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Acclimatization Protocols and Their Outcomes

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Public Health
with a concentration in Occupational Exposure Sciences
College of Public Health
University of South Florida

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ABSTRACT

Heat acclimatization provides the opportunity to better tolerate heat stress. Different methods are used to acclimatize participants as part of heat stress studies in the laboratory. The usual acclimatization protocols are greater than the occupational exposure limit represented by the ACGIH TLV® and NIOSH REL. The purpose of this paper was to examine the acclimatization state prior to and at the end of a one-week acclimatization program using two acclimatization protocols.

Prior heat stress studies at the University of South Florida (USF) used two heat stress conditions for participants' acclimatization. Participants (n = 43) were evaluated using four different studies consisting of two types of acclimatization protocols. Conditions for the protocols were designated as conditions 1 (CD1) (n = 35) and conditions 2 (CD2) (n = 8). CD1 environmental conditions were 50^0C, 20% rh (36^0C, WBGT) and those for CD2 were 40^0C, 30% rh (30^0C, WBGT). All acclimatization protocols involved walking on a motorized treadmill at a moderate work rate (300 W) for 2 hours. The reference TLV® was 28°C. Heart rate (HR) and rectal temperature (T_{re}) were measured. Trials lasted 120 minutes unless any of the termination criteria was reached: $T_{re} = 39^0$C, HR > 90% of maximum HR or participant wished to stop. Acclimatization status for the first and last day was determined by two experienced researchers based on T_{re} and HR.

On the first day, 14% of the participants were classified as acclimatized under the CD1 protocol.

Three quarters of participants under CD2 were also classified as acclimatized on the first day. Full acclimatization was achieved in 34% of participants in CD1 protocol on the last day. Another 34% demonstrated some improvement and the remaining 31% showed no improvement in heat tolerance under the CD1 protocol. There was no change in acclimatization status for participants in the CD1 protocol on the last day, with 2 of the 8 showing no improvement. The harsher the condition, the harder it is to tolerate heat stress at the TLV and CD1 appeared to be more successful at acclimatizing participants than CD2.

INTRODUCTION

Heat related injuries and illnesses pose a great public health challenge in the U.S. (Vaidyanathan, Mallilay, Schramm, & Saha, 2020). In 2004 – 2018, the Centers for Disease Control and Prevention (CDC) reported an average of 702 heat-related deaths annually in the general population because of exposure to natural heat (Vaidyanathan et al., 2020). The U.S. Bureau of Labor Statistics (BLS) reported 37 work-related deaths and 2,830 nonfatal occupational injuries and illnesses from exposure to environmental heat in 2015 (BLS, 2017). However, this count only includes injuries and death resulting from days away from work implying that the actual heat-related injuries and illnesses count is unknown (BLS, 2017; National Institute for Safety and Health [NIOSH], 2016). Heat stress represents the total heat load on the human body (NIOSH, 2016, Occupational Safety and Health Administration [OSHA], 2017) that arises from a combination of excessive environmental heat, increased physical activity, and the effect of worn clothing (Department of Defense [DOD], 2003; NIOSH, 2016; OSHA, 2017; Periard, Racinais, & Sawka, 2014). In healthy individuals, thermoregulation allows maintenance of core body temperature within a very narrow range (Periard et al., 2014). However, inadequacy or failure of physiologic response to heat stress subjects the human body to undue heat strain (Navy Environmental Health Center [NEHC], 2007). Physiologic strain manifests as heat-related illnesses such as heat exhaustion, heat rash, heat cramps, and heat stroke (American Conference of Industrial Hygienists [ACGIH], 2017; NIOSH, 2016; OSHA, 2017; Periard et al., 2014; Tustin et al., 2018). Lowering heat stress minimizes physiologic strain and thus serves to lessen possibility of heat related injuries and illnesses.

Multiple approaches for controlling heat stress are predicated on understanding the heat balance mechanism based on the heat balance equation, $S = (M-W) \pm C \pm R \pm K-E$ (NEHC, 2007; NIOSH, 2016). Controlling environmental factors through manipulation of convection, radiation, and evaporation processes can reduce heat stress (NIOSH, 2016). The main heat exchange process is convection and can be enhanced by engineering techniques that take advantage of temperature differentials between the air and skin surface (NIOSH, 2016). Increasing air movement through use of either general or local ventilation, cooling of air using refrigeration, or evaporation promotes convection (NIOSH, 2016; OSHA, 2017). Contribution of heat stress by radiation can be controlled by either reducing the amount of heat from the source, by shielding the radiation path, or via isolation of work processes (NIOSH, 2016; OSHA, 2017). Evaporation from the skin, is a form of convection process (NEHC, 2007) and an important thermoregulatory mechanism. It is a function of water vapor gradient between the skin surface and the surrounding air as well as the air movement (DOD, 2003). The hierarchy of controls prescribes the use engineering controls over administrative controls for lowering heat stress. However, there are instances that demand the application of administrative heat control measures (NIOSH, 2016; OSHA,2017).

Application of administrative controls for heat stress can be effective in reducing physiologic heat strain. Implementation of practices such as work/rest cycles, scheduling work on cooler times of day or season, and the alternating of workers operating in hot environments are measures that aim to limit duration of heat exposure (ACGIH, 2017, DOD 2003; NEHC, 2007; NIOSH, 2016; OSHA, 2017). Additionally, lowering metabolic heat load through approaches such as proper workflow design and automation are important in controlling heat stress (NIOSH, 2016). An effective education and training program (NIOSH, 2016) and a robust medical screening program (NEHC, 2007; NIOSH 2016) for employees are essential in prevention and early identification of heat-related injuries and illnesses. Human beings are capable of developing mechanisms to adapt to undue heat strain (Chong et al., 2019; Griefahn, 1997; Tyler et al., 2016; Periard et al., 2014). Therefore, enhancing heat tolerance among individuals can be a very effective and inexpensive administrative control for lowering heat strain (NIOSH, 2016).

Heat acclimatization is an example of heat tolerance recommended by NIOSH, ACGIH, and is required by OSHA (OSHA, 2017) for employers whose employees must work in hot environments (NIOSH, 2016; Tustin et al., 2018). Heat acclimatization confers physiological adaptations to the body that enables heat tolerance to levels above occupational exposure limits (OELs) prescribed as NIOSH Recommended Alert Limits (RALs) or Recommended Exposure Limits (RELs) (NIOSH, 2016), AGCIH Threshold Limit Values (TLVs®) (ACGIH, 2017), and U.S Navy's Physiologic Heat Exposure Limits (PHELs) (NEHC, 2007). Heat acclimatization among individuals varies (Corbett et al., 2018) and there are multiple methods to achieving heat tolerance (NIOSH, 2016). The purpose of this paper was to examine the acclimatization state prior to and at the end of a one-week acclimatization program using two acclimatization protocols.

LITERATURE REVIEW

In an OSHA review of 20 cases that occurred between 2012 and 2013, the absence of heat acclimatization programs in workplaces was noted as a contributor to heat-related illnesses and injuries, or deaths (Arbury et al., 2014; NIOSH, 2016). Similarly, a CDC retrospective review of 25 cases of heat-related illnesses and deaths from 2011 to 2016 found nearly half of the victims to have been unacclimatized to heat (Tustin et al., 2018). Heat acclimatization allows the human body to develop physiologic adaptations for tolerating heat stress better (Arbury et al., 2014; NEHC, 2007; NIOSH, 2016; Periard et al., 2015). During heat acclimatization, multiple adaptations develops including the early onset of sweating (DOD, 2003; Hellon, et al., 1956), increased sweat rate (Arbury et al., 2014; DOD, 2003; Pandolf, 1998; Racinais et al., 2012; Sawka et al., 2011), lowered metabolic rate (DOD, 2003; Garrett et al., 2012, Sawka et al., 1996; Tyler et al., 2016), cardiovascular stability (DOD, 2003; Garrett et al., 2012; Garrett et al., 2009; Pandolf, 1998; Tyler et al., 2016), and lowered core body temperature (Sawka et al., 2011; Tyler et al., 2016). The goal of a heat acclimatization protocol is to enhance these physiologic adaptations and hence lower the heat strain (Periard et al., 2015, Tyler et al., 2016).

Myriad heat acclimatization protocols of varying durations, frequencies, intensities, and environmental conditions are employed to achieve heat adaptation (Chong et al., 2018; Sawka et al.,1996; Tyler et al., 2016). The main heat acclimatization regimens usually involve activities under either the traditional constant work-rate, self-paced method, or controlled hyperthermia approach (Periard et al., 2015; Taylor, 2000; Tyler et al., 2016). Heat acclimatization protocols are carried out either in laboratory-controlled/artificial or natural settings (Hellon et al., 1956;

Periard et al., 2015). In laboratory-controlled/artificial settings, parameters such as WBGT and relative humidity (rh) are manipulated to mimic desired environmental exposure conditions (Tyler at al., 2016). Typically, conditions are set above known or recommended OELs such as the NIOSH RELs for acclimatized individuals and NIOSH RALs for unacclimatized individuals to elicit a high level of heat strain and hence foster physiologic adaptive responses (NIOSH, 2016; Tyler at al., 2016). Environmental conditions have been described as hot and dry, hot and humid, or warm and humid depending on the purpose of study (Ashley, Ferron, & Bernard, 2015; Griefahn, 1997; Garett et al., 2012; Tyler et al., 2016). Generally, heat acclimatization is achieved within a range of 7 to 14 days with some studies reporting improvements using shorter durations (ACGIH, 2011; Ashley et al., 2015; Periard et al., 2015; Tyler et al., 2016). Consequently, heat acclimatization protocols have been categorized as either short-term (≤7 days), medium-term (8-14 days), or long-term (≥15 days) (Chalmers et. al., 2014; Garett et al., 2012; Periard et al., 2015; Tyler et al., 2016). It is generally considered that 75-80% of acclimatization occurs within the first 7 days (Periard et al., 2015). However, it has been established that longer acclimatization protocols confers a more complete heat adaptation (Pandolf, 1998; Tyler et al., 2016). NIOSH recommends a gradual graded heat acclimatization schedule for both new hires and experienced workers (NIOSH, 2016). New hires should be acclimatized to heat beginning on day one at a rate of 20% of their work duration at expected normal work-rate in the heat followed by 20% daily increments to full acclimatization (NIOSH, 2016). The process of acclimatizing experienced workers should start out at 50% of schedule duration at the usual work-rate in the heat on day one followed by 60% on day two, 80% on day three, and 100% on day four (NIOSH, 2016). Determination of acclimatization status can be assessed using different physiologic parameters such as the attainment of steady T_{re} and HR

(Ashley et al., 2015; Chong et. al, 2019; Garrett et al., 2012; Sawka et al., 1992; Tyler et al., 2016). An accurate assessment of heat acclimatization status is important in establishing progress of a regimen and, on a practical approach, the need to onboard individuals to their successive tasks or activities.

Outcomes from heat acclimatization studies have found useful applications in occupational (Chong et al., 2019) and sports (Garret et al., 2012; Tyler et al., 2016) settings. For the outcomes to find practical applications, protocol conditions must be clearly specified. Griefahn found no difference in acclimatization outcomes between hot/dry (50^0C, 15% rh, WBGT [33.5^0C]) and wet/humid (37^0C, 70% rh, WBGT [33.6^0C]) conditions after 15 consecutive days of exposure to heat (Griefahn, 1997). Understandably, the WBGT between these two conditions was identical. Using two groups subjected to 28^0C (WBGT), rh 32% and 30^0C (WBGT), rh 32% environmental conditions, respectively, Chong et al concluded that the WBGT conditions did not influence the ending heat acclimatization effectiveness (Chong et al., 2019). However, it is well established that exposing individuals to environmental heat conditions above OEL triggers adaptation eventually (Chong et al., 2019; Griefahn, 1997; Tyler et al., 2016).

Garzón et al (2017) reported the exposure-response curve for acclimatized participants as shown in Figure 1. The probability of unsustainable (point of maximum exposure for an individual) is related to the elevation above the OEL. This information can be used to estimate the percent of participants who would be expected to tolerate an exposure above the OEL. For instance, the hot/dry trials of the preceding paragraph would be about 5 to 6 °C-WBGT above the OEL. At that level of heat stress, about 55% of the participants would be expected to tolerate that level of heat stress; and 45% would not. Because the difference between unacclimatized

(Action Limit) and acclimatized (TLV) limits is about 2.5°C-WBGT, the curve would shift to the left. In a similar thought process, the number of unacclimatized participants who could tolerate the hot, dry conditions at 300W would be 10%, with 90% failing to maintain thermal equilibrium. If the acclimatization protocol calls for a lower WBGT, then the proportions of those who could tolerate the exposure at the beginning and end of the week would be higher.

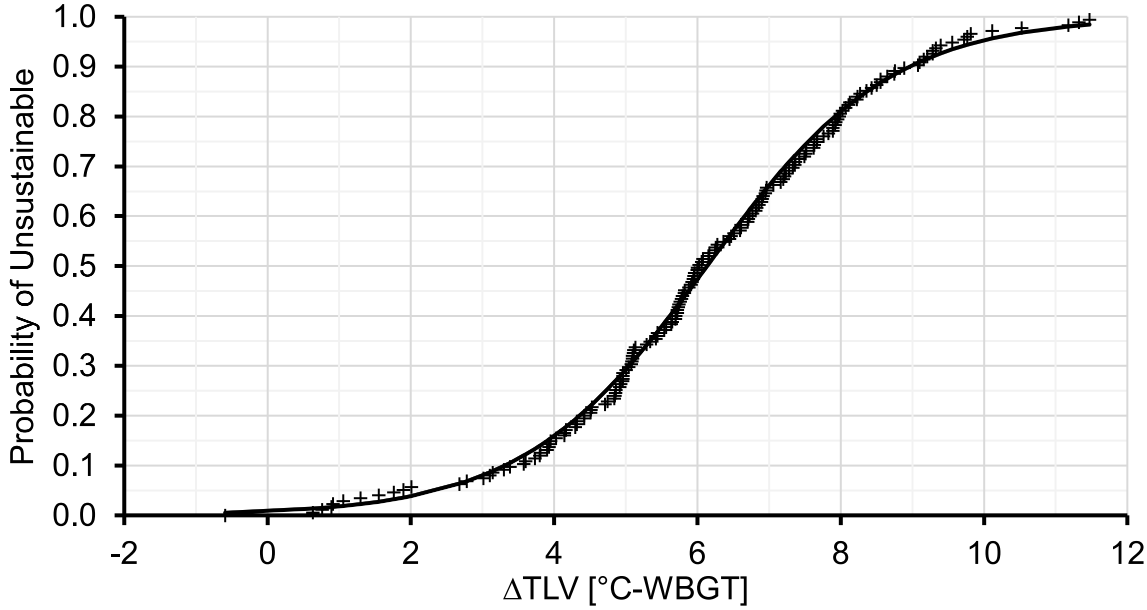

Figure 1. Exposure-Response for Acclimatized Healthy Participants (Garzon et al., 2017).

In this study, it was hypothesized that when participants are subjected to environmental heat conditions above the OEL, some will have difficulty tolerating the heat stress, but others will become acclimatized over a given time and for different protocols under different environmental conditions, the proportions of acclimatization will be different. This study examined heat acclimatization status of participants prior to and at the end of a one-week acclimatization program using two different protocols.

METHODS

Prior heat stress studies at USF used two different protocols to acclimatize participants (Ashley et al., 2015; Bernard, Caravello, Schwartz, & Ashley, 2008; Bernard, Luecke, Schwartz, Kirkland, & Ashley, 2005; Garzon et al., 2017). Data from four different studies involving the two protocols were used for this paper (Ashley et al., 2015; Bernard et al., 2008; Bernard et al., 2005; Garzon et al., 2017). All the studies were approved by the USF Institutional Review Board. Volunteers recruited for the studies were medically evaluated by licensed practitioners for participation.

All studies were conducted in a climate-controlled chamber with participants wearing shorts, tee-shirts (sport bras for females), and shoes. Activities involved walking on a motorized treadmill with speed and grade set to elicit a moderate work-rate approximately 300W. 44 participants took part in the four studies designated as protocols A, B, C, and D. Protocols A, B, and C were based on the same environmental conditions of 50^0C, 20% relative humidity (rh) (WBGT = 36^0C) designated as conditions 1 (CD1). Protocol D environmental conditions were 40^0C, 30% rh (WBGT = 30^0C) and were designated as conditions 2 (CD2). Participants were advised to refrain from strenuous physical activities and caffeinated drinks at least three hours prior to the trials. However, they could drink water as much as they wished including on trial days. To assess acclimatization, T_{re} and HR were monitored continuously. Participants T_{re} were measured using a flexible thermistor (401, Yellow Springs Instruments, Yellow Springs, OH) by insertion at approximately 10 cm beyond the anal sphincter muscles (Ashley et al., 2015; Garrett, Creasy, Patterson, & Cotter, 2011). T_{re} were taken every 15 minutes for 90 minutes and at 5 minutes intervals thereafter. HRs were similarly monitored using a HR monitor (Polar Electro Inc., Lake Success, NY) (Ashley et al., 2015). Trials lasted 120 minutes unless any of the termination criteria was reached: $T_{re} = 39^0C$, HR > 90% of maximum HR or participant wished to stop (Ashley et al., 2015; Bernard et al., 2008; Bernard et al., 2005). Data from acclimatization of up to seven days were used.

Data from one participants and 23 other data points were excluded from the final analysis due to failure to meet acclimatization assessment criteria. The excluded data were not used in the assessment of acclimatization statuses. The demographic data for the 43 participants in all the four protocols are presented in Table I.

Table I. Demographic Data for Participants by Acclimatization Protocols and Gender.

Protocols/Participants	**Age (years)**	**Height (m)**	**Weight (kg)**	**BSA (m^2)**
A (men & women) (n =14)	30.1 ± 7.5	1.75 ± 0.1	85.2 ± 24.1	2.0 ± 0.3
B (men & women) (n = 9)	27.0 ± 9.0	1.73 ± 0.1	77.0 ± 15.4	1.9 ± 0.2
C (men & women) (n = 12)	30.9 ± 8.2	1.70 ± 0.1	79.0 ± 22.0	1.9 ± 0.3
D (all men) (n = 8)	23.1 ± 3.3	1.86 ± 0.1	83.0 ± 5.0	2.1 ± 0.1

Note: mean ± standard deviation
Protocols A, B, & C were under CD1 conditions; Protocol D was under CD2 conditions.

Acclimatization statuses for the first and last days were determined by two experienced researchers using participants' T_{re} primarily augmented with HR. These parameters have been extensively used in other studies as indicators of heat acclimatization (Ashley et al., 2015; Garret et al., 2012; Sawka et al., 1992; Tyler et al., 2016). On the first day, participants were classified as acclimatized (A) if they had a steady T_{re} and HR in the last 15 minutes of trial. They were partially acclimatized (PA) if they exhibited some stability in T_{re} and HR; otherwise, they were classified as unacclimatized (UA). On the last day, participants were classified as fully acclimatized (FA) if they exhibited a steady T_{re} and HR in the last 15 minutes of the trial and maintained it across days one and two. Participants were classified as PA if they had failed to achieve T_{re} and HR steady state in days one and two but were able to do so in days 3 and 4. Lastly, they were classified as not improving (NI) if they failed to acclimatize by the end of the fourth day. Classification criteria established allowed for participants to advance from A to FA, PA to FA, PA to PA, UA to PA, UA to FA, or UA to NI. Change of acclimatization status from A to PA and PA to NI were not permitted hence depicted as N/A.

RESULTS

On the first day, 14% of the participants were classified as acclimatized compared to 60% categorized as unacclimatized under the CD1 protocols. Three quarters of participants under CD2 protocol were also classified as acclimatized on the first day. Full acclimatization was achieved in 34% of participants in CD1 protocols on the last day. Another 34% were classified as partially acclimatized and the remaining 31% showed no improvement in heat tolerance under the CD1 protocol. There was no change in acclimatization statuses for participants in the CD2 protocol on the last day, with 2 of the 8 showing no improvement. Tables II and III presents acclimatization statuses on the first and last days of the protocols under CD1 and CD2.

Table II**.** First Day Versus Last Day, CD1.

		Last Day			
Status	Status	FA	PA	NI	Total No.
First Day	A	5	N/A	N/A	5
	PA	7	2	N/A	9
	UA	N/A	10	11	21
Total No.		**12**	**12**	**11**	**35**

A = Acclimatized, FA = Fully Acclimatized, PA = Partially Acclimatized, UA = Unacclimatized, NI = Not Improving, CD1 = Conditions 1 (36^0C, WBGT).

Table III**.** First Day Versus Last Day, CD2.

		Last Day			
Status	Status	FA	PA	NI	Total No.
First Day	A	6	N/A	N/A	6
	PA	0	0	N/A	0
	UA	0	0	2	2
Total No.		**6**	**0**	**2**	**8**

A = Acclimatized, FA = Fully Acclimatized, PA = Partially Acclimatized, UA = Unacclimatized, NI = Not Improving, CD2 = Conditions 2 (30^0C, WBGT).

The percentage changes in acclimatization status from the first to the last day by protocol are presented in Table IV and depicted in Figure 2. On the last day, 69% of participants were either fully or partially acclimatized under the CD1 protocols. This was approximately a 50% increase from the beginning of the one-week acclimatization.

Table IV. Comparison of Change (%) in Acclimatization Status Between CD1 and CD2.

	A-FA	PA-FA	PA-PA	UA-PA.	UA-NI
CD1	14	20	6	29	31
CD2	75	0	0	0	25

A = Acclimatized, FA = Fully Acclimatized, PA = Partially Acclimatized, UA = Unacclimatized, NI = Not Improving, CD1 = Conditions 1((36^0C, WBGT), CD2 = Conditions 2 (30^0C, WBGT).

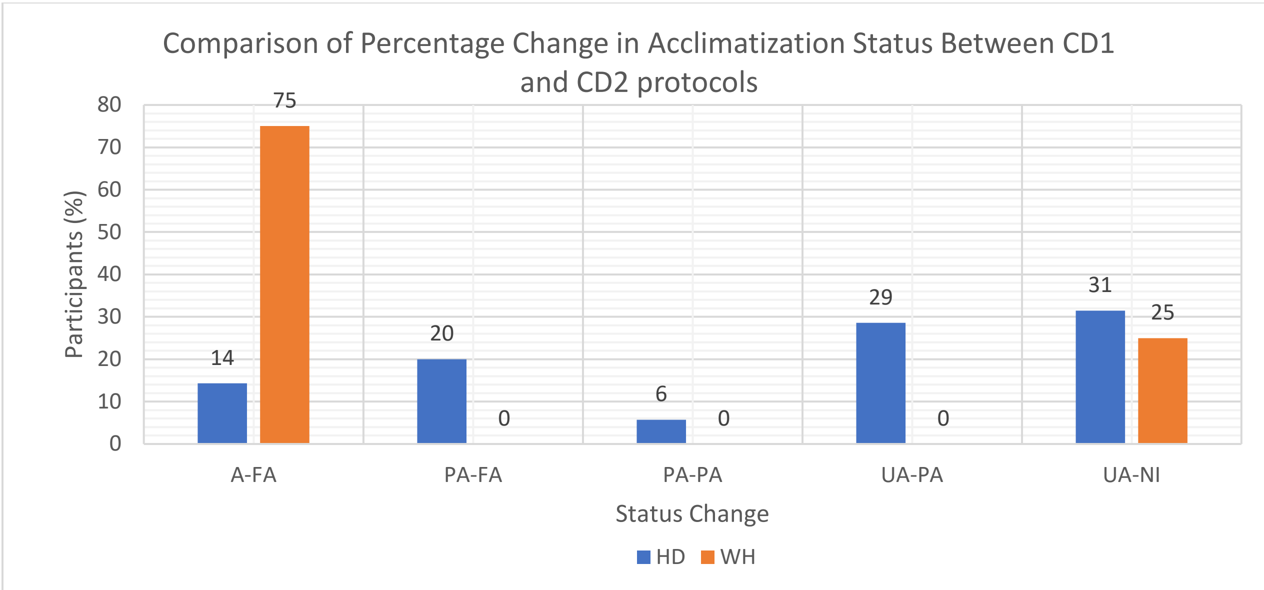

Figure 2. Percentage Change in Acclimatization Status for CD1 and CD2 protocols.

DISCUSSION

On day one, under the CD1 protocols, 21 out of 35 participants were categorized as unacclimatized while under CD2 protocol, only 2 out of 8 participants were classified as unacclimatized. CD1 and CD2 conditions were 8^0C and 2^0C above the ACGIH TLV®, respectively. At and below the NIOSH REL, 95% of individuals are expected to comfortably tolerate heat stress (NIOSH, 2016). However, it was expected that an elevation of heat stress to levels above the prescriptive zone would result in a decline in the number of individuals that are able to tolerate heat stress. First day results from the two protocols agreed with this expectation. CD1 protocols were relatively harsher with 60% of the participants unable to tolerate compared to only 25% of the participants under the less severe CD2 protocol.

On the last day of CD1 protocols, 14 out of 35 participants were either fully or partially acclimatized while under CD2 protocol, there was no difference in acclimatization statuses between first and last days. With subsequent exposure to heat stress levels above TLV®, the human body develops physiologic adaptations to tolerate the increased heat stress (Arbury et al., 2014; NEHC, 2007; NIOSH, 2016; Periard et al., 2015). Therefore, under both protocols, it was expected that some participants would develop adaptive mechanisms for tolerating heat stress. The intensity of heat exposure and the environmental conditions to which individuals are subjected to determines the rate of adaptations (Tyler, 2016). Participants under the CD1 protocols exhibited greater change in status with approximately 70% increase in the fully or partially acclimatized from the first to last day. Under the CD2 protocol, whose conditions were just above the TLV®-heat stress level, there was no change in participants acclimatization status.

It is speculated that, at the TLV®-heat stress level, the fully acclimatized number would have been greater than 75%.

The reference TLV® for moderate work (metabolic rate = 300W) for acclimatized individuals is 28^0C (ACGIH, 2017) and therefore, the action limit (AL) which is 2.5^0C below the TLV® is 25.5^0C. ACGIH has set AL as protective point for the unacclimatized individuals (ACGIH, 2017; NIOSH, 2016). Therefore, for CD1, the change in AL for pre-acclimatization is 10.5 (36^0C - 25.5^0C) while that for CD2 is 4.5 (30^0C - 25.5^0C). At the end of the acclimatization program, the change in OEL for CD1 and CD2 were 8^0C and 2^0C, respectively. Using the exposure-response curve presented by Garzon et al. in Figure 1 (Garzon et al., 2017), the percentage of participants expected to tolerate heat stress can be derived and compared to observed values. Table V shows this comparison.

Table V. Observed & Expected Percentages for CD1 & CD2 Pre- & Post-Acclimatization.

	Pre-Acclimatization		**Post-Acclimatization**	
Condition	CD1	CD2	CD1	CD2
Δ (AL or OEL)	AL = 10.5	AL = 4.5	OEL = 8	OEL = 2
Observed (%)	14	75	34	75
Expected (%)	2	80	20	95

CD1 = Conditions 1 (36^0C, WBGT), CD2 = Conditions 2 (30^0C, WBGT), AL =Action Level (unacclimatized), OEL = Occupational Exposure Limit (acclimatized).

The observed percent of the participants who exhibited a full tolerance to the heat stress exposure were greater than the expected for CD1. The opposite was true for CD2, the observed percent of participants was less than the expected, but this may be attributable to the relatively small number of participants in the study.

Heat acclimatization protocols are useful in establishing physiologic adaptation to heat stress. There is a wide variability in the outcomes from different protocols utilized in acclimatizing participants as noted in this and other studies (Tyler et al., 2016). To date, there are no standardized protocols for acclimatizing participants but rather the choice is dependent on specific needs. Furthermore, individual variations in heat acclimatization as well as other factors may also influence outcomes (Racinais et al., 2012). Therefore, it is helpful to know the expected outcomes from a protocol to facilitate implementation of an acclimatization program. This heterogeneity in expected results could be useful in identifying individuals who could benefit from heat acclimatization and those that would not need it.

This study has limitations arising from the studies upon which it was based. First, although participants were instructed not to participate in vigorous activities prior to and during the trials and experiments, it could not be confirmed as to whether these instructions were adhered to. Therefore, it is possible that some participants might have achieved some acclimatization prior to the studies. Another limitation is the acknowledgement that these studies were carried out in Florida and the relatively warm temperatures may have conferred acclimatization benefits to participants prior to the study periods. This implies that generalization of the findings to other populations should be approached with caution. Finally, the mean age of participants in the studies was 27 – 30 years. This is a relatively younger population compared to what would generally be encountered in a typical occupational setting. However, it should be noted that this could be advantageous in other settings such as sports.

The study looked at only two environmental conditions. However, it is known that typical environmental conditions fluctuate over a wide range sometimes over a very short period. Future research is needed to shed light on expectations from other ranges of environmental conditions. Another future research area could be the comparison of the results obtained from this or other traditional heat acclimatization protocols with the recommended NIOSH graded acclimatization process. This could help evaluate effectiveness of current recommended practice or perhaps suggest alternatives.

CONCLUSIONS

The purpose of this paper was to examine the acclimatization state prior to and at the end of a one-week acclimatization program using two acclimatization protocols. The following conclusions can therefore be made:

1. The harsher the environmental conditions the harder it is to tolerate heat stress,
2. An effective heat acclimatization program will eventually acclimatize some more individuals, and
3. Protocols under different conditions had varied proportions of acclimatization and the harsher environmental conditions seem to have greater success in acclimatizing individuals to the OEL.

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