



Vulnerability and adaptation to heat waves in preschools: Experiences, impacts and responses by unit heads, educators and parents

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ABSTRACT

With global warming, heat waves are becoming more frequent and intense, particularly in northern latitudes, where the pace of warming is faster. Due to its northern location, Swedish society has been built primarily to manage a cold climate, and is less prepared to manage heat, which the 2018 heat wave demonstrated. While young children are recognized as vulnerable to heat, and are reliant on preschool care, few studies have examined how the young and vulnerable people are cared for during heat waves in the institutional preschool setting. This exploratory study demonstrates how children in preschool environments are vulnerable to heat, in order to identify management needs by assessing experienced impacts and responses to the 2018 heat wave in Sweden. Empirically, the study builds on a survey completed by 33 unit heads responsible for 77 preschools in the focused municipality, and qualitative interviews with five educators and five parents, as well as temperature measurements in three selected preschools. This study shows that: (i) children and educators are exposed to both high indoor and outdoor temperatures in the preschools; (ii) both children and educators were affected by the heat wave in the preschools, and their sensitivity is deeply intertwined due to their dependency relationship, rendering a form of double sensitivity to heat; and (iii) the preschool heads and educators were unprepared to sufficiently cope with the heat wave, and organizational strategies for managing heat were lacking, indicating weak adaptive capacity. The significant exposure to heat in preschool environments, the dual sensitivity of children and preschool educators, and the low organizational readiness resulting in uncoordinated responses to reduce heat stress suggest a pronounced vulnerability to heat waves in preschools.

1. Introduction

Heat waves, as experienced in Sweden and other European countries during the summer of 2018, delivering record-breaking temperatures in July and August, heavily affect vulnerable parts of the population (Åström et al., 2019). Climate change research

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signals that such events will gradually become more frequent and intense, and that the rate of warming is greater in northern latitudes (SMHI, 2019). It is further well established that the heat intensity is more pronounced in urban areas, where care for heat-sensitive groups such as young children is often located (Uejio et al., 2011; O'Lenick et al., 2019).

Young children are identified as relatively more heat-sensitive than the average population (Wilhelmi and Hayden, 2010; McBride, 2016). For example, heat has been found to cause negative health effects (Xu et al., 2012; Zivin and Shrader, 2016), reduced cognitive abilities, and adverse effects on learning (Salthammer et al., 2016).

In some welfare states, such as Sweden, most young children spend considerable time, during the hot hours of the day, in preschools. Further, children are indirectly impacted by way of e.g. the impact of heat on the educators (Kousky, 2016), and by the extent to which heat is organizationally or practically managed. Since young children are reliant on care during their time at their preschools, it is argued that policies and routines (including contingency plans and warning systems), as well as pedagogic, caring and play activities must be adapted to cope with heat waves (Zivin and Shrader, 2016).

However, though preschools are found to be essential for the well-being of young children during heat waves, few studies have analyzed in what way children in preschool environments are vulnerable to heat, and what adaptive actions are and could be taken to reduce heat stress in preschools. As pointed out by Xu et al. (2012), more research is needed on both adaptive measures, and on what effects caregiving behavior can have during heat waves, in order to find effective strategies to manage heat risks in preschools.

Contributing to this so far under-researched field, this study aims to demonstrate how children and staff in preschool environments are vulnerable to heat waves, in order to identify management needs in this particular welfare sector. This exploratory study was designed to reactively assess impacts of and responses during an unanticipated event; the heat wave in Sweden during the summer of 2018. To enable rapid empirical collection, the study builds on established collaboration between the authors and a targeted mid-sized Swedish municipality, Norrköping (population 140,000). The study has further been pragmatically designed to assess both widely how the heat wave has affected most of the preschools in the municipality, and as a follow-up, individual preschools. Empirically, a survey was distributed to all preschool heads shortly after the summer of 2018. After interpreting the results of this survey together with the municipal education department, qualitative interviews with educators and parents as well as temperature measurements were conducted at three selected preschools during the summer of 2019. Results were interpreted in accordance with the conceptualization of heat vulnerability as consisting of exposure, sensitivity, and adaptive capacity (Wilhelmi and Hayden, 2010).

2. Background

2.1. Heat in a Swedish perspective

Based on the World Meteorological Organization (WMO) definition of heat waves as five or more consecutive days with daily maximum temperatures surpassing the average maximum temperature by 5 °C, the Swedish Meteorological and Hydrological Institute (SMHI) has defined a heat wave in Sweden as a period when the daily maximum temperature exceeds 25 °C during at least five consecutive days (SMHI, 2011). Daily summer maximum temperatures in Sweden have already increased by 1.7 °C degrees from 1880 to 2005 (SMHI, 2019). As global warming continues, both maximum temperatures and the number of consecutive days with temperatures above 25 °C are expected to increase (SMHI, 2019). The SMHI has developed a heat wave warning system based on three levels: message of high temperatures when the daily maximum temperature is expected to be at least 26 °C for three days; Class 1 warning when the daily maximum temperature is expected to be at least 30 °C for three days; and Class 2 warning when the maximum temperature is expected to be at least 30 °C for five days and/or at least 33 °C for three days (Oudin Åström et al., 2020).

As indicated above, compared to warmer countries, in Sweden the absolute temperature does not need to be very high before there are impacts. Being situated in the north, Swedish society is built primarily to manage a cold climate (Thorsson et al., 2011), meaning that e.g. large windows and air intakes often face south to utilize solar radiation, and that buildings are generally well-isolated. Very few buildings have air conditioning or district cooling, and heat issues are seldom a factor in urban planning (Glaas et al., 2015).

The summer of 2018 was exceptional from a climatological viewpoint, particularly in terms of heat duration (SMHI, 2018a, 2018b). For instance, July was 3 °C to 5 °C warmer than the normal average, resulting in monthly mean temperature records in most of Sweden (SMHI, 2018a). Even if the daily maximum temperatures were also significantly higher than average, they were not as exceptional as the monthly average temperature. In the study location, Norrköping, the monthly mean temperature in July was 21.7 °C, which is 5.5 °C higher than normal and included 19 consecutive days with temperatures above 25 °C (SMHI, 2018b). Consequently, the whole period from 10 to 28 July qualifies as a heat wave. Two times during this period, the maximum daily temperature exceeded 30 °C for at least three consecutive days, thus generating Class 1 warnings.

The 2018 heat wave in Sweden has been estimated to have caused an excess mortality of 601–745 people (Åström et al., 2019), drought, historically low river discharge (SMHI, 2018c), and widespread forest fires (SOU 2019:7). However, beyond analyses of excess mortality, few studies have analyzed experienced heat impacts, vulnerability and adaptation.

2.2. Preschools in Sweden

Municipalities are the primary managers of preschools in Sweden, and the practices are regulated by the school Law (2010:800) and the curriculum for preschools (Swedish National Agency for Education, 2018). As stated in the law, preschools are to stimulate children's learning and provide safe care. The curriculum specifies, for instance, mathematical, language, and digital skills. Regulations for care are less detailed, but it is stated that preschools are to offer a healthy environment and well-balanced daily rhythm including both rest and activity, provide both cold and hot meals, and care for the children's general well-being. The preschools should

further offer good physical and outdoor activities (Swedish National Agency for Education, 2018).

Preschool heads (Swedish: *rektorer*) and preschool teachers (Swedish: *förskolelärare*) are mainly responsible for compliance with the law and curriculum, while the preschool teachers are to lead the educational activities. However, other staff categories work in preschools, including day-care attendants and substitute teachers. In this paper, preschool teachers, day-care attendants and substitutes are jointly labelled “educators”. In the studied municipality, most preschool heads were responsible for 1 to 3 preschools, depending on the size and location of the preschools.

The Swedish municipalities offer all children aged one to five preschool services. Preschool is included in the educational system and is regulated by a national curriculum that puts considerable weight on teaching and learning (Swedish National Agency for Education, 2019). Attending preschool is not mandatory but is offered for a low fee due to tax funding. In 2018, 85% of the 1- to 5-year-olds used the services, staying on average 31 h per week at the preschool. The preschools have on average 5.1 children per staff member, and each preschool teacher is responsible for 12.9 children (Swedish National Agency for Education, 2019). The vast usage of preschool services implies that there are many preschools, spatially distributed across the municipality’s territory. In the studied municipality, Norrköping, there were 115 preschools at the time of the study, with 20 to 150 children in attendance (median number 57). In rural areas and suburbs, preschools are commonly located in separate buildings with an adjacent schoolyard, while in central locations they are often located on the bottom floor of a multi-story building. During summer, when most Swedes take vacation, children and educators from several preschools are usually merged into a few units, available for children whose parents work during summer. In summer 2018, 38 of 115 preschools in Norrköping stayed open throughout the summer, most of them with children from up to three preschools, six of them had children from five to eight different preschools.

3. Heat vulnerability in preschools

The scientific understanding of heat vulnerability is progressing. Conceptually, [Wilhelmi and Hayden \(2010\)](#) extended the [IPCC’s \(2007\)](#) integrated vulnerability framework, conceiving heat vulnerability as a function of exposure, sensitivity and adaptive capacity to extreme heat. Importantly, this conceptualization stresses that consideration of both people (in this paper preschool children and educators), and place (in this paper the preschool buildings and their surroundings) are needed to provide a holistic representation of heat vulnerability ([Wilhelmi and Hayden, 2010](#)). To guide this exploratory study of preschool vulnerability during a heat wave, findings from urban vulnerability to extreme heat, children’s heat sensitivity, and adaptation to heat in another sector, elder care, have been used to inform how exposure, sensitivity and adaptive capacity apply to preschools in Sweden.

3.1. Exposure to heat waves in preschools

Exposure to heat waves relates essentially both to the outdoor and indoor environments ([O’Lenick et al. 2019](#)). A combination of factors including wind, radiation, humidity, and air temperature contribute to exposure during heat waves (e.g. [Teli et al., 2012](#)). In dense urban environments with a high share of impervious or darkened surfaces and generally less wind flow, thus, heat exposure is more pronounced than in more vegetated areas ([Uejio et al., 2011](#); [Vanos, 2015](#); [O’Lenick et al., 2019](#)). In the studied municipality, a large proportion of the 115 preschools in the municipality were located in urban areas.

Outdoor heat stress in general, and temperature in particular, is influential also for indoor heat stress in buildings without cooling or air condition ([Lundgren Kownacki et al. 2019](#)). As also found in Germany ([O’Sullivan and Chisholm, 2020](#)), almost none of the 115 preschool buildings had any form of cooling in the studied location ([Opach et al., 2020](#)). Moreover, shading, both inside and on the building’s exterior, is also found important to avoid high indoor temperatures ([Lundgren Kownacki et al., 2019](#)). Availability of shading differs greatly among preschools in the studied municipality, as there are no local guidelines for such equipment.

Heat generation and storage are important for determining how well a building can withstand heat waves without resulting in excessively high indoor temperatures ([Uejio et al., 2011](#); [O’Lenick et al., 2019](#)). Generally, indoor temperatures in light-weight modular buildings increase more during heat events, while masonry wards and brick buildings are found more resistant to heat, at least in the short perspective ([Lundgren Kownacki et al., 2019](#)). In the studied municipality, the preschools are located in many different types of buildings, ranging from ground floors of multi apartment buildings to solitary small wooden pavilions.

3.2. Preschool sensitivity to heat waves

Sensitivity to heat waves in preschools relates directly to the heat-sensitivity of children, but also to the sensitivity of the preschool educators, likely in a similar way as [Jonsson and Lundgren \(2015\)](#) found for staff in elder care in Sweden.

Children are identified as relatively more heat-sensitive than the average population ([Zivin and Shrader, 2016](#); [Teli et al., 2017](#); [Sheffield et al., 2018](#); [O’Sullivan and Chisholm, 2020](#)). [Xu et al. \(2012\)](#) suggest that children’s physiological, metabolic, cardiovascular, behavioral, and self-care characteristics all contribute to the pronounced heat-sensitivity. For instance, children are considered more heat-sensitive than adults since their bodies contain less fluid, aggravating the risk of dehydration ([Kousky, 2016](#)). Heat waves have been showed to both cause acute health risks including injuries and exacerbate pre-existing medical conditions for children ([Xu et al., 2012](#); [Sheffield et al., 2018](#)) rather than excess deaths ([Xu et al., 2012](#); [Vanos, 2015](#)).

Beyond the effects on mortality and illnesses ([Xu et al., 2012](#)), heat can also negatively affect children’s achievement, attention, understanding, and learning ability ([Salthammer et al., 2016](#); [Zivin and Shrader, 2016](#)). Children living in cities with colder climates, such as the Swedish, have been found more affected by summer heat than children in warmer climates ([Cho, 2017](#)). High indoor temperature has been found to result to children feeling drowsy ([Salthammer et al., 2016](#)), and increasing levels of aggressive behavior

(Anderson et al., 2000; Wargocki and Wyon, 2013).

Studies of how children in preschool environments are affected by indoor temperatures are rare, but suggest that children are more comfortable in lower temperatures (Rupp et al., 2015) and that children's thermal comfort level is at least 2 °C lower than adults' (Teli et al., 2012). While the heat sensitivity of children is recognized, O'Sullivan and Chisholm (2020) noted that recommendations for indoor temperatures in schools and preschools were lacking or vague in the three countries studied: Germany, New Zealand and the United States. The same goes for Sweden, where no such national guidelines exist.

There are, to our knowledge, no studies of how preschool educators are impacted during heat waves. However, a study of how staff in elder care were impacted by heat identified both direct physiological and mental effects, and indirect effects caused by increased workload due to the elderly's increased need for care, as well as by a reduced ability to take breaks, reduce pace and stay hydrated (Jonsson and Lundgren, 2015). The increased workload and feelings of frustration and hopelessness of not being able to care for the heat-stressed elderly was seen as causing mental stress (Jonsson and Lundgren, 2015). Due to similarities in caring for heat-sensitive groups, preschool educators are likely to be impacted in a similar way.

3.3. Adaptive capacity to heat waves in preschools

Studies of adaptive capacity to heat waves in preschools are also lacking, but studies of heat vulnerability in elder and health care point to the importance of organizational readiness, knowledge, and ability to perform measures that reduce heat stress (Jonsson and Lundgren, 2015).

Organizational readiness includes the availability of e.g. heat contingency plans and checklists (Price et al., 2018), indoor temperature monitoring (Price et al., 2018), and heat warning systems (Lerch and Oris, 2018). In the studied location, the education department had developed neither heat contingency plans nor guidelines on what measures to take during a heat wave. Further, heat wave messages and warnings from the SMHI were distributed to unit heads in elder care, but not to preschool unit heads.

The ability to perform measures that reduce heat stress concerns educating staff about preventive and reactive measures, the ability to detect potential consequences and symptoms of stress among the elderly, and identifying the most heat-sensitive individuals (Benmarhnia et al., 2018; Price et al., 2018). Since the preschool children are less able to cope with extensive heat due to their limited agency, they depend on the preschool educators' ability to perform measures that reduce heat stress such as using shading, temporarily cooling the premises, adjusting daily schedules, and facilitating possibilities for sleeping, eating and hydration (Kousky, 2016). The preschool educators, hence, are key to understanding adaptive capacity during a heat wave.

4. Methods and materials

This exploratory study was designed to compile data on impacts of an extreme weather event: the heat wave that affected Sweden in 2018. Established collaboration between the authors and the targeted municipality enabled the rapid collection of survey data, which otherwise would have been difficult. Further, the study was designed to capture both how the heat wave impacted all preschools in the municipality (i.e. at the broad level), and, as a follow-up, how the heatwave was experienced in three selected preschools (the in-depth level). Below is a presentation of the study context, its design, the applied research methods, and the data analysis.

4.1. Study context

Since 2015, the authors of this study have collaborated with Norrköping Municipality in a joint project on municipal governance of climate change vulnerability, focusing on how flooding and heat impacts can be assessed and mainstreamed in municipal planning, management and decision-making (Glaas et al., 2020; Glaas et al., 2019). Prior to the 2018 heat wave, temperatures were measured in order to validate and identify heat islands in the city center, including one schoolyard of a preschool selected in this study (Hjerpe et al., 2020). This data informed education department staff to initiate climate adaptation action by identifying factors shaping vulnerability in preschools and in various building types (Opach et al., 2020).

4.2. Study design

The 2018 heat wave provided opportunities for the education department and the researchers to analyze how a real heat event played out in practice as perceived by key operative staff in this sector, as well as by parents of preschool children. First, a survey was designed and sent out to all preschool heads shortly after the summer. The survey showed significant impacts, initiating discussions at the education department about how to reduce heat vulnerability, and illuminating the need to learn more about how the heat wave was experienced. Second, qualitative in-depth interviews were conducted with parents and educators at three target preschools. The interviews were conducted during the summer of 2019.

The design of the present study can be characterized as a stepwise mixed-methods approach combining quantitative and qualitative methods. Using combined methods is a way to strengthen the foundations of the analysis, and to deepen the understanding of the research aim at hand, which is described as particularly useful in areas or topics where few studies have previously been undertaken (Hesse-Biber, 2010). The present study combines the benefits of a quantitative survey to assess to what extent and how the heat wave affected a large set of preschools in Norrköping, and in-depth interviews to assess in more detail how the heat wave was experienced at three selected preschools. To provide a context for the interviews on experiences of heat, automatic measurements of indoor and outdoor temperatures were conducted at the selected preschools during the summer of 2019. The measurements aimed to provide a

background understanding of how children and preschool educators are exposed to heat in the preschool environments they actively use. Details about the measurements and the results are found in the [Supplementary Material](#).

4.3. Overview survey immediately after the 2018 heat wave

The survey was sent out in September 2018 to all 49 preschool heads of the 115 preschools in the municipality. Responses were received from 33 preschool heads, responsible for 77 preschools, covering 67% of the preschools. The six survey items, whereof four multiple choice options, are found in the [Supplementary Material, Table S1](#). The survey items concerned: a ranking of the degree to which their preschools had been affected by the heat; the main impacts they had observed; the reactive measures taken during the heatwave; and how they would describe the indoor climate at their preschools. Two open-ended items allowed unit heads to describe key measures for improving management of heat and issues related to the heat wave that were not covered by the survey. Responses to the four multiple choice items are displayed in the [Supplementary Material, Table S1](#). In the results section, free-text responses from this survey are referred to as “(Unit head, number 1–33)”.

4.4. Qualitative interviews in the summer of 2019

Three preschools that reported significant impacts in the survey, and that stayed open during the whole summers of 2018 and 2019, were selected for data collection in the summer of 2019. Preschools 1 and 2 are located in suburban areas, while Preschool 3, divided into two separate entities, 3a and 3b, is located towards the inner city. The number of children, average weekly time spent in the preschool, proportion of children staying a limited time, and building and schoolyard characteristics are displayed in [Table 1](#). The preschools host up to 100 children each. Preschools 1 and 2 are two-story detached houses, recently constructed as “model preschools” intended to provide a good indoor and outdoor environment. Both Preschool 3 buildings are located on the ground floor of multi-story apartment houses. All preschool yards are relatively flat, with few trees and a large proportion of impervious surface, often facing south, except for Preschool 3a whose yard is covered by trees.

Semi-structured in-depth interviews were conducted in July 2019 with five parents and five preschool educators in the selected preschools. The interview guide included questions about the experience of the heatwave and its effect on the children and staff, and about measures taken by the preschool and municipality. The full interview guide is found in the [Supplementary Material, Table S2](#).

All interviewees were women. All preschool educators and three parents spoke Swedish fluently. The five preschool educators were aged 23–62 years. Two of them were day-care attendants, two were preschool teachers and one was a substitute teacher. All educators were recruited at their workplace. One parent interview was held with the aid of an interpreter, and one was held in Swedish despite the interviewees’ limited Swedish language skills. The latter situation resulted in communication challenges and the need for additional clarifications. The five parents were aged 28–42 years. Two of them had two children and three had four children, with at least one child in preschool age. The parents were recruited at the preschool when picking up their children at the end of the day.

The interviews lasted 20 to 61 min, averaging 42 min, and were audio-recorded and transcribed verbatim. Interview excerpts are referred to as “(Preschool Educator, number 1–5)” or “(Parent, number 1–5)”. All interviewees were given oral and written information about the aim and procedure of the study prior to their participation, and gave their written informed consent to participate.

4.5. Data analysis

An initial data analysis focused on the interview data. The 10 interviews were analyzed using thematic analysis according to [Braun and Clarke’s \(2013\)](#) description. A detailed coding of the entire data set was undertaken, and codes were sorted into candidate themes (e.g. “Conflicts among children”, “Organizational challenges”). As a next step, the survey data was added to the analysis. At this point the researchers decided to revise the candidate themes through the theoretical perspective of exposure, sensitivity and adaptive capacity, because this framework was helpful in interpreting the results. The final themes were defined through this abductive method, and have guided the division of the results below.

Table 1
Characteristics of the selected preschools.

No	No. children	Average time/ week	% staying 15 h	Vegetation share	Building	Yard
1	75 (+87)	28.8 h	36.4	Very low, mostly impervious	Suburb, 2-story detached house (Model preschool)	Flat, no trees, all facing south
2	100	31.6 h	33.3	High, most green surface.	Suburb, 2-story detached house (Model preschool)	Mostly flat, some bushes, close to large forest, facing south-west
3a	56	33.5 h	17.9	Very low, mostly impervious	Inner city, ground floor in multistory house	Contained yard with large trees
3b	100	36.8 h	9.3	Very low, mostly impervious	Inner city, ground floor in multistory house	Contained yard with few trees, facing south

5. Results

This section presents how preschool unit heads, educators, and parents experienced the 2018 heat wave, and provides results from the conducted temperature measurements. First are the results related to exposure, based on survey results, interview findings and temperature measurements. Second, findings related to sensitivity are presented, divided into children's decreased well-being and educators' decreased well-being. Third, results related to adaptive capacity are presented, according to expressed practical and mental coping measures used during the heat wave, and perceived lack of organizational strategies to manage heat.

5.1. Preschool exposure to heat waves

The surveys and interviews both suggest that preschools are significantly exposed to heat waves. In the survey, 79% of the unit heads responded that it was very hot indoors throughout the summer, cutting across preschool buildings of all types and in both the inner city, suburbs and rural areas. Moreover, rooms considered unusable due to heat were reported by 93% of the unit heads. One unit head commented:

"It was extremely hot inside and ventilation is beneath contempt in all our rooms" (Unit head, 22)

Like the unit heads, most educators also described the physical environment at the preschool, both indoors and outdoors, as inadequate and unpleasant during the heat wave. Educators explained how they were advised to seek shade outside, and to stay inside during the hottest hours. The educators, however, found this problematic since the indoor temperature was also high. The educators generally preferred outdoor activities when the school yards were shaded and breezy, but stayed indoors when they could not find shade. As both outdoor and indoor temperatures were high, they claimed that neither was a pleasant choice.

While some parents had the impression of a relatively well functioning preschool environment during the heat wave, others described their worries about their children's well-being during the preschool day. One parent had chosen to keep her children at home during the hottest days. She said:

"My husband and I change, you know, when we learn that it will be hot tomorrow, we change work schedule and make sure that one of us stays at home with them [the children]." (Parent, 5)

Statements in both the survey and the interview material also indicate the significant exposure during the heat wave. For example, several respondents reasoned about whether to establish thresholds for when to shut down preschools because of the heat. In this regard, educators and preschool unit heads refer to the limited ability to cool down the children and the educators' tough working conditions, as portrayed by the following quotes:

"We need to take a decision about thresholds. At what temperature is it too hard for us to ensure that the young children will not become dehydrated" (Unit head, 29)

"So, even if we [educators] did our very best, the children were affected by the heat, and us adults too, maybe even more than the children. In my view, you should close down when it is like this." (Preschool educator, 5)

The temperature measurements at the preschools provide a similar picture, and thus a context to, the interviews. The daily indoor and outdoor temperatures during a period of six consecutive hot days in 2019 for each of the selected preschools are displayed in the [Supplementary Material, in Fig. S1](#).

The measurements indicate that two preschools (Preschools 1–2) experienced very high indoor temperatures, whereas the two others (Preschools 3a and 3b) had slightly lower yet still high temperatures ([Supplementary Material, Table S3](#)), during the hot period. Outdoor temperatures at the preschool yards also show similar patterns. In Preschools 1 and 2, the outdoor temperatures at a shaded location where the children often play exceeded 30 °C during a majority of the day between 7 am and 5 pm, which is when most of the children attend the preschool ([Supplementary Material, Table S4](#)).

A likely explanation for the differences between preschools 1 and 2 on the one hand, and preschools 3a and 3b on the other, is that the former buildings are smaller, with large windows, and have open, less tree-covered yards. In Preschools 3a and 3b, located in larger brick buildings, heat exposure was less pronounced. The considerably longer duration of the heat wave in 2018 is likely to have caused more significant heat stress both indoors and outdoors.

In sum, the survey results, educators' and parents' accounts and the temperature measurements show that the preschools were considerably exposed to heat waves, both indoors and outdoors.

5.2. Sensitivity to heat waves in preschools

In the survey, 87% of the unit heads reported that the heat impacted the preschool significantly or very significantly, and this picture was confirmed by the interviews.

While just 3–5% of the unit heads reported severe medical conditions, both the survey and interviews establish that the heat wave led to minor health conditions and impaired the general condition of children and staff. This supports the unit heads' observations of less participation in activities (45%) and activities that had to be cancelled due to the heat (58%) as reported in the survey. The subsequent sections present experiences of how children and educators were affected by the heat wave.

5.2.1. Children's reduced well-being

Unit heads, educators, and parents described the children as dozy, lethargic and unable to participate in activities. In the free-text

responses in the survey, 39% of the unit heads noted fatigue or exhaustion in the children. Besides impairment of the children's general condition, the study identifies impacts on the children's basic needs – sleeping, eating, hydration, and comfort – and increased conflicts/aggression. It was reported that many children showed changes in sleeping patterns, where the quality of sleep lessened while the quantity of sleep increased. The unit heads and educators also observed difficulties with feeding and hydrating the children. One unit head and several educators noted that this difficulty was particularly severe for the youngest children.

Parents and educators expressed an increased need for care among the children during the heat wave, as well as worries about the preschools' ability to meet this. For example, one parent was concerned that her youngest child would not drink and eat well enough if he went to preschool during hot days. She also expressed a worry that substitute teachers would not notice the child's needs. Educators also observed that the children were crying more frequently and sought more comfort and attention than usual. The educators also described a decreased threshold of irritation among the children, and – as a result – more conflicts. One educator described her observations:

“It was a little bit upside down for the children. Some were very hot and didn't have the energy to do anything. And some days there were many conflicts. I would say that the heat had a large part in that too.” (Preschool educator, 4)

Likewise, one parent recalled the dialog with the educators when picking up her child one afternoon:

“One day they [the educators] told me that his mood had been terrible, and they thought it was the heat.” (Parent, 3)

Despite the clear sensitivity expressed above, there appear to be great differences in how various children were impacted by the heat wave. Some children were perceived as not notably affected, while others seemed to experience the heat as highly unpleasant. Further, while some parents and educators were highly concerned about the children's wellbeing, others considered the situation manageable.

5.2.2. Educators' reduced well-being

In the survey, 21% of the unit heads reported impaired general conditions and minor health impacts on the educators, including fatigue, exhaustion, headache, and dizziness. Educators themselves described how the heat wave affected their well-being both physically, depicting themselves as tired, sweaty and with difficulty breathing, and mentally, experiencing physical symptoms of stress, such as tension in neck and shoulders. Moreover, educators described a sense of worry, both for their colleagues and for the children's well-being, illustrated by the following excerpt:

“At home it doesn't really matter if I'm tired and worn out. But at work it really does matter, because we take care of children, that's my responsibility, with parents relying on me to do a good job and to take care of their children. I get very frustrated when I can't do that. [...] It was mainly the heat that took its toll and then that you had more stress and worries about colleagues and the children, because of the heat.” (Preschool educator, 1).

The heat affected the educators' ability to concentrate on the children, and to be patient with them. One of them even described her inability to focus as a safety risk for the children. The educators also reported that their ability to plan ahead was constrained, because the general condition of both children and educators varied from day to day, adding to the already stressful and unclear work situation.

In the survey, 93% of the unit heads observed that it became harder for the preschool educators to perform their duties. Some unit heads described educators as being overwhelmed by the situation, and feeling uncertain about how to manage during the heat wave, while most described their staff as doing their best to cope during the tough situation. One unit head even noted:

“I suspect that it will become harder to get educators to work during summer when it is this hot.” (Unit head, 20).

The preschool educators also experienced an increased workload during the heat wave. Some educators explained that their focus shifted towards care duties, while the teaching assignment had to be put aside. Faced with the increased need to care for the children, preschool educators put their own needs aside, thus aggravating their heat sensitivity.

The study confirms the key role of the preschool educators during heat waves. The results depict the preschool educators as caught in a vicious cycle of heat sensitivity, where the educators' wellbeing and general condition are impaired. The low energy level and the mental and cognitive impacts reduce their ability to work. Simultaneously, their workload is increased, and more tasks must be carried out with unfamiliar children and colleagues. By putting their own needs aside, the educators' general condition is further impaired.

5.3. Adaptive capacity to heat waves in preschools

The subsequent sections report on responses by the educators and unit heads to reduce the impact of the heat wave at the preschools, and on their perceived lack of organizational strategies to manage heat.

5.3.1. Practical coping measures

Both educators and unit heads described a range of practical reactive responses employed during the heat wave. Responses to meeting the children's increased need for care were seen essential. 58% of the unit heads reported cancelled activities, and 33% of them restricted work duties or changed activities at the preschool.

The educators also reported adjustments to meet children's and educators' lower energy levels, and explained that they focused more on caring than on teaching. Caring for one another among colleagues arguably increased, as the educators reminded each other to drink water and take breaks. In free-text responses, unit heads noted both the educators' creativity and decisiveness as well as indecisiveness and lack of knowledge of how to act during the heat wave.

Unit heads expressed that they tried to reduce the hot indoor temperatures. Usage of portable AC or fans was reported by 24% of the

unit heads. Attempts to acquire portable AC units and fans were reported by 45% of the unit heads, where 15% could not acquire fans because there was no such equipment available on the market. Unit heads also contacted property managers and caretakers to notify them about the high indoor temperature, and asked for more outdoor shading and improved indoor ventilation, but did not succeed.

Practical responses further relate to ensuring that the children and educators ate and drank sufficiently. Both preschool unit heads and educators reported purchases of extra food and drinks, such as watery fruits, ice cream and beverages. They also described innovative ways to encouraging children to drink, for instance by adding frozen fruit to the water.

Educators further provided water for the children to play with outdoors, and adjusted clothing to ensure they were as cool as possible while still being protected from the sun. Keeping the children in shaded areas while being outside, and staying outside only during early mornings, were also reported. One educator said:

“When part of the yard was shaded, you tried to stay at that side and, perhaps, play with water or rest and eat fruit at that side” (Preschool educator, 1)

There were, however, diverging opinions whether playing indoors or outdoors was better during the heat wave. Most preschool educators explained that they chose to stay indoors during the hottest hours of the day.

However, despite these practical coping measures employed, the well-being of the children and educators was still described as notably affected during the heat wave. This suggests that these practical reactive responses were insufficient to counteract the increased heat sensitivity. Some educators expressed frustration at not being able to help the children better. They also remarked that children missed opportunities to learn and develop when focus was shifted towards caregiving rather than teaching.

5.3.2. Mental coping measures

All educators mentioned a range of mental measures employed to cope with the stressful situation during the heat wave. Most educators mentioned how they had been determined to stay focused on their duties and on the children’s needs. One educator described this mindset:

“When working with children, you have to forget the pain you have in your body, and keep on working” (Preschool educator, 5)

Some educators described how they had decided to focus on coping one day at a time, and to push themselves to keep doing their best and to keep their ambitions low. One interviewee described acceptance as a mental strategy, while others focused on positive thinking. Several educators also described the importance of resting at home to recover.

The new and stressful situation, and working with new colleagues and children, arguably led to increased needs for compromise and cooperation. Compromise at group level was seen as necessary because of the lack of organizational routines and guidelines for heat, and to meet different opinions within the work team. One educator described her experience:

“It was hard to get together to make a joint decision. So, you had to find that middle way.” (Preschool educator, 1)

Despite the above mental coping measures, the educators still portrayed their work effort as reduced. They described themselves as tired, stressed, and unfocused. Some educators described being less involved with the children’s play, or unable to provide learning opportunities. The educators also described how they felt frustrated about not being able to do their job as well as they normally would.

5.3.3. Perceived lack of organizational strategies to manage heat

Unit heads and educators reported a lack of guidelines and routines for how to govern and organize their preschools during heat waves. They asked for guidelines applicable to all preschools in the municipality, as illustrated by one unit head:

“We must have a plan for situations like this that is applicable to all preschools in the municipality. It should not be up to each unit head to decide” (Unit head, 29).

Unit heads called for specific guidelines on how to inform parents about heat waves, what measures are taken at the preschools and how parents should respond, when and how dietary guidelines can be disregarded, when and how fans and portable AC can be allocated and located, how windows and doors should be operated, when and where children should stay outdoors, and what activities should be cancelled during a heat wave, and that heat should be taken into account when deciding which preschools should stay open during summer. Further, unit heads and educators expressed a need for a threshold for when preschools should be closed due to heat.

The educators reported how organizational deficiencies added to their stress during the heat wave. Amidst the lack of guidelines and routines, the educators themselves had to work out how to manage the situation and handle diverging opinions among themselves on how to proceed. One educator described how she managed the situation without guidelines:

Interviewer: Did you have any guidelines last summer for how to manage the heat?

Educator 5: No, we don’t have that.

Interviewer: No policy documents of how to..?

Educator 5: No. No, nothing like that. We just tried to cool them, make sure that children are wearing caps, and sunscreen, and being outside when it’s a bit cooler, that they drink. That’s what occurs to me.

Lack of guidelines put more strain on the educators’ abilities to solve problems and compromise with each other. For example, some educators note that they disagreed on when indoor activities would be preferred over outdoor activities, and vice versa, and whether or not they should let the children play with water when water usage was restricted.

The educators also observed that vacation adjustments of the preschool units added to the stressful situation. Because preschools are merged during summer, the children and educators are not always familiar with each other, although the group sizes do not differ

markedly from the rest of the year. There are also more substitute educators working during summer. This situation created a need for compromise, discussing routines and measures, and made it harder to observe if the general condition of the children or educators was affected.

Despite the lack of general guidelines, 45% of the unit heads reported informing staff about practical measures during the heat wave. Despite the increased workload, only one unit head (3%) reported increasing the number of staff, and only two (5%) unit heads asked parents for help.

6. Discussion and conclusions

This study aimed to contribute to the understanding of how the young and vulnerable people are cared for during heat waves in the institutional preschool setting. In order to identify management needs, the study demonstrates how children in preschool environments are vulnerable to heat. This exploratory study was designed to reactively assess impacts of and responses to an unanticipated event, the heat wave in Sweden in summer 2018, by surveying and interviewing preschool heads, educators and parents in one mid-sized municipality (Norrköping). This section discusses the results of the study according to the exposure, sensitivity and adaptive capacity components of vulnerability.

As regards exposure, the study demonstrates that children and educators are exposed to both high indoor and outdoor temperatures in the preschools. The survey results showed, for example, that 79% of the unit heads considered the indoor temperatures as too hot for the whole summer, and 93% of them reported that rooms at their preschool were unusable. The interviews further revealed that both educators and parents worried about the well-being of the children during the heat wave. Respondents even discussed whether to shut down some preschools during heat waves, as occurred in 2018.

The temperature measurements, conducted in 2019, provide a background to the experiences above, signaling both high indoor and outdoor temperatures at the preschools. Though the absolute temperatures measured are not very high compared to warmer countries, they exceed children's thermal comfort range (Teli et al., 2012), and are well above the five degrees above average seasonal temperature in the studied municipality. This, in combination with an anticipated higher increase in temperatures in northern latitudes due to climate change, and the fact that Swedish society is built for a cold rather than a hot climate (Thorsson et al., 2011), point to the importance of rethinking how preschools should be planned and ventilated, and how schoolyards should be designed (Lundgren Kownacki et al., 2019).

As for sensitivity, the study demonstrates that both children and educators were impacted by the heat wave in the preschools, and that their sensitivity is deeply intertwined due to their dependency relationship, rendering a form of double sensitivity to heat. This study has shown that the sensitivity of the preschool children increased directly by impacts on their well-being, affecting basic needs such as eating, hydrating, and sleeping. These impacts were expected, considering children's physiological characteristics (less effective temperature regulation and higher breathing and heart rates), and because their bodies contain less fluid (Xu et al., 2012; O'Sullivan and Chisholm, 2020). However, the children's sensitivity during heat waves is also increased indirectly by the preschool educators' reduced ability to provide care.

Like the children, the sensitivity of the preschool educators increased directly by physical impacts such as fatigue and headache, and by mental impacts including anxiety, stress and ambiguity concerning how to handle the situation. In addition, the preschool educators' sensitivity is also indirectly affected by way of the increased need to provide care for the children, which resembles what Jonsson and Lundgren (2015) found with staff in elder care. Preschool unit heads and educators face the hard decision to allow sufficient time for resting and hydration, while the children simultaneously depend more on their care.

Based on these findings, this study suggests that evaluations of children's mortality and morbidity (such as hospital admissions) after a heat wave should be complemented with evaluations of less dramatic, but likely more widespread, impacts on both children's and educators' well-being, in order to better represent the impacts of, and sensitivity to, heat waves in preschools.

Related to adaptive capacity, the study demonstrates that the preschool heads and educators were unprepared to sufficiently cope with the heat wave, and that organizational strategies and support for managing heat were insufficient. The study suggests that weak organizational readiness indicated by the absence of routines, checklists, and heat wave contingency plans limited the capacity of preschool educators and unit heads to respond to the heat wave. The importance of such organizational readiness and capacity to reduce heat stress has been emphasized in previous studies (Jonsson and Lundgren, 2015; Price et al., 2018). The lack of guidelines implies that preschool educators themselves need to overcome diverging opinions about if and how to put in place all kinds of practical measures that reduce heat stress, such as feeding, hydration, sleeping, ventilation, pedagogic activities, and timing of outdoor stays. Such decisions had to be made under very stressful circumstances, creating irritation among staff and affecting the ability to cooperate and find appropriate solutions. Pedagogic and outdoor activities were often cancelled, since focus was shifted to the increased need for care.

Nevertheless, the preschool heads and educators did apply many reactive measures to reduce heat stress during the heat wave, both practical measures for keeping the children and educators as hydrated and cool as possible, and psychological measures such as acceptance and positive thinking. However, the preschool heads and educators clearly stated that the coping strategies were insufficient, resulting in a continued stressful situation for both children and adults. The reported experiences further suggest the risk of creating a randomness and system imbalances in preschool practices, where outcomes are heavily reliant upon the performance of individual educators and their capacity to manage novel challenges, rather than agreed-upon principles and solutions. This reduced organizational performance risks increasing system vulnerability.

To sum up, the significant exposure to heat in preschool environments, the dual sensitivity of children and preschool educators, and the low organizational readiness resulting in uncoordinated responses to reduce heat stress suggest a pronounced vulnerability to heat

waves in preschools. Since Swedish society is unaccustomed to heat waves, and heat stress has not been considered in the planning, design, organization, and management of preschools, the potential for reducing vulnerability to heat waves in preschools is likely to be high. The study results point to the importance of the organizational level, because the widespread deficiencies in the preschool buildings and schoolyards will take considerable time to counteract, if this can be done at all. In the meantime, organizational routines and guidelines should be developed to specify what measures should be taken during a heat wave. Also, educational departments should give heat risk more consideration when deciding which preschools to keep open during summer, and what is considered a proper group size for children, in order to be better prepared if a heat wave would occur, increasing the need for care. Raising the preschool educators' awareness about not only practical care during heat events, but also mental strategies to cope with the heat and the ability to detect symptoms of heat stress, also appears essential in reducing heat vulnerability in preschools.

Being designed to reactively assess impacts and responses from an unanticipated event, the present study has limitations that should be kept in mind when interpreting the results. The interviews were conducted one year after the heat wave, and memories fade over time (Talarico and Rubin, 2003). This is likely to have affected the interview data primarily in two ways: (i) descriptions of the impacts and responses would be less detailed, and (ii) the experience of the heat wave would be less consistent. A range of impacts and responses were identified in the 2018 survey, which were confirmed and complemented by the interviews. Consequently, the authors suggest that this exploratory study is likely to have under-represented the impacts and how these were experienced by staff and children, rather than the opposite. Moreover, the study only examines preschools in one Swedish municipality. The survey data covers a large proportion of the preschools in the municipality, therefore can the findings regarding be considered valid there, but experiences may differ in other municipalities. Also, the interviews, intended to provide a more nuanced understanding of the actual experiences of educators and parents, were rather few, meaning that they might not capture a greater variation in experiences. Further, even if temperatures were measured during the hottest period in the summer of 2019, the heat stress in the summer of 2018 was probably more pronounced. However, the measurements can establish that preschools are exposed to heat.

The present exploratory study has opened up the issue of vulnerability and adaptation to heat waves in preschools, and there are many promising prospects for further studies. For instance, there is a need for studies of preschools in other municipalities, in order to enable generalization of the results of this study as regard exposure, impacts and responses. Studies are also needed in order to analyze the effect of increased organizational readiness on adaptive capacity during a heat wave. Since many preschool buildings have similar neighborhood and building characteristics, studies should also examine the efficiency of different physical measures to reduce outdoor and indoor heat stress in preschool environments. The combination of direct physical impacts, mental impacts and increased workloads for preschool educators suggest a highly unfavorable working condition. How this should be improved, and how to mitigate physical and mental impacts among educators, is also important to clarify.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.crm.2020.100271>.

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