms, tornadoes, and evacuation orders.[18] These alerts have been effective in protecting people exposed to this kind of climatic events from more severe consequences. Similarly, we believe that mHealth could be applied at the person level to prevent heat-related symptoms such as heat stroke, heat illness, and even death.

This project focuses on mHealth technologies for monitoring health risks related to heat exposure, ensuring user safety and well-being. Artificial Intelligence (AI) algorithms can be used to integrate data from smartwatches (e.g., physical activity level, duration, heart rate) with real-time environmental conditions (e.g., temperature, humidity, wind speed). This will provide personalized alerts and recommendations without constant human monitoring. The app will use real-time physiological data, hourly weather information, and exercise responses to predict heat-related health risks. It will also incorporate guidelines on work-pause ratios based on ambient conditions and clothing. By monitoring heart rate and body temperature via smartwatch sensors, the app will offer personalized safety recommendations such as hydration and breaks, helping users plan safe outdoor activities, especially those with comorbidities (e.g., hypertension, diabetes). The aims of the project are outlined below:

Phase 1 ($5,000)

1. To collect preliminary data and analyze real-time weather and physiological data to assess the feasibility and compatibility of developing a mHealth-AI integrated mobile application.
2. To conduct a one-day awareness campaign addressing heat-related health risks, providing hikers with essential precautionary measures to enhance safety.

Phase 2 ($50,000)

1. To develop an innovative mHealth-AI integrated mobile application (SmartHeat Tracker) specifically tailored for monitoring and advising individuals regarding potential health risks posed by extreme heat and promptly alert users to take necessary precautions.
2. To test the usability and acceptability of the developed 'SmartHeat Tracker' application in a sample of 30

volunteer mountain hikers at the selected study site.

Phase 1: As the first step, we require accurate weather data specific to the locality, including ambient temperature, heat mapping, and humidity levels. Our mentors, Drs. Wardenaar, Vanos, and Budruk have established connections with the City of Phoenix (as well as other organizations within Arizona), and have previously organized similar data collection efforts, providing a solid foundation for this project. We plan to run a trial using the Labfront platform (https://www.labfront.com/) to collect basic demographic data, including age, gender, and trail location, which participants will provide during the app's signup process. The wearable device will be a Garmin vívoactive® 5 smartwatch equipped with real-time sensors capable of measuring heart rate, blood pressure, and skin temperature (which will be used to calculate core body temp). Using the Labfront platform, we will monitor real-time physiological functions and integrate this data with weather information as a preliminary trial. Moreover, we will conduct a one-day awareness campaign about heat-related health risks at a selected study site. This campaign will outline precautionary measures hikers should take to ensure their safety during their hike, serving as a community engagement initiative. During the awareness campaign, we will randomly select three adult volunteers to test the trial app's functionality during their hikes. Each participant will receive a $50 Amazon gift card.

Phase 2: Throughout the project, we will consult a software developer for support in the mHealth app development. We plan to leverage platforms offered by paid providers that facilitate the hosting and integration of physiological data from wearable devices with environmental data (costs are included in the budget). These platforms allow efficient data collection and real-time monitoring, ensuring users receive timely alerts and personalized recommendations. By building AI support on top of these platforms using the data, we aim to enhance the app's capability to provide individualized advice, further mitigating heat-related health risks.

Subsequently, we will test the usability and acceptability of the developed mHealth tool with a volunteer group of 30 mountain hikers aged 18 years and above at the selected study site. Drs. Budruk and Wardenaar have connections with officials at the Grand Canyon, and we intend to discuss whether they might be interested in allowing us to test this app. In this phase, we will gather additional information collected during Phase 1, such as participants' race/ethnicity, height, body mass, health conditions, and smoking status provided during sign-up. Due to the sensitive nature of this data, we will utilize REDCap for secure collection. We plan to recruit participants through a one-week awareness campaign about this SmartHeat Tracker app. This will involve setting up a booth at the trail base and placing banners at the trail entrance featuring QR codes linking to the app. Each participant will receive a smartwatch and be requested to wear it throughout the hike, typically lasting 2-3 hours. Upon completing the hike, participants must return the smartwatch to our booth located at the trail's base. Subsequently, they will be guided to complete a feedback survey hosted by REDCap. After completing these steps, each participant will receive a $75 Amazon gift card. Moreover, refreshments will be provided for the public and our participants free of charge at all awareness events. Concurrently, we will conduct a social media campaign on Facebook to provide the general public with essential medical information for summer outdoor activities. This includes hydration tips, recognizing early signs of heat-related illnesses, and effective first-aid responses for heatstroke and heat exhaustion. The page will feature interactive content such as live Q&A sessions with health professionals, informative videos, and infographics, helping community members stay informed and engaged with the latest safety advice and resources.

Overall Impact

We aim to promote summer physical activity while prioritizing heat protection. The intervention includes alerting users about weather changes and recommending safety measures during hikes. The app serves as a resource for seeking medical attention for heat-related illnesses, locating cooling centers, and accessing emergency departments. This project addresses weather-related barriers to physical activity, mitigates heat-related health risks, and promotes safe exercise practices. Upon evaluating user satisfaction, the intervention will be refined for potential extension to other vulnerable populations as deemed appropriate.

(2) Team Details

Our multidisciplinary team combines expertise from public health, exercise physiology, engineering, and computer science, with academic credentials ranging from Master's to PhDs. Our mentors, Dr. Floris Wardenaar (performance nutrition in hot environments), Dr. Jennifer Vanos (extreme heat, thermal comfort, and health impacts on vulnerable groups), and Dr. Megha Budruk (natural resource management and community development), bring extensive experience, including prior heat-related projects in Arizona, to guide our work. Team members and their roles are: **(1) Binoli Herath:** A first-year PhD student in Population Health and Research Associate at ASU's College of Health Solutions, with a background in Pharmacy and Health Development. Binoli will coordinate the project, lead meetings, manage project work, prepare and submit IRB documents, and participate in awareness campaigns and participant recruitment.

(2) Raul Freire: A first-year PhD student at ASU's College of Health Solutions specializing in exercise and sports physiology, focusing on human thermoregulation. Raul will oversee outdoor exercise project execution, advise on physiological and weather data selection for the predictive model, and assist in awareness campaigns and participant recruitment. **(3) Rashmi Neelawathura:** A first-year PhD student in Engineering Education Systems & Design at ASU with research interests in AI in engineering efficiency and human systems engineering. Rashmi will handle app design and AI integration, advise on AI utilization for personalized experiences and data analytics insights, and assist in awareness campaigns and participant recruitment. **(4) Tanmai Mukku:** A first-year Master's student in Computer Science at ASU and Data Science Specialist Aide at CHiR. With experience in data science and machine learning, Tanmai will advise on the app's design from a data science perspective, contribute to technical development and algorithm design, and support awareness campaigns and participant queries. Their combined expertise will ensure a robust approach to developing our heat-related health risk prediction app, fostering connections with local entities, and supporting the project's success.

(3) Budget Plan

CATEGORY	DESCRIPTION	COST	TOTAL
PERSONNEL	Student stipends for the four team members	$300x4	$1,200
CONSULTANT COSTS	Software Developer consultation	$1,000	$1,000
EQUIPMENT	3 Garmin vívoactive® 5 smart watches ($250x3=$750) Lab front platform, cloud storage, data analysis ($600)	$1,350	$1,350
TRAVEL	Reimbursement mileage for transporting to Grand Canyon (round-trip) ($500)	$500	$500
PARTICIPANTS COST	Incentive for participation for the 3 volunteers (Amazon gift cards $50 each)	$50x3	$150
FOOD	Refreshments (water, energy drinks, and cereal bars) ($6 each) We expect about 50 people on a random day at the selected study site	$6x50	$300
OTHER EXPENSES:	Awareness campaign requires two banner stands [2 Ft x 5 Ft] ($100), table runner ($40), printing handbills ($50), one canopy tent ($130), one desk ($70), two folding chairs ($60), first aid box ($50)	$500	$500
		SUBTOTAL	**$5,000**

CATEGORY	DESCRIPTION	COST	TOTAL
PERSONNEL	Student stipends for the four team members	$1,200x4	$4,800
CONSULTANT COSTS	Software Developer consultation	$3,000	$3,000
EQUIPMENT	15 Garmin vívoactive® 5 smart watches ($250x15=$3,750) App development and hosting ($25,750)	$29,500	$29,500
TRAVEL/ CONFERENCES	Reimbursement mileage for transporting to Grand Canyon ($500 per day x 7days =$3,500). Conference travel for two team members ($3,600)	$7,100	$7,100
PARTICIPANTS COST	Incentive for participation for the 30 volunteers (Amazon gift cards worth $75 each) for taking part in the study and completing the feedback survey	$75x30	$2,250
FOOD	Refreshments (water, energy drinks, and cereal bars) ($6 each) We expect about 50 people on a random day at the selected study site (x7days)	$6x50x7	$2,100
OTHER EXPENSES:	Awareness campaign on the app requires two banner stands [2 Ft x 5 Ft] ($100), printing handbills for one week campaign ($200), 3 first aid boxes ($50x3=$150), stationary items ($50) Social media campaign ($750)	$1,250	$1,250
		SUBTOTAL	**$50,000**

References: Click here to see the list