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Thermal Safety of Children’s Outdoor Play Equipment
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Abstract
As the world gradually warms due to climate change, evidence has arisen pertaining to the lack of correctly constructed play spaces. With outdoor play areas being a common place for children to gather, this puts them at a high risk of more likely for them to suffer from issues such as heat exhaustion. Children, with their incomplete heat regulation systems and speech limitations, have a more difficult time adjusting to the increase in heat. Given this vulnerability, design of parks, playgrounds, and other play spaces is critical. This presentation provides a brief overview of how children's outdoor play spaces.

Research Objective
The main purpose of this research is to understand the research that has been done on this subject and figure out what is known and what we still need to understand. This review is immensely important due to the lack of knowledge in a vulnerable part of the population, children. In a search done on a PubMed database in a review paper done by Falk and Doltan (2008), it showed that from 1980-2006 a total of 8 papers had been published on children (Figure 1).

Introduction
Children require enough exercise to have a successful development for physical, social, emotional, and cognitive functions. Most of the time, this exercise is done outside in play areas. With the rising temperatures due to climate change, heat related illnesses have become more frequent. In fact, it is the most common weather related death (Figure 2). The outdoor play areas that children frequent have a lack of efficient mitigative thermal designs. This means that the play spaces available now trap heat and intensifies it where the children play.

Data & Methods
Starting sources had been given to introduce this topic and to get a basic knowledge of papers needed to be found to support this research. A meeting with a librarian was conducted in order to understand how to efficiently navigate the databases and find relevant sources for research. The Web of Science database was used to locate the papers that were used in this review. Queries such as “thermoregulation AND children” were used to identify relevant papers. After a relevant paper had been found, the paper was then annotated in order to identify usable information for the review. This process was repeated until enough information was obtained.

Results
It can be determined from the papers reviewed that there is a lack of thermoregulation in the design of outdoor play equipment and outdoor play areas in general. The main way people had determined heat was through the heat index. However, Grundstein, et al. (2017) discovered the heat index did not determine temperature of outdoor equipment. Through the research Grundstein, et al. (2017) conducted, the had designed an updated heat index (Figure 3) to accommodate for outdoor play equipment. With the increase in heat in the interior of play equipment, heat problems and bad air quality at play areas have been discovered to have started to increase. This problem has been discovered in other countries who have moved towards urbanization. In a study that was completed by Vanos (2014), the heating differences between a thermally safe park design and a poorly designed park was discovered and shown in Figure 4.

Conclusions
How heat affects children is relatively unknown due to the amount of limitations. Based upon research done by Grundstein, et al. (2017), it can be determined that there is an increased temperature change from the outside temperature compared to the interior of a play structure (Figure 5). This can increase the effects and frequency of heat related illnesses in children playing inside of them and causes the need for a thermally safe play area design. Research has already started being conducted into this area as is shown in an experiment done by Egerhazi et al. (2013), in which 2 outdoor play areas were compared and elements that cooled an area down were identified.

Future Work
- How can we make play area equipment more thermally safe so that outside temperatures does not affect the internal temperature where children play as drastic as it does now?
- What do children, who can speak, identify what hot exactly is and how can it be effectively understood in order to help children who may be under the effects of heat already?

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