From Teaching to Trails: Occupation, Heat Exposure, and Leisure Time Physical Activity in Phoenix, Arizona

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Problem Statement & Research Context

When considering heat exposures and vulnerabilities, two important aspects for consideration are the influences of occupation and income. While heat is the leading cause of weather-related deaths, there are only a few states with occupational heat exposure regulations (NOAA 2011). According to Gubernot et al. (2014), "Workers who perform strenuous work while exposed to high temperatures are especially vulnerable to HRI [heat-related illnesses] as the combined metabolic and environmental heat loads challenge the bodies' cooling mechanisms". Heat stress can come in forms other than physical harm by affecting one's behavior, which is significant for analysis of Leisure Time Physical Activities (LTPA). Kirk and Rhodes (2011) found that higher status (non-manual/white collar) jobs were associated with more LTPA, and that lower status jobs (often manual labor) were associated with less LTPA. Applying this to the jobs in Phoenix that are often outside, physical strain is often present when one is outside (i.e. construction workers), further worsening the effects the job strain as heat stroke becomes a danger. Harlan et al. (2006) showed that heat vulnerability varied by neighborhood, so it seems that an individual's neighborhood, often associated with their occupation and income, can affect how one experiences heat in terms of LTPA. Behavior in LTPA (i.e. going for a jog outside vs. going to an indoor gym) could be affected by one's work-related activities and exposure to heat. Though heat is an almost unavoidable aspect of life in Phoenix, how one experiences this heat may vary even between occupations that require outside time, like the variance between heat exposure for agricultural workers (active, manual labor) and lifeguards (mostly passive).

What is the relationship of income, occupation, heat exposure, and LTPA? Does heat exposure during work-related activities affect one's LTPA and heat exposure? Does this vary by income and type of occupation?

Methods

During a week in September 2014, study participants from five Phoenix metro neighborhoods wore small sensors that recorded air temperature (iButton), giving us individually experienced temperatures (IETs) for each participant. Our research team collected contextual data in the form of background surveys, activity logs, daily surveys, and exit interviews, along with ambient air temperature data from iButtons in the neighborhoods throughout the week.

For the purposes of this question, we looked at the study data from three diverse neighborhoods: Coffelt (hereafter CO), Thunderhill (hereafter TH), and Garfield (hereafter GF). We paid special attention to contextual data about occupation, income, work environment, and exercise habits, whether explicitly divulged or implied from related data. Combined with case studies, census data, and the average, maximum, and minimum IET temperatures for all the participants of interest in each neighborhood, we analyzed IET data on both the individual and collective level.

Results

Figure 1 shows that those inside while at work generally participate less in inside-only LTPA. Most occupations for the participants are Not primarily outside, so that cannot be meaningfully analyzed, but participants whose occupations involved both inside and outside time were varied in their outdoor/indoor LTPA. This is not surprising considering the variability of the "both" categorization when considering workplace heat exposure, and suggests that a closer look at may be needed at the specifics of participants' heat exposure at work, such as how long they were outside, how often they had to adjust to the inside/outside switch, and what they were doing (i.e. unloading boxes or standing in the shade).

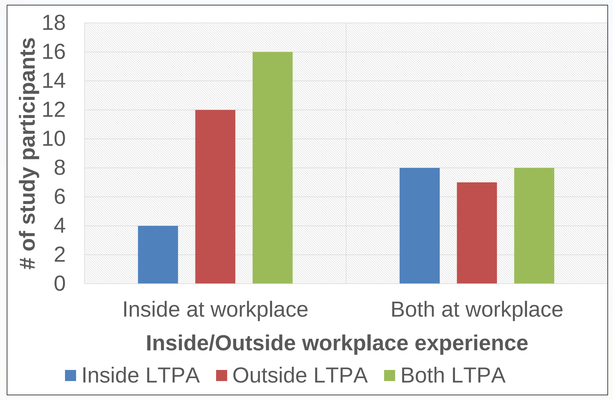

Figure 1. **Inside/Outside workplace environment and LTPA**

Despite a general homogeneity of income for study participants in a particular neighborhood, between neighborhoods, income varied from $13k in CO, to $27k in GF to $154k in TH (U.S. Census Bureau 2014). Somewhat surprisingly, average IET temperatures did not vary much between income brackets (figure 2). While temperatures vary between neighborhoods due to built-environment factors, this may be explained by the fact that every resident of Phoenix experiences extreme heat in mid-September if he/she is outside at all, and often even minimums can be similar if everyone goes to an air-conditioned grocery store, for example. However, though the averages may look similar, behaviors are what distinguish those of different occupations, incomes, and neighborhoods and allow for determining heat vulnerability. The data suggests that though average temperatures may be similar between incomes, the experiences related to those temperatures are what is important.

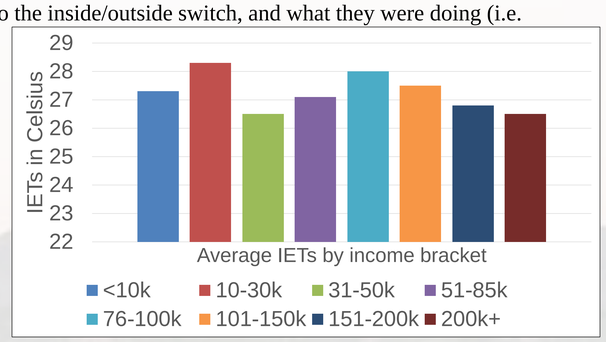

Figure 2. **Average IETs by income**

Hunter, a resident of GF and chef who is often hot at work in the kitchen. He expressed his perception of the LTPA/heat relationship by focusing on the tiring aspect of heat: he says it is easy for one to be so tired out by the heat that LTPA becomes taxing, but his strategy for mitigating his heat exposure relies on his ability to take a cold shower and turn down his air conditioning. Though Hunter has a lower annual income range of $10-30k, he also has a gym membership and exercises indoors. Hunter's case brings up the complexity of categorizing inside as a cool space; though outside is most certainly equated with heat, inside can be, too, depending on one's activities and cooling resources.

Bernarda is a stay-at-home grandmother living in CO who experiences heat often and does not participate in much LTPA. Partly because of her low income, Bernarda walks most of the time or rides the bus, rarely riding in a car. She does not feel safe in her neighborhood to exercise or engage in physical activity and she often feels sick even walking to the grocery store; even inside her home and her grandchildren's school, she feels hot. Her occupation requires her to be outdoors often, even though it consists of traveling between indoor places. So, though Bernarda may be indoors most of the day, her income inhibits her comfort level indoors (quality/presence of cooling), access to a cool method of transportation, sense of ease with being outside, and overall discourages her from participating in any LTPA. Bernarda is especially vulnerable to extreme heat, as shown by her IETs (blue line) for the week (figure 3), which often exceed ambient temperature (black line). Whereas a different income level may have allowed Bernarda access to a free indoor gym, a nearby gym membership, or safer/better-maintained parks, she is more limited by these factors relating to her income even though her occupation would conventionally involve more indoor activity that one might expect to lead to some outdoor LTPA.

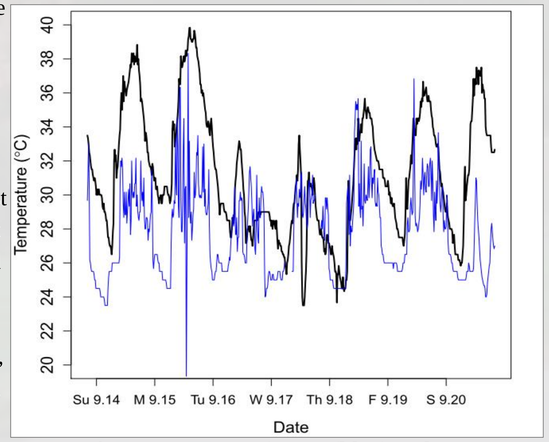

Figure 3. **Bernarda's IET (blue) and ambient temperature (black) 9/14/14-9/20/14**

Discussion of Significance and Contribution

Through the study of the IET temperatures of Phoenix residents of varied age, income, residency, and occupation, it seems that occupation and income factors can have an effect on a person's ability to or likelihood of participating in LTPA. Occupation and income are just one piece of the behavioral puzzle, but this study of IETs and analysis gives some insight as to how certain occupations may affect why or how a person participates in LTPA. For example, those who are in higher income brackets might be more likely to include LTPA as a part of their lives than those in lower income brackets due to heat exposure required through one's occupation, as was the case with Bernarda. Inside workplaces also seem more likely to induce outdoor LTPA, and so this study suggests that occupation and income are important factors when considering public health campaigns. Health concerns from heat exposure and lack of physical activity are especially related in hot climates like Phoenix, and heat is an important everyday factor to consider when analyzing health behaviors of residents. Future analysis of the topic should include comparisons of specific occupations and income levels with controlled factors and more detailed measurements of activities along with IET data.

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