PROPOSAL NARRATIVE

I. Project Title

Predicting Heat Stress Event with Physiological and Environmental Metric-Based Mathematical Model

II. Abstract

Exposure to high heat and humidity can lead to serious health risks, including heat stroke and other heat-stress related events. Wet Bulb Globe Temperature has historically been used to predict heat stress events, but individualized factors are not included in the measurement. It has been shown that there is a relationship between cardiovascular measurements and heat stress, which could be used to measure on an individual level. Research has been done to find relationships between cardiovascular metrics in a workplace environment, however the study did not include the use of a controlled environment as a baseline. Our study will provide measurements of TEWL, arterial compliance, heart rate, and blood pressure in a controlled environment when humans are exposed to heat and humidity. Our hypothesis is that an algorithm can be developed based on individualized metrics including TEWL, arterial compliance, blood pressure, heart rate, and other physiological metrics that can serve as a mathematical model to predict heat stress related events.

III. Introduction

Heat stress is often an overlooked hazard that can become lethal if precautionary steps are not taken, including hydrating and taking rest breaks when appropriate. Some people are more at risk of heat stress based on occupation, residence, and activities, like playing sports. In addition, climate change and heat waves pose a threat to over 150,000 heat-related deaths annually, according to the World Health Organization. Even during this past summer, six people died of heat-related causes during a record-breaking heat spell in California's Bay Area. Heat stress is categorized into heat exhaustion and heat stroke based on the types of symptoms faced. Heat exhaustion symptoms include dizziness, headaches, fainting, vomiting, and weakness, whereas heat stroke symptoms can include seizures, convulsions, unconsciousness, mental confusion, and hot, dry skin without sweating.

The resultant elevation in body temperature from excessive heat exposure has no standard safety measure to indicate an individual's degree of heat stress. Wet Bulb Globe Temperature (WBGT), a type of apparent temperature, is currently used to classify heat stress for a given activity performed over a given period of time. Physiological factors are also known to affect heat stress. One's ability to adapt to heat decreases due to increasing age, being ill, and low levels of physical activity. Body core temperature can fluctuate based on individual-based parameters, such as age, gender, medications, and cardiovascular health. Heart rate, stroke volume, blood pressure and arterial compliance change as the intensity of heat stress increases, from symptoms of heat oedema to heat stroke. Relationships between transepidermal water loss (TEWL) and cardiovascular metrics have been assessed in high heat risk environments,

which show a possible correlation with environmental metrics, such as infrared imaging and WBGT.

Graduate students McKenzie Barlow (Cal Poly) and Jacob Thomas (University of Utah) will be working together to take the experimental measurements at University of Utah, and McKenzie will measure the physiological variables at Cal Poly. Both experimental and physiological data would then be analyzed to draw any conclusions about how the environment affects changes in body core temperature, which can lead to heat stress related events.

IV. Objective(s)

1. Measure WBGT, TEWL, arterial compliance, blood pressure, heart rate, and use thermal imaging of human subjects in a controlled environment while exercising and at rest.
2. Find a relationship between individual metrics and body core temperature as the temperature and humidity in an environment change.
3. The relationship would be used to create an algorithm and mathematical model to predict heat related events before they occur based on an individual's response to exposure of heat and humidity. The model could be incorporated into biomedical devices to mitigate heat stress events that could otherwise be prevented.

V. Methodology

Participants will be asked to exercise on a step-climber in a room with controlled temperature and humidity, and measurements of the variables mentioned in the first objective will be taken with equipment already supplied by University of Utah and Dr. Whitt (faculty advisor) at 0, 10, 20, and 30 minutes. The equipment necessary to measure WBGT for the experiment is at the University of Utah campus.

VI. Timeline

The timeline for this project is to take measurements in a controlled environment at Cal Poly in the beginning of January 2018 and to collect measurements for up to 1 week. McKenzie Barlow will need to travel to University of Utah to take environmental measurements to compare to the physiological measurements taken at Cal Poly. The statistical analysis of the results, as well as the written thesis report, will be completed by June 2018 in order to be defended before the end of spring 2018 quarter.

VII. Final Products and Dissemination

The final product is a research study with statistical analysis that can be applied to future products developed to measure an individual's body core temperature using cardiovascular measurements. This project's goal is to understand the effect of heat stress and how to prevent heat stress related events from occurring in the form of a thesis project to help McKenzie Barlow finish the Master's 4+1 Program.

VIII. Budget Justification

The requested budget of $1,000 is needed for this project in order for the researcher to travel to Salt Lake City, Utah to take environmental measurements, WGBT, of human subjects in a controlled environment. It was estimated that flight and hotel costs sum to $700, and the equipment cost is about $300, making a total of $1,000. The equipment McKenzie Barlow needs to purchase include a space heater, vaporizer, step climber, and a temperature and humidity reader.

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PROPOSAL BUDGET

Student Applicant(s):	McKenzie Barlow	
Faculty Advisor:	Dr. Michael Whitt	
Project Title:		**Requested Endowment Funding**
Travel	*subtotal*	**$700**
Travel: In-state		**$0**
Travel: Out-of-state		**$700**
Travel: International		**$0**
Operating Expenses	*subtotal*	**$ 300**
Non-computer Supplies & Materials		**$300**
Computer Supplies & Materials		**$0**
Software/Software Licenses		**$0**
Printing/Duplication		**$0**
Postage/Shipping		**$0**
Registration		**$0**
Membership Dues & Subscriptions		**$0**
Multimedia Services		**$0**
Advertising		**$0**
Journal Publication Costs		**$0**
Contractual Services	*subtotal*	**$0**
Contracted Services		**$0**
Equipment Rental/Lease Agreements		**$0**
Service/Maintenance Agreements		**$0**
	TOTAL	**$1,000**