THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF KINESIOLOGY

Older vs Younger Adults' Thermal Perception During Progressive Heat Stress

DYLAN PEREZ
SPRING 2023

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Kinesiology
with honors in Kinesiology

Reviewed and approved* by the following:

W. Larry Kenney
Noll Chair in Human Performance
Professor of Physiology and Kinesiology
Thesis Supervisor

Lacy Alexander
Professor of Kinesiology
Honors Adviser

* Electronic approvals are on file.

TABLE OF CONTENTS

ABSTRACT

Purpose: The purpose of this present study was to compare older vs younger adults' perceptions of heat and humidity at rest and while active. Comparing physiological responses in relation to perception of the environment may change with aging.

Methods: 35 older adults (aged 65-92 yrs) and 41 younger adults (aged 18-29 yrs) were placed in an environmental chamber where they were either sat at rest or performed light activity on a stationary bike in warm-humid or hot-dry environments. In warm-humid tests ambient temperature was held constant and humidity increased progressively; in hot-dry tests absolute humidity was held constant and temperature increased. During the trial, subjects were given two scales that assess their perception of how hot or humid they felt every 5–10-minutes. Core (gastrointestinal) temperature (T_{gi}) was continuously measured and sent to a data acquisition system. A two-way ANOVA was performed to detect differences in thermal perception at the start, equilibration phase of T_{gi}, and inflection of T_{gi} once heat stress became uncompensable for younger compared with older adults.

Results: At the start of the trial, the point of T_{gi} equilibration, and at the point of T_{gi} inflection, there were no significant age group differences in thermal or humidity perception Further, there were no differences in mean body temperature at the start, equilibration, or inflection points for older compared with younger adults.

Conclusions: No differences were found between young adults and older adults' perception of how hot or humid they were for a given mean body temperature. This suggests that while the older population is at an increased risk of heat-related illness, they may still be able to accurately perceive the environment in relation to their core and mean body temperature.

ACKNOWLEDGEMENTS

Words alone cannot express how grateful I am for the opportunity to complete a thesis for Penn State and the Schreyer Honors College. It is an honor I do not take lightly and is one I will forever be proud of completing. This was an achievement I could not have completed on my own as I had so many brilliant minds offering me guidance and assistance throughout my journey. First, I would like to offer my thanks and appreciation to my thesis supervisor, Dr. Kenney, who gave me the platform to work on my thesis and offered me a variety of ideas to help me find my thesis' identity. I would also like to recognize my honors advisor Dr. Lacy Alexander for introducing me to Dr. Kenney and helping me formulate an efficient and structured plan to complete my thesis in a timely manner. Finally, I would like to thank Ms. Rachel Cottle, for being my mentor during this experience, and for always being a resource for me through all the highs and lows.

Chapter 1

INTRODUCTION

It has been proven that the Earth has been steadily increasing in temperature for the past several decades and is believed to continue increasing throughout this century. In addition to the average global temperature increasing, the frequency, duration, and severity of heat waves have also increased (Perkins et al.). Current records indicate that over 11000 people have died from heat related illness since 1979 (US EPA). This is a number that is hypothesized to only increase over time, especially when considering the current state of the general population. At its current state, with new medicines and practices being developed every day, and fertility rates rapidly decreasing, studies have shown that we are getting older as a society (Robine & Michel, 2004). It is believed that by 2050, there will be more people over 60 than those under 15 which will be the case for the first time in human history (United Nations, 2022). While longevity is a great thing, this is an alarming revelation when you consider the fact that if the world is getting older and hotter, than that means over time more people will be at risk and vulnerable to heat stress.

During severe heat environments, adults over the age of 65 are at the greatest risk to experience detrimental health effects. When compared to different age ranges, those over the age of 65 experience such health issues at an exponentially greater rate than other age groups (Kenney et al.). Regarding older adults, the highest rates of morbidity and mortality during heat occur primarily in indoor settings, including residencies and institutions (Klenk et al., 2010). There are a multitude of studies that evaluate physiological variables such as sweat rate, cardiac responses, skin blood flow, etc. and their progressive age-related decline in response to heat

stress (Armstrong & Kenney, 1993). However, one type of variable that has been called for others to look more into are psychological variables. Specifically, the variable being called into question is the personal perceptual factor of heat and humidity in relation to how their body is physiologically responding to the environment. In humans, it is hypothesized that there is an age-associated discordance with older subject's perception of heat as heat stress increases. It is believed that this perception becomes skewed due to the natural deterioration of your sensory nerves as you age (Verdú et al., 2000).

If there is in fact a negative correlation between age and one's ability to perceive conditions, then older adults are at an even greater risk than previously perceived. Perception refers to the way sensory information is organized, interpreted, and consciously experienced (OpenStax & Learning, n.d.). A lack of accurate thermal perception would suggest that in the event an older person is in an environment that is putting a lot of stress on them they may not recognize the stress; and as a result, they are not proactive which inadvertently puts them in harm's way. As mentioned earlier, the highest rates of morbidity and mortality occur indoors when talking about heat and older people. A perceptual discordance with mean body temperature during heat stress could be a key contributor to this. It is not too farfetched to imagine an older person, who may not potentially feel hot and enjoys the warmth because they get cold easily, keeping their air conditioning off to save power and money (Malmquist et al., 2022). On the surface, this is a perfectly harmless decision, however it can be the difference between life and death given the circumstances. This can even apply to older people who are used to the heat as well. An older person who has lived in Texas all their life may say that they're fine but if they cannot recognize the difference between 85 degrees and 93 degrees because it feels "the same" then they can be in danger without even knowing it.

Therefore, the purpose of this thesis was to investigate young and older adult's psychological perception of the environment in relation to their physiological (i.e., mean body temperature) response during progressive heat stress in warm-humid (WH) and hot-dry (HD) environments during minimal activity. As a secondary exploratory aim, we examined perceptual and physiological responses in older adults during progressive heat stress during rest and minimal activity. The expected result is to see the younger adult population having a more accurate perception of the heat and humidity when compared to the older population.

Chapter 2

METHODS

Subjects:

All experimental procedures were approved in advance by the Institutional Review Board at Pennsylvania State University. Oral and written consents were obtained voluntarily from all subjects before participation and in accordance with the guidelines set forth by the Declaration of Helsinki. All testing was conducted in Noll Laboratory at the Pennsylvania State University.

35 Healthy older individuals (15 Men and 20 Women) aged 65-92 and 41 healthy young adults (21 men and 20 women) aged 18-29 were recruited to participate in this study. All participants were healthy, normotensive, nonsmokers, and were not taking any prescription medications that might affect the physiological variables of interest in this study. No attempt was made to control for menstrual status or contraceptive use. During the experiments, clothing was standardized with subjects wearing thin, short sleeved cotton tee-shirts, a sports bra for women, shorts, socks, and walking/running shoes (Wolf et al., 2022).

Testing Procedures:

Experimental trials were conducted on separate days with at least 72 h between visits. Participants were asked to abstain from caffeine consumption for at least 12 h, and alcohol consumption or vigorous exercise for 24 h, before arrival for experimental trials. Prior to the experiment, subjects were given gastrointestinal (T_{gi}) telemetry capsules and were required to ingest 1-2 hours before the study began. This is in congruence with studies showing ingestion time prior to use within in the set time range will not alter the accuracy or precision of the T_{gi} data (Notley et al., 2020). Upon arrival at the laboratory, participants provided a urine sample to

ensure they matched the proper hydration threshold (urine specific gravity <1.020). The subjects were then weighed and instrumented with skin temperature (T_{sk}) probes and electrodes for heart rate monitoring. They were then moved to the preconditioned environmental chamber.

While in the environmental chamber, subjects performed light activity at a metabolic intensity reflecting the metabolic demand of minimal activity (MinAct) or rested (older adults only). For the MinAct trials, subjects cycled on a cycle ergometer against zero resistance at a cadence of 40–50 rpm. All experiments began between the hours of 8am and 3pm; thus, although minor differences in absolute core temperature may have existed due to time of testing, the biophysics of heat exchange, and therefore the critical environmental conditions, were unlikely to have been affected by circadian rhythm (Wolf et al., 2022).

Throughout the duration of the study, the subjects were asked to honestly answer scales on humidity and thermal perception. For, the thermal perception scale, subjects were asked how hot they perceived the environment to be during HD trials. A 1 indicated that they did not perceive the environment to be hot, while a 10 indicated that they felt extremely hot. For the humidity scale, subjects were asked how humid they perceived the environment to be during WH trials. A 1 indicated that they did not perceive the conditions to be humid and an 8 was indicative of the feeling that the environment was extremely humid.

The critical ambient vapor pressure (P_{crit}) and critical dry bulb temperature (T_{crit}) for the upward inflection of body core temperature (T_c) was found in an environmental chamber at two different dry bulb temperatures (T_{db}) conditions of: 34℃, and 36℃ and two ambient water vapor pressure (P_a) conditions of 12mmHg and 16mmHg, respectively. The WH environment was a combination of the 34℃ and 36℃ P_{crit} trials. The HD environment was a combination of the 12mmHg and 16mmHg T_{crit} trials. During P_{crit} experiments, T_{db} was held constant while, after

a 30-min equilibration period, P_a was increased by 1 mmHg every 5 min. Conversely, during T_{crit} experiments, P_a was held constant and T_{db} was increased by 1°C every 5 min after a 30-min equilibration period. Progressive heat stress continued until a clear and continuous rise in T_c was observed (Wolf et al., 2022). Perceptual measures and blood pressure were taken at the end of every stage (i.e., at every increase in T_{db} (T_{crit} trials) or P_a (P_{crit} trials)). Heart rate, T_{sk}, and T_{gi} were continuously measured and transmitted to a PowerLab data acquisition system and LabChart signal processing software (ADInstruments, Colorado Springs, CO) using an Equivital wireless physiological monitoring system (Equivital Inc., New York, NY) (Wolf et al., 2022). The perceptual measures used for data analysis were taken at the beginning of the study (5 min), at the point of T_{gi} equilibration, and at the point of T_{gi} inflection (i.e., critical environmental limit). Mean body temperature (T_{mb}) was calculated using the formula $T_{mb} = 0.9*T_{gi} + 0.1*T_{sk}$. T_{mb} was calculated at the start of the trial, at T_{gi} equilibration, and T_{gi} inflection. Once a clear and continuous rise and T_{gi} was observed, the study was completed, and the participants were allowed to leave the chamber. Experimental visits lasted approximately 90-120 minutes.

Statistical Analysis:

For the purpose of this study, statistical comparisons were made between WH and HD environmental conditions. Data were analyzed (GraphPad Prism, v. 9.2, GraphPad Software, San Diego, CA) using PROC MIXED two-way ANOVA (age x time) to detect within- and between group differences for perception and T_{mb}. Tukey's post hoc corrections were performed to account for multiple comparisons in the ANOVA when necessary, and significance was set a priori and accepted at $\alpha = 0.05$. Group data are presented with means and standard deviations.

CHAPTER 3

RESULTS

Subjective Characteristics:

Subjects were recruited to be representative of the population in these age groups. By design, there was a considerable age difference between the young and older groups ($p < 0.05$). Within each age group, there were no differences in height, weight, AD, AD/kg, or VO2max among all trial conditions (all p >0 .05). Subject characteristics are presented in **Table 1** and **Table 2**.

Humidity Perception:

There were no significant differences found in humidity perception when comparing young with older adults at the start ($p=0.18$), at equilibration ($p=0.09$), and at inflection ($p=0.45$). When comparing humidity perception for older adults at rest vs MinAct, there were no differences found at the start ($p=0.57$), at equilibration ($p=0.86$), and at inflection ($p=0.68$). However, humidity perception significantly increased across all time points for younger adults during MinAct and older adults at rest and during MinAct (all $p < 0.05$).

Thermal Perception:

There were no differences in thermal perception between young and older adults during MinAct at the start ($p=0.99$), equilibration ($p=0.62$), or inflection ($p=0.41$). When comparing older at rest vs MinAct, there were no differences in thermal perception at the start ($p=0.97$), at equilibration ($p=0.99$), and at inflection ($p=0.75$). However, thermal perception significantly

increased across all time points for younger adults during MinAct and older adults at rest and during MinAct (all $p < 0.05$). This data is shown in **Figure 1** and **Figure 2.**

Mean Body Temperature:

In younger adults, T_{mb} significantly increased across all time points for HD environments (all $p < 0.05$). In WH environments, T_{mb} was greater during equilibration compared to start ($p < 0.0001$), but there were no differences between inflection and equilibration T_{mb} ($p = 0.69$) for younger adults. Similarly, in WH and HD environments during MinAct in older adults, T_{mb} was greater during equilibration compared to start (all $p < 0.0001$), but there were no differences between inflection and equilibration T_{mb} (all $p > 0.05$). In HD and WH environments at rest, T_{mb} was greater during equilibration compared to start (all $p < 0.0001$), but there were no differences between inflection and equilibration T_{mb} (all $p > 0.05$). The T_{mb} was significantly greater at inflection compared to start for all conditions in younger and older adults (all $p < 0.0001$). There were no differences in T_{mb} at the start ($p=0.89$), at equilibration ($p=0.10$), and at inflection ($p=0.99$) for younger compared with older adults in WH environments. Further, there were no differences in T_{mb} at rest vs MinAct at the start ($p=0.99$), at equilibration ($p=0.99$), and at inflection ($p=0.99$) for older adults in WH environments. Similarly, in HD environments, there were no differences in T_{mb} at the start ($p=0.65$), at equilibration ($p=0.99$), and at inflection ($p=0.91$) for young compared with older adults during MinAct. Additionally, there were no differences in T_{mb} at rest vs MinAct at the start ($p=0.93$), at equilibration ($p=0.82$), and at inflection ($p=0.99$).

Table 1: Subject Characteristics – Young Adults

Characteristics	**Means ± SD**	**Range**
Age	23 ± 3	18 - 29
Height, m	1.7 ± 0.1	1.6 - 1.9
Weight, kg·m^{-2}	75.0 ± 16.0	50.8 - 117.6
BMI	25.23 ± 4.6	18.66 - 38.82
A_D, m^2	1.87 ± 0.22	1.50 - 2.40
$A_D \cdot kg^{-1}$, $m^2 \cdot kg^{-1}$,	0.025 ± 0.003	0.020 - 0.030
Vo_{2max}, mL· $kg^{-1} \cdot min^{-1}$	45.0 ± 10.9	27.5 - 74.3

n = 41; 21 *M*/20 *W*. A_D, DuBois body surface area; $A_D \cdot kg^{-1}$, body surface area-to-mass ratio; $\dot{V}O_{2max}$, maximal oxygen consumption.

Table 2: Subject Characteristics – Older Adults

Characteristics	**Means ± SD**	**Range**
Age	71 ± 6	65 - 92
Height, m	1.7 ± 0.1	1.52 - 1.85
Weight, kg·m^{-2}	74.0 ± 17.0	50.8 - 113.5
BMI	25.73 ± 4.7	17.8 - 35.8
A_D, m^2	1.83 ± 0.23	1.39 - 2.32
$A_D \cdot kg^{-1}$, $m^2 \cdot kg^{-1}$,	0.030 ± 0.003	0.020 - 0.031
Vo_{2max}, mL· $kg^{-1} \cdot min^{-1}$	29.0 ± 9.5	16.2 - 61.1

n = 35; 15 *M*/20 *W*. A_D, DuBois body surface area; $A_D \cdot kg^{-1}$, body surface area-to-mass ratio; $\dot{V}O_{2max}$, maximal oxygen consumption.

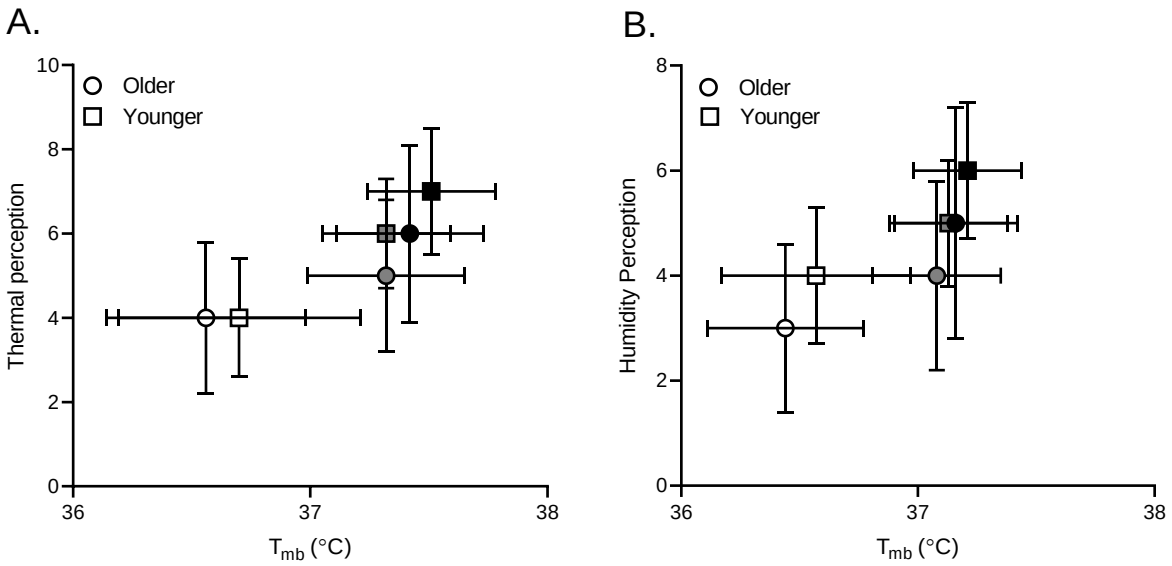

Figure 1: Age differences in mean body temperature and thermal (panel A) and humidity (panel B) perception for young (circles) and older (squares) men and women during progressive heat stress at minimal activity. Thermal perception was taken in hot-dry environments and humidity perception was taken in warm-humid environments. Perception was taken at the start (white), equilibration (grey), and inflection (black) points throughout the study. Data are presented as means with standard deviations.

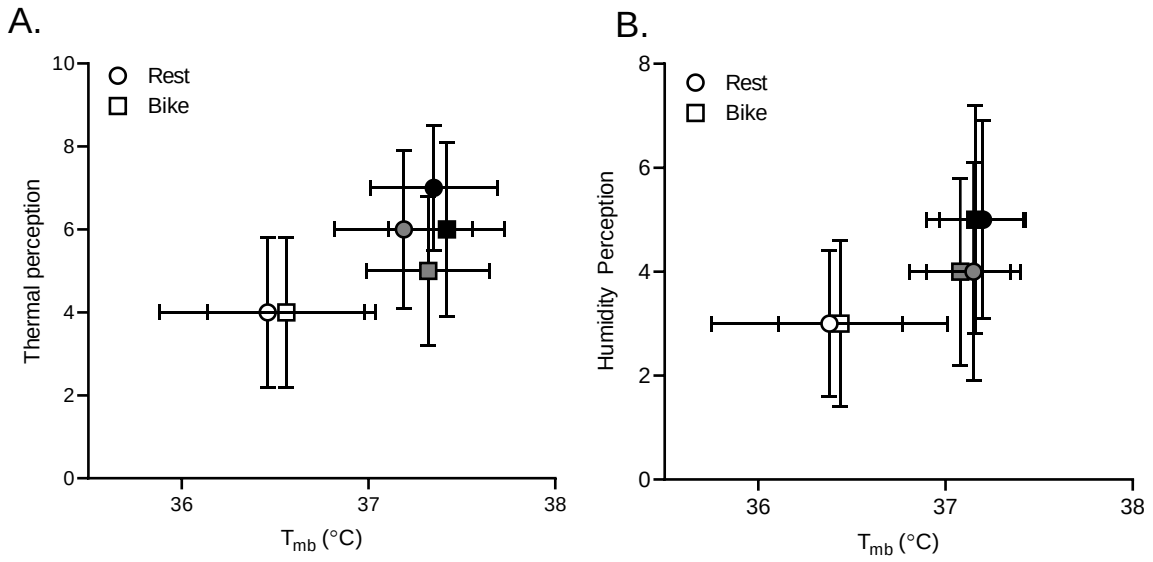

Figure 2: Differences in mean body temperature and thermal (panel A) and humidity (panel B) perception during progressive heat stress at rest (circles) and during minimal activity (squares) in older men and women. Thermal perception was taken in hot-dry environments and humidity perception was taken in warm-humid environments. Perception was taken at the start (white), equilibration (grey), and inflection (black) points throughout the study. Data are presented as means with standard deviations.

Table 3: Environmental perceptions during minimal activity for young and older adults at the start, equilibration, and inflection time points of mean body temperature. Data are presented as means ± SD.

	Start	Equilibration	Inflection
WH – humidity perception			
Young	4 ± 1	5 ± 1	6 ± 1
Older	3 ± 2	4 ± 2	5 ± 2
HD - thermal perception			
Young	4 ± 1	6 ± 1	7 ± 2
Older	4 ± 2	5 ± 2	6 ± 2

Table 4: Environmental perceptions during rest and minimal activity for older adults at the start, equilibration, and inflection time points of mean body temperature. Data are presented as means ± SD.

	Start	Equilibration	Inflection
WH - humidity perception			
Rest	3 ± 1	4 ± 2	5 ± 2
MinAct	3 ± 2	4 ± 2	5 ± 2
HD - thermal perception			
Rest	4 ± 2	6 ± 2	7 ± 2
MinAct	4 ± 2	5 ± 2	6 ± 2

CHAPTER 4

DISCUSSION

Led by Dr. Kenney, the PSU HEAT study is a project that is looking to determine and understand critical environmental limits beyond which thermal balance with the environment cannot be maintained (Wolf et al., 2022). Although the primary goal of the PSU HEAT study is to establish these uncompensable environments for aged and vulnerable populations, the purpose of this thesis was to highlight the potential age-related diminish of perceptual senses in combination with these critical environmental limits. We hypothesized that as you age, there is a difference in thermal and humidity perception when compared to a younger population. Our findings showed that there was not an age-related difference between perception of the environment and mean body temperature. These data suggest that there is not an age-related decrement in perception of heat and humidity for a given mean body temperature.

When looking at Figures 1 and 2, we could see that both young and older adults showcased a perceptual understanding of their increase in mean body temperature over time both at rest and when they were on the bike. This progression of thermal/humidity perception across the board in WH and HD environments at the start, at equilibration, and at inflection of T_{gi} for young vs older adults is an indication that aging may not directly affect one's danger of the heat from a perceptual standpoint. However, it is too soon to rule out the possibility of age affecting one's perception of heat and humidity as there may be other variables that influence one's ability to perceive environmental conditions in addition to age.

Possible explanations as to why there were not significant differences in perception for a given T_{mb} include: 1) psychosocial variables like current mood/mindset, 2) underestimation of

our bodies' ability to quickly and efficiently analyze and acclimate to an environment, and 3) experimental limitations like lack of previous research on this topic.

Psychosocial variables such as current mood, mindset, and perceived life stress could alter one's ability to perceive the environment. Take one's current mood for example; if a subject wakes up with a positive mindset or mood, they can make quick and realistic assessments of themselves (Taylor & Gollwitzer, 1995). In this context, this would mean that having a clear and positive mindset allows someone to better perceive heat, humidity, and their health. Now take someone who is in a bad mood. Let's say for example someone is under a lot of stress at home because they are in between jobs and money is tight. That person is more likely to respond with poorer health perceptions which could lead to inaccuracies in identifying if they are under heat stress (Bonner et al., 2017). Often our mood is the driving force of how we respond to things, so if someone goes into the chamber in a bad mood, it could potentially amplify how hot or humid it truly is in there.

The same logic can be applied to someone who comes in with the mindset of what they are getting into from an experimental standpoint. The PSU HEAT study is public knowledge and is one that many understand what the premise of the experiments are. Knowing what is to come is a mental advantage and allows you to mentally prepare yourself for the stress your body is going to go through. This would alter one's perception versus someone who has no idea what our study is about.

Another variable that may have had a significant impact on our findings would be heat acclimation. Heat acclimation is defined as physiological adaptations that improve thermoregulation, attenuate physiological strain, reduce the risk of serious heat illness, and

improve aerobic performance in warm-hot environments and potentially in temperate environments (Périard et al., 2015). It is believed that short term adaptations begins as soon as you are exposed to the environment, and long-term adaptations occur after 15 days (Périard et al., 2015). This would mean that if someone is acclimated to being in a WH or HD environment, then their perception of heat may be different compared with the individuals who experience four seasons or live in cold environments. We attempted to combat this by running tests throughout the year with enough participants during each season to avoid potential acclimation differences. This does not take into account those who may have been born, grew up, or worked in these WH and HD environments. For example, while someone may currently live in an area that gets 4 seasons that may not alter their ability to acclimate to WH or HD weather if they lived in the Bahamas, or Texas, or Brazil for a portion of their lives. Overall, one's ability to acclimate to weather is extremely situational and is a factor that is hard to keep consistent amongst participants especially if you're looking for differences in age.

The last explanation as to why the results failed to conclude difference was due to experimental limitations. The biggest limitation seen in this study was the lack of research on potential influencing factors. This is most evident when considering how gender may have impacted this study. Our project was not powered to evaluate gender differences in perception as the priority was understanding the age-related differences. However, that isn't to say age and gender aren't factors that go hand and hand when influencing perception. This is a topic that has not really been investigated. With the knowledge gained from this study, a long-term goal of the PSU HEAT project is to better understand if there are sex-related differences in heat perception.

The present study's findings suggest that for a given mean body temperature, older adults perceive the environment the same as younger adults during minimal activity. Further, minimal activity does not influence older adults' perception of the environment compared to when they're at rest. This is significant because it potentially rules out a factor that plays into older people being at an increased risk of heat related illnesses. If older people can properly perceive heat and humidity, then we can begin to devote all of our time and energy into physiological aspects of this issue. Older people are physiologically proven to be at greater risks for these illnesses; but if we know that risk does not increase from a sensory standpoint, then we can focus on how to bring the internal temperature down in the event an older person begins to feel the effects of the heat.

In summary, the present study has provided information pertaining to how young and older adults subjectively perceive warm-humid/hot-dry environments at rest and while active. There were no significant differences between the two age groups' perception of the heat and humidity.

REFERENCES

Bonner, W. I. A., Weiler, R., Orisatoki, R., Lu, X., Andkhoie, M., Ramsay, D., Yaghoubi, M., Steeves, M., Szafron, M., & Farag, M. (2017). Determinants of self-perceived health for Canadians aged 40 and older and policy implications. *International Journal for Equity in Health*, *16*(1). https://doi.org/10.1186/s12939-017-0595-x

Cottle, R. M., Wolf, S. T., Lichter, Z. S., & Kenney, W. L. (2022). Validity and reliability of a protocol to establish human critical environmental limits (PSU HEAT Project). *Journal of Applied Physiology*, *132*(2), 334–339. https://doi.org/10.1152/japplphysiol.00736.2021

Kenney, W. L., Craighead, D. H., & Alexander, L. M. (2014). Heat waves, aging, and human cardiovascular health. *Medicine & Science in Sports & Exercise*, *46*(10), 1891–1899. https://doi.org/10.1249/mss.0000000000000325

Kenney, W. L., Mikita, D. J., Havenith, G., Puhl, S. M., & Crosby, P. (1993). Simultaneous derivation of clothing-specific heat exchange coefficients. *Medicine and Science in Sports and Exercise*, *25*(2), 283–289. https://pubmed.ncbi.nlm.nih.gov/8450734/

Klenk, J., Becker, C., & Rapp, K. (2010). Heat-related mortality in residents of nursing homes. *Age and Ageing*, *39*(2), 245–252. https://doi.org/10.1093/ageing/afp248

Malmquist, A., Hjerpe, M., Glaas, E., Karlsson, H., & Lassi, T. (2022). Elderly people's perceptions of heat stress and adaptation to heat: An Interview Study. *International Journal of Environmental Research and Public Health*, *19*(7), 3775. https://doi.org/10.3390/ijerph19073775

Périard, J. D., Racinais, S., & Sawka, M. N. (2015). Adaptations and mechanisms of human heat acclimation: Applications for competitive athletes and sports. *Scandinavian Journal of Medicine & Science in Sports*, *25*(1), 20–38. https://doi.org/10.1111/sms.12408

Piko, B. F. (2006). Self-perceived health among adolescents: the role of gender and psychosocial factors. *European Journal of Pediatrics*, *166*(7), 701–708. https://doi.org/10.1007/s00431-006-0311-0

Perkins, S. E., Alexander, L. V., & Nairn, J. R. (2012). Increasing frequency, intensity and duration of observed global heatwaves and warm spells. *Geophysical Research Letters*, *39*(20). https://doi.org/10.1029/2012gl053361

Robine, J.-M. ., & Michel, J.-P. . (2004). Looking forward to a general theory on population aging. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *59*(6), M590–M597. https://doi.org/10.1093/gerona/59.6.m590

Taylor, S. E., & Gollwitzer, P. M. (1995). Effects of mindset on positive illusions. *Journal of Personality and Social Psychology*, *69*(2), 213–226. https://doi.org/10.1037/0022-3514.69.2.213

US EPA. (2016, July 1). *Climate Change Indicators: Heat-Related Deaths*. US EPA. https://www.epa.gov/climate-indicators/climate-change-indicators-heat-related-deaths

United Nations. (2022). *World Population Prospects - Population Division - United Nations*. Un.org; United Nations. https://population.un.org/wpp/

Verdú, E., Ceballos, D., Vilches, J. J., & Navarro, X. (2000). Influence of aging on peripheral nerve function and regeneration. *Journal of the Peripheral Nervous System: JPNS*, *5*(4), 191–208. https://doi.org/10.1046/j.1529-8027.2000.00026.x

Wolf, S. T., Cottle, R. M., Vecellio, D. J., & Kenney, W. L. (2022). Critical environmental limits for young, healthy adults (PSU HEAT Project). *Journal of Applied Physiology*, *132*(2), 327–333. https://doi.org/10.1152/japplphysiol.00737.2021

APPENDIX A:
INFORMED CONCENT FORM

CONSENT FOR RESEARCH

The Pennsylvania State University

Title of Project: Identification of Critical Thermal Environments for Aged Adults

Principal Investigator: W. Larry Kenney

Address: 102 Noll Laboratory

Telephone Number: 814-867-1781

Subject's Printed Name: _____

We are asking you to be in a research study. This form gives you information about the research.

Whether or not you take part is up to you. You can choose not to take part. You can agree to take part and later change your mind. Your decision will not be held against you and there will be no penalty or loss of benefits to which you are entitled.

Please ask questions about anything that is unclear to you and take your time to make your choice.

KEY INFORMATION

The following is a short summary of this study to help you decide whether or not to be a part of this research. More detailed information is listed later in this form. If you have any questions, be sure to ask the study team.

Why am I being invited to take part in a research study?

We invite you to take part in a research study because we are looking for healthy adults aged 18 and older. We think that you may be a good fit for this study.

What is the purpose of this research study?

This study is being done to learn about limits of body temperature control in the heat. We also want to learn how taking aspirin affects these limits in older adults.

How long will the research study last?

The study will take about 3 months to complete. You will be asked to return to the research site for the following visits:

Screening (1 visit): About 1.5 hours
Maximal exercise testing (1 visit): About 1 hour
Experimental Visits (4 - 14 visits): About 3 hours each
Total: About 14.5 – 44.5 hours

You may be asked to repeat each visit after taking Aspirin for a week or (young adults only) with sunscreen applied to the skin during the heat exposures. You will be asked to return to the research site for the following visits:

Screening (1 visit): About 1.5 hours
VO_2max testing (1 visit): About 1 hour
Experimental Visits (8 - 26 visits): About 3 hours each
Total: About 26.5 – 80.5 hours

What will you need to do?

You will be asked to exercise in conditions of heat and humidity. You will be asked to come into the lab for testing on at least 4 days, up to 14 days. Each day will have different heat, humidity, and exercise conditions.

What are the main risks of taking part in the study?

For this study, the main risks to know about are: discomfort with exercising in hot and humid conditions; discomfort with needles during blood draws; allergies to tape or latex; infection from blood draws. The study may also be unsafe for those who with bleeding disorders, nosebleeds, or allergies to aspirin. More information about risks can be found in the section labeled "What are the risks and possible discomforts from being in this research study?"

What are the possible benefits to you that may reasonably be expected from being in the research?

We cannot promise any benefits to you from your taking part in this study. You receive a screening that informs you about your health such as your blood pressure and blood cholesterol levels. You could learn about how your body works. The study may benefit people in the future by helping us learn more about the limits of body heat control.

What happens if you do not want to be in this research?

Participation in research is completely voluntary. You may choose not to take part in this research study.

DETAILED INFORMATION

The following is more detailed information about this study in addition to the information provided above.

1. Why is this research study being done?

The earth's climate is warming, and the number of heat waves has increased in recent years. At the same time, the number of adults over the age of 65 is growing. Humans sweat and increase blood flow to the skin to cool their body when they get hot. Older adults do not do this as well as young adults. This makes it harder to safely exercise in warm and/or humid conditions. It is important to learn about safe limits of heat and humidity for older adults to exercise. Also, nearly 40% of adults over age 50 take aspirin to lower their risk for heart disease. Our lab has shown that aspirin lowers the control of body heat.

In this study, we will look at body temperature control during exercise in the heat and humidity and how this changes with age. We will also look at how aspirin may change the control of body heat in older adults. About 80 people will take part in this study.

2. What will happen in this research study?

_____ initial **A. Screening**

You come to the lab for a screening visit to see if you qualify for this study.

1. You drink only water and do not eat for 12 hours before the screening.
2. The research staff measures the following:
    a. Height;
    b. Weight;
    c. Waist circumference;
    d. Blood pressure;
    e. Heart rate;
3. You complete a health history questionnaire.
4. You complete the 2017 Physical Activity Readiness Questionnaire for Everyone (PAR-Q+).
5. Women of childbearing age have a urine pregnancy test.
6. The research staff will draw 30 mL (2 Tbsp) of blood from a vein in your arm. Some of the blood is sent to a lab to see if the proteins, blood cells, electrolytes, etc. are within normal levels. We do not look for the presence of disease (e.g. HIV). All the blood tests are common tests to determine your health status. If you are eligible, we invite you back to the lab for the study visits.
7. Adults aged 40+ only: The research staff performs a resting ECG to ensure you have no heart conditions that preclude you from exercise. The results are sent to a study physician for review.

_____ initial **B. Maximal Exercise Test**

You will complete a maximal exercise test on a treadmill before the experimental visits. This will allow us to see how hard you should exercise during the visits. Trained laboratory members and/or a physician will oversee your test.

1. Do not eat or drink caffeine or alcohol for 3 hours before the test.
2. Do not exercise hard for 24 hours before the test.
3. Wear clothing and shoes that you will be comfortable exercising in.
4. We place a blood pressure cuff around your upper arm to measure your blood pressure. For older adults, we place ECG stickers on your torso to measure your heart rate and rhythm during the test.
5. We take resting blood pressure and (for older adults) heart rate and rhythm measurements. We then take your blood pressure at the end of each stage of the test.
6. We explain how to rate your effort during the test.
7. We show you hand signals to communicate with us during the test.
8. You wear a snorkel-like mouthpiece and nose clip. This allows us to look at how hard you are working during the test.
9. You choose a comfortable walking or jogging pace on the treadmill while we monitor you.

10. After you choose a pace on the treadmill, the grade and/or speed is increased every 2 minutes. This continues until: (1) you reach your maximal capacity; (2) you ask to stop; or (3) study personnel see something that causes them to stop the test.
11. Once the test is over, you walk on the treadmill at a slow speed while we monitor you.
12. You then sit until your heart rate and blood pressure start to return to pre-exercise levels.

_____ initial **C. Measurements of Body Core Temperature**

During each experimental visit, body core temperature will be measured in two ways:

Esophageal probe insertion:

1. A temperature probe of ~3 mm in diameter is placed through your nostril into the esophagus.
2. You sip water through a straw while the probe is placed through the nostril.
3. A numbing jelly can be put on the probe to lower discomfort.
4. The probe is placed to a depth of 40 cm past the nostril, or at the same level as your heart.
5. This temperature is measured throughout the study.

Temperature-sensing pill:

1. Intestinal temperature is measured with a temperature-sensing pill.
2. You swallow the pill with water.
3. You return the pill wrapping to the research team.
4. This temperature is measured every 5 minutes using a remote detector.

_____ initial **D. Measurements of Skin Temperature**

1. Four sites are used to measure skin temperature:
    a. Leg
    b. Thigh
    c. Arm
    d. Chest
2. Each site is cleaned with alcohol wipes.
3. A temperature probe is applied to each site using double-sided stickers.
4. Skin temperature is recorded at all four sites throughout the test.

_____ initial **E. Environmental Chamber Experiments**

You complete 4-14 trials randomized for 2-7 environmental protocols. The protocols are: (1) temperature increases while humidity stays the same, and (2) humidity increases while temperature stays the same. You complete each condition twice exercising at different intensities.

Critical Temperature Experiments:

1. You complete 1-3 experiments, each with a constant water vapor pressure (humidity):
    a. 12 Torr
    b. 16 Torr
    c. 20 Torr
2. You enter the chamber and rest for 30 minutes.
3. A blood pressure cuff is placed around the upper arm.

4. ECG electrodes are placed on your chest to measure heart rate/rhythm during the test.
5. Resting blood pressure and heart rate are measured.
6. Blood pressure and heart rate are measured every 5 minutes during the test.
7. Core temperature is measured throughout the study.
8. For each humidity condition, you perform trials at two different metabolic rates:
    a. Young adults: You walk on a treadmill at a speed of about 2 mph or (in separate trials) gently pedal on a stationary bicycle.
    b. Middle-aged and older adults: You rest in a chair with no physical activity or (in separate trials) gently pedal on a stationary bicycle.
9. After 30 minutes of rest, you start exercising.
10. Chamber temperature is increased by 1°C every 5 minutes.
11. Your core temperature will rise, and then become stable.
12. Twice during exercise you put on the snorkel-like mouth piece and nose clip for 5 minutes to see how hard you are working. This happens at the 30 and 60 minute time points. The mouthpiece is removed at the end of the 5 minutes.
13. You exercise until your core temperature starts to rise again.
14. After this rise happens, the test ends.
15. The chamber is returned to normal conditions.
16. The esophageal probe is removed.

<u>Critical Vapor Pressure Experiments</u>:

1. You complete 1-4 experiments, each with a constant temperature:
    a. 34°C
    b. 36°C
    c. 38°C
    d. 40°C
2. You enter the chamber and rest for 30 minutes.
3. A blood pressure cuff is placed around the upper arm.
4. ECG electrodes are placed on your chest to measure heart rate/rhythm during the test.
5. Resting blood pressure and heart rate are measured.
6. Blood pressure and heart rate are measured every 5 minutes during the test.
7. Core temperature is measured throughout the study.
8. For each temperature condition, you perform trials at two different metabolic rates:
    a. Young adults: You walk on a treadmill at a speed of about 2 mph or (in separate trials) gently pedal on a stationary bicycle.
    b. Middle-aged and older adults: You rest in a chair with no physical activity or (in separate trials) gently pedal on a stationary bicycle.
17. After 30 minutes of rest, you start exercising.
18. Chamber water vapor pressure is increased by 1 Torr every 5 minutes.
19. Your core temperature will rise, and then become stable.
20. Twice during exercise you put on the snorkel-like mouth piece and nose clip for 5 minutes to see how hard you are working. This happens at the 30 and 60 minute time points. The mouthpiece is removed at the end of the 5 minutes.
9. You exercise until your core temperature starts to rise again.
10. After this rise happens, the test ends.
11. The chamber is returned to normal conditions.
12. The esophageal probe is removed.

_____ initial **F. Aspirin Supplementation**

1. You may be asked to repeat all trials after taking 81 mg/day aspirin for at least 7 days before testing.
2. After 7 days of taking aspirin, you repeat each of the trials.
3. You continue taking aspirin until you finish all study visits.
4. You may choose not to complete this part of the study.

_____ initial **G. Sunscreen (Young adults only)**

1. You may be asked to repeat all trials with sunscreen applied to your skin.
2. You will apply sunscreen in the same way as you would normally apply it. Sunscreen will only be applied to skin regions that are not covered by clothing.

3. What are the risks and possible discomforts from being in this research study?

Esophageal probe: The probe is inserted through the nose into the esophagus. The probe rests at the level of the heart. There can be mild discomfort and/or a mild gagging reflex from swallowing the probe. However, this feeling should pass soon (2-3 min). Lidocaine jelly can be put on the probe to reduce discomfort. While very rare, the probe can puncture the esophagus. To lower this risk, trained personnel will insert the probe. This procedure will not be performed if there are any contraindications based on their medical history. Our lab has used this technique for many years with no problems.

Temperature-sensing pill: Although very rare, there are some risks to taking this pill. The pill could be inhaled into the lungs. The pill could also cause a puncture, blockage or infection of the intestines. This may require endoscopy or surgery to remove it. This pill should not be taken by anybody weighing less than 80 pounds, or by anybody who has or has had any gastrointestinal disease or surgery.

Maximal exercise test: Risks of this test include fatigue, irregular heart rate, changes in blood pressure, and fainting. Cardiac events are very rare. The risk of a cardiac event during the test, not resulting in death, is less than 4/10,000. The risk of a fatal cardiac event is less than 1/10,000. The research staff will watch closely to minimize the chance of injury. General Indications for Stopping an Exercise Test will be followed, per the American College of Sport Medicine. You may request to stop the test at any time.

Exercise: It is possible that you may experience faintness, fatigue, muscle pain, or chest pain during the exercise bouts. Your heart rate, blood pressure, and core temperature will be monitored for the duration of the protocol. You should communicate any difficulty you experience. You may end the experiment at any time. All lab personnel are certified and have current CPR/AED and First Aid qualifications. There is an AED in the laboratory. In any emergency, 911 will be called immediately.

Environmental Chambers: The chamber uses a three-mode controller to optimize stability and response. Air enters through the ceiling and returns through base molding on three sides. Because air returns behind the walls, wall temperature increases linearly with air temperature. You will complete 4-12 trials randomized for 2-6 environmental conditions (2 trials in each condition at differing intensities). These environments are as follows: temperatures of 36, 38, and 40°C while ambient vapor pressure remains constant; ambient vapor pressures of 12, 16, and 20 Torr while temperature remains constant. In these environments, your core temperature will rise before becoming steady by ~min 40 and remains at an elevated steady state. You may feel some discomfort associated with increased body temperature and sweat on the skin. This is normal in hot and humid conditions. These chambers have been used for 25 years in our laboratory without any incidence of adverse events.

Blood Pressure (manual, CardioCap 5): The manual method and CardioCap5 use a cuff that inflates on the upper arm. The cuff slowly deflates while the researchers listen to pulse-sounds at the inside of the elbow with a stethoscope, or the CardioCap 5 takes a measurement. The inflated cuff may make the arm feel tingly and numb. The cuff may temporarily bruise the arm. Efficient and competent measurement technique minimizes the duration of cuff inflation. These techniques are unlikely to produce lasting ill effects.

Blood draw: Blood draws can cause anxiety (with increased heart rate and blood pressure), mild pain, swelling, nausea, lightheadedness, fainting, or bleeding. There is a slight chance of infection. A nurse performs blood draws using standard procedures and techniques that minimize the chance of infection. Participants may recline for the procedure.

Tape and sticky disks: The tape or sticky disks could cause a rash. During screening, you tell us if you are sensitive to tape. If a disk sticks very strongly, removing the disk could cause an abrasion like a rug-burn on your skin. An abrasion can feel tender or slightly painful, and can increase risk of infection. If you are sensitive to tape, you may have an increased chance for abrasion. An abrasion has occurred only twice during the years that the disks have been used in similar studies in our lab. We may use an adhesive remover like that used in a doctor's office to remove the disks. If you get an abrasion a nurse checks the site. Antibiotic ointment and a sterile bandage are applied. We tell you how to take care of the site. You could have an allergic reaction to the adhesive remover. The reaction could include rash, itching, fever, or breathing problems. Also, it could include changes in pulse, and/or blood pressure, convulsions, shock, and/or fainting. If a bad reaction occurs, we call for medical help right away.

Screening: You may feel shy about giving health information. The staff collects the information in a private and professional manner. You may feel shy about being measured. You may request someone of the same sex to conduct parts of the screening.

Initial screening form: Only members of our lab group use this form. We use the form to help decide whether you are a good candidate for the study. You may feel shy about answering questions. You may request someone of the same sex to ask you the questions. We collect the information in a private and professional manner. We keep the completed form confidential and secure.

ECG: The researchers attach three to twelve electrodes to your chest and then attach the electrode wires to an ECG machine. The machine records the electrical activity of the heart. There are no adverse effects from this measure. A subject may be shy about electrodes applied to the chest. The staff carefully remove the tape afterward. They conduct the test professionally and privately.

Thermoregulation and Microvascular Lab Websites: You may enter data into the screening form or questionnaires via the REDCap website. REDCap is a secure website and survey application designed to support data capture for research studies. You may be concerned about data security. All web traffic to and from the REDCap application website is done via a Secure Socket Layer (SSL) that encrypts the data in transmission. The questionnaire contains statements advising of the limitations of technology and that there is no confidentiality guarantee. Subjects may choose a personal interview instead.

Latex: Some gloves and medical materials are made of latex rubber. Some people may be sensitive to latex. We exclude those with a known latex allergy.

Aspirin: Taking aspirin may be unsafe for those with bleeding disorders or allergies to aspirin. You tell us if you have bleeding disorders or allergies to aspirin. In this case, you will be excluded from the aspirin portion of the study. Some more common side effects of aspirin include: rash, upset stomach, heartburn, headache, cramping, gastrointestinal ulcers, and nausea. Rare side effects include: anemia, bleeding, bronchospasm, and liver damage. If you start to experience side effects, you stop taking aspirin immediately and are advised to call your doctor if you have any any major and/or lasting symptoms.

SPF-50 Sunscreen: If you are allergic to sunscreen, you could get an itchy red rash. An allergic reaction could include pain, swelling, burning, and/or blistering of the skin. Tell us if you are allergic or sensitive to sunscreen.

There is a risk of loss of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening. The confidentiality of your electronic data created by you or by the researchers will be maintained as required by applicable law and to the degree permitted by the technology used. Absolute confidentiality cannot be guaranteed.

4. What are the possible benefits from being in this research study?

4a. What are the possible benefits to you?

There is no guarantee that you will benefit from this research. You receive a screening that informs you about your health such as your current blood pressure and blood cholesterol levels. You could gain knowledge about how your body works.

4b. What are the possible benefits to others?

This research may help scientists better understand age-related changes in the limits of body temperature control during exercise in the heat. It may also help to better understand how

taking aspirin may alter control of body temperature in older adults. The project provides valuable experience and education for graduate and undergraduate students of The Pennsylvania State University.

5. What other options are available instead of being in this research study?

You may decide not to participate in this research study.

6. How long will you take part in this research study?

If you agree to take part, it will take you about 3 months to complete the study. Subjects will be asked to return to the research site for the following sessions and times:

Screening (1 visit): About 1.5 hours
VO_2max testing (1 visit): About 1 hour
Experimental Visits (4 - 14 visits): About 3 hours each
Total: About 14.5 - 44.5 hours, depending on how many trials are completed

A sub-group of participants will be asked to take Aspirin for a week and then repeat each of the experimental visits. Should you agree to this, you will be asked to return to the research site for the following sessions and times:

Screening (1 visit): About 1.5 hours
VO_2max testing (1 visit): About 1 hour
Experimental Visits (8 - 26 visits): About 3 hours each
Total: About 26.5 - 80.5 hours, depending on how many trials are completed

7. How will your privacy and confidentiality be protected if you decide to take part in this research study?
7a. What happens to the information collected for the research?

Efforts will be made to limit the use and sharing of your personal research information to people who have a need to review this information.

- We keep the list that matches your name with your code number in a locked file or password protected file on a computer in a room that is locked when unoccupied. Only authorized members of the lab have access to the list.
- We label your research records with your code number and keep them in a locked file or password protected computer in a room that is locked when unoccupied.
- We label your research samples with your code number. We keep the samples in a dedicated ultralow freezer in Noll Lab until analysis.

All research specimens sent to outside labs for analysis (e.g. Quest Labs) are identified only by a code number.

This research is covered by a Certificate of Confidentiality from the National Institutes of Health. This means that the researchers cannot disclose information that identifies you to anyone not connected with the research. This protection also prevents this information from being used or disclosed for legal

proceedings, such as being accessed through a court order. The Certificate of Confidentiality however does not prevent disclosures required by law, such as information about child abuse or neglect and harm to yourself or others. Also, your information may be disclosed in accordance with any consent you provide, including for your medical treatment or use in other research. Additionally, the Certificate of Confidentiality does not prevent your information from being disclosed to the National Institutes of Health in order for it to evaluate or audit the research, or prevent disclosures required to meet FDA requirements. For additional information ask the principal investigator or a member of the study team or contact the Office for Research Protections at (814) 865-1775.

In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

We will do our best to keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people may find out about your participation in this research study. For example, the following people/groups may check and copy records about this research.

- The Office for Human Research Protections in the U. S. Department of Health and Human Services
- The Institutional Review Board (a committee that reviews and approves research studies)
- The Office for Research Protections
- The U. S. Food and Drug Administration

Some of these records could contain information that personally identifies you. Efforts will be made to limit the use and sharing of your personal research information to people who have a need to review this information. Reasonable efforts will be made to keep the personal information in your research record private. However, absolute confidentiality cannot be guaranteed.

7b. What will happen to my research information and/or samples after the study is completed?

Your information or samples that are collected as part of this research will not be used or distributed for future research studies, even if all your identifiers are removed.

Most tests done in research studies are only for research and have no clear meaning for health care. The screening includes some standard medical tests that may yield results that do have meaning for your health. You will receive copies of the results from the standard blood tests performed in the screening. The researchers inform you of test results about which you may wish to tell your own doctor. If this happens, then you may want to get a second test from a certified clinical laboratory and consult your doctor. You will have to pay for those additional services yourself.

8. What are the costs of taking part in this research study?
8a. What happens if you are injured as a result of taking part in this research study?

In the unlikely event you become injured as a result of your participation in this study, medical care is available. It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. By signing this document, you are not waiving any

rights that you have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

9. Will you be paid or receive credit to take part in this research study?

If you are eligible for this study, you will receive payment as follows. There is no payment for the screening visit.

Environmental chamber experiments: $75 per experiment
Total: Up to $1050 (14 experiments)

Aspirin subset total: Up to $1950 (26 experiments)

The researchers pay an amount of money equal to the part completed. For instance, if a subject completes 6 experiments, they will receive a total payment of $450. Researchers may ask subjects to repeat a trial. If subjects agree to repeat a trial, they receive payment for the repeated trial as stated above. They are reimbursed for gasoline if they live more than 20 miles from Noll Lab.

Total payments within one calendar year that exceed $600 will require the University to report these payments to the IRS annually. This may require you to claim the compensation that you receive for participation in this study as taxable income. You will need to provide your social security number and address to receive a check for payment and for tax reporting purposes.

10. Who is paying for this research study?

The institution and investigators are receiving a grant from the National Institutes of Health to support this research.

11. What are your rights if you take part in this research study?

Taking part in this research study is voluntary.

- You do not have to be in this research.
- If you choose to be in this research, you have the right to stop at any time.
- If you decide not to be in this research or if you decide to stop at a later date, there will be no penalty or loss of benefits to which you are entitled.
- If you choose to withdraw from the study, all data collected up to the point of withdrawal will remain part of the study and may not be removed.

The person in charge of the research study can remove you from the study without your approval. Possible reasons for removal from the study include if we deem that your health or behavior adversely affects the study or increases risks to you beyond those approved by the Institutional Review Board and agreed upon by you in this document. You may decline to answer certain questions. You may decide not to comply with certain procedures. However, your being in the study may be contingent upon answering these questions or complying with the procedures.

During the course of the research you will be provided with any new information that may affect your health, welfare or your decision to continue participating in this research.

12. If you have questions or concerns about this research study, whom should you call?

If you have any questions, complaints or concerns about this research, you may call any of the phone numbers below. You can also call these numbers if you feel this study has harmed you. If there are findings during the research that could relate to you wanting to help with the study, you will be told of the findings.

- Stephen (Tony) Wolf (W: 814-863-8557, C: 559-269-5198)
- Rachel Cottle (W: 814-863-8557, C: 949-728-8870)
- Susan Slimak (W: 814-863-8556, C: 814-880-4396)

You may also contact the Office for Research Protections at (814) 865-1775, IRB-ORP@psu.edu if you:

- Have questions regarding your rights as a person in a research study.
- Have concerns, complaints, or general questions about the research.
- You may also call this number if you cannot reach the research team or wish to offer input or to talk to someone else about any concerns related to the research.

You may visit the Office for Research Protections' website at https://www.research.psu.edu/irb/participants for:

- Information about your rights when you are in a research study;
- Information about the Institutional Review Board (IRB), a group of people who review the research to protect your rights; and

Links to the federal regulations and information about the protection of people who are in research studies. If you do not have access to the internet, copies of these federal regulations are available by calling the ORP at (814) 865-1775.

A description of this clinical trial will be available on http://www.ClinicalTrials.gov, as required by US Law. This website will not include information that can identify you. At most, the website will include a summary of the results. You can search this website at any time.

f. INFORMED CONSENT TO TAKE PART IN RESEARCH

g.

h. Signature of Person Obtaining Informed Consent

Your signature below means that you have explained the research to the subject or subject representative, provided the subject or subject representative an opportunity to discuss and consider whether or not to participate in the research, and have answered any questions the subject or subject representative has about the research.

_____	_____	_____
Signature of person who explained this research	Date	Printed Name

(Only approved investigators for this research may explain the research and obtain informed consent.)

Signature of Person Giving Informed Consent

Before making the decision about being in this research you should have:

- Discussed this research study with an investigator,
- Read the information in this form, and
- Had the opportunity to ask any questions you may have.

Your signature below means that you have received this information, have asked the questions you currently have about the research and those questions have been answered. You will receive a copy of the signed and dated form to keep for future reference.

i.

j. Signature of Subject

By signing this consent form, you indicate that you voluntarily choose to be in this research and agree to allow your information to be used and shared as described above.

_____	_____	_____
Signature of Subject	Date	Printed Name

The researchers pay an amount of money equal to the part completed. For instance, if a subject completes 6 experiments, they will receive a total payment of $450. Researchers may ask subjects to repeat a trial. If subjects agree to repeat a trial, they receive payment for the repeated trial as stated above. They are reimbursed for gasoline if they live more than 20 miles from Noll Lab.

Total payments within one calendar year that exceed $600 will require the University to report these payments to the IRS annually. This may require you to claim the compensation that you receive for participation in this study as taxable income. You will need to provide your social security number and address to receive a check for payment and for tax reporting purposes.

10. Who is paying for this research study?

The institution and investigators are receiving a grant from the National Institutes of Health to support this research.

11. What are your rights if you take part in this research study?

Taking part in this research study is voluntary.

- You do not have to be in this research.
- If you choose to be in this research, you have the right to stop at any time.
- If you decide not to be in this research or if you decide to stop at a later date, there will be no penalty or loss of benefits to which you are entitled.
- If you choose to withdraw from the study, all data collected up to the point of withdrawal will remain part of the study and may not be removed.

The person in charge of the research study can remove you from the study without your approval. Possible reasons for removal from the study include if we deem that your health or behavior adversely affects the study or increases risks to you beyond those approved by the Institutional Review Board and agreed upon by you in this document. You may decline to answer certain questions. You may decide not to comply with certain procedures. However, your being in the study may be contingent upon answering these questions or complying with the procedures.

During the course of the research you will be provided with any new information that may affect your health, welfare or your decision to continue participating in this research.

12. If you have questions or concerns about this research study, whom should you call?

If you have any questions, complaints or concerns about this research, you may call any of the phone numbers below. You can also call these numbers if you feel this study has harmed you. If there are findings during the research that could relate to you wanting to help with the study, you will be told of the findings.

- Stephen (Tony) Wolf (W: 814-863-8557, C: 559-269-5198)
- Rachel Cottle (W: 814-863-8557, C: 949-728-8870)
- Susan Slimak (W: 814-863-8556, C: 814-880-4396)

You may also contact the Office for Research Protections at (814) 865-1775, IRB-ORP@psu.edu if you:

- Have questions regarding your rights as a person in a research study.
- Have concerns, complaints, or general questions about the research.
- You may also call this number if you cannot reach the research team or wish to offer input or to talk to someone else about any concerns related to the research.

You may visit the Office for Research Protections' website at https://www.research.psu.edu/irb/participants for:

- Information about your rights when you are in a research study;
- Information about the Institutional Review Board (IRB), a group of people who review the research to protect your rights; and
  Links to the federal regulations and information about the protection of people who are in research studies. If you do not have access to the internet, copies of these federal regulations are available by calling the ORP at (814) 865-1775.

A description of this clinical trial will be available on http://www.ClinicalTrials.gov, as required by US Law. This website will not include information that can identify you. At most, the website will include a summary of the results. You can search this website at any time.

INFORMED CONSENT TO TAKE PART IN RESEARCH

Signature of Person Obtaining Informed Consent

Your signature below means that you have explained the research to the subject or subject representative, provided the subject or subject representative an opportunity to discuss and consider

whether or not to participate in the research, and have answered any questions the subject or subject representative has about the research.

_____	_____	_____
Signature of person who explained this research	Date	Printed Name

(Only approved investigators for this research may explain the research and obtain informed consent.)

Signature of Person Giving Informed Consent

Before making the decision about being in this research you should have:

- Discussed this research study with an investigator,
- Read the information in this form, and
- Had the opportunity to ask any questions you may have.

Your signature below means that you have received this information, have asked the questions you currently have about the research and those questions have been answered. You will receive a copy of the signed and dated form to keep for future reference.

Signature of Subject

By signing this consent form, you indicate that you voluntarily choose to be in this research and agree to allow your information to be used and shared as described above.

_____	_____	_____
Signature of Subject	Date	Printed Name

APPENDIX B:
THERMAL AND HUMIDITY PERCEPTION SCALES

Thermal Sensation Scale

0 Neutral
1
2 Slightly Warm
3
4 Warm
5
6 Hot
7
8 Very Hot
9
10 Extremely Hot

Humidity Sensation Scale

0 Neutral
1
2 Slightly Humid
3
4 Humid
5
6 Very Humid
7
8 Unbearably Humid

APPENDIX C:
ACADEMIC VITA

Dylan Perez
(201) 259 9832 | dmp6088@psu.edu

EDUCATION

Schreyer Honors College | The Pennsylvania State University University Park, PA
College of Health and Human Development August 2019 – May 2023
Intended Bachelor of Kinesiology

ACADEMIC EXPERIENCE

Pennsylvania State University
Learning Assistant- The History, Cultural, and Social Dynamics of Sport (Kinesiology 341)

- Spearheaded innovative learning experiences for 5-10 students each week.
- Facilitated an enjoyable and productive learning atmosphere.
- Allowed me the opportunity to hone my interpersonal and communication skills when delivering content.

Pennsylvania State University – Noll Laboratory
Research Volunteer Assistant – Dr. Larry Kenney's Human Thermoregulation Research

WORK EXPERIENCE

Kessler Rehabilitation Center Union, NJ
Physical Therapy Intern (outpatient) May 2022 – August 2022

- Created a welcoming and positive work environment for 20-30 patients through recovery exercise demonstration and assistance.
- Worked with and shadowed 4 Licensed Physical Therapists; aided in the planning and orchestration of nutrition-based plans that went in tandem with their recovery plans.

Delicious Heights Berkley Heights, NJ
Senior Server May 2019 – Present

- Forged a friendly and sociable dining atmosphere amongst customers and staff.
- Molded and demonstrated elite problem-solving skills and composure when dealing with a variety of personalities and a large workload.

Drayer Physical Therapy Institute Port Matilda, PA
Physical Therapy Intern (Outpatient) February 2022 – April 2022

- Shadowed 5 Licensed Therapists
- Aided patients in exercise and maintained rehabilitation equipment.

Optimal Care at Castle Hill Union City, NJ
Physical Therapy Intern (Subacute) July 2022 – August 2022

- Shadowed a PT who specializes in subacute care.
- Help bring patients to and from their appointments. Created a filing system for patient's health charts, insurance, and notes.

LEADERSHIP EXPERIENCE

THON – Penn State's Student Run Philanthropy University Park, PA
Rules and Regulations Committee Security Leader

- Trained team of students tasked with leading a group of 20-25 students in running security for THON related events.
- Established safety protocols and enforcement methods to ensure every event is run efficiently and is an enjoyable experience for everyone involved.