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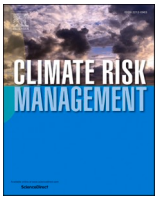

How do childcare centers cope with heat? – Findings of a mixed-method approach from three German cities

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ABSTRACT

Heat poses a crucial threat to human health, and infants and young children are considered as especially vulnerable. Therefore, staff in childcare facilities are responsible for taking actions to minimize health effects caused by heat. So far, however, little is known about the impacts of heat and how heat is dealt with in childcare facilities. To gain insights on this, we used a mixed-method approach including five semi-structured interviews, a survey (n = 51) and three workshops (n = 21) with staff from childcare centers and their overarching facilitating organizations in three mid-sized German cities. This study shows that the extent of heat exposure differs due to heterogeneous physical and structural pre-conditions, but heat-health impacts are still quite common among children as well as staff members. The staff report on various prevention and immediate adaptation measures that have already been or will be implemented indoors and outdoors in case of heat waves. Nevertheless, the study reveals that the warning and information situation needs improvement, and that heat issues need to be better institutionalized in the childcare sector in Germany in order to enhance heat adaptation.

1. Introduction

The average global temperature is observed to getting warmer. The years between 2015 and 2021 were the warmest seven years on record (WMO 2022). At the same time, heat waves seem to become more frequent (Masson-Delmotte et al., 2021). Germany has generally a temperate climate but has experienced outstanding hot summers, e.g. in 2003, 2006, 2015, 2018, 2019 and 2022, with record temperatures of up to 41.2 °C in July 2019.

Heat poses a crucial threat to human health and has effects on morbidity and mortality – evidenced also in Germany (an der Heiden et al., 2020; Karlsson and Ziebarth, 2018). Among other groups, infants and young children are particularly vulnerable to heat. Although there is not yet sufficient literature to produce robust findings, some research shows that child mortality rates, various morbidities and emergency department visits within this group increase during and shortly after heatwaves (Campbell et al., 2018; Fuller et al., 2022; WHO, 2021; Helldén et al., 2021; Iñiguez et al., 2016; Basu and Ostro, 2008; Bernstein et al., 2022; Sheffield et al., 2018). A higher vulnerability among infants and young children is caused inter alia by a physiologically lower ability to regulate body temperature and their greater body surface in relation to their volume. Furthermore, children behave differently and tend to show a higher activity level (Heidenreich et al. 2021). They are less able to express heat-related discomfort and cannot implement heat adaptation measures on their own but depend on the actions of their caregivers (Helldén et al., 2021; Zivin and Shrader, 2016; WHO, 2021).

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Therefore, parents and staff members of childcare facilities – where, in many countries, young children spend several hours each working day – need to take special care during hot days. Thus, the literature and some heat action plans demand that stakeholders such as childcare centers and educators to be targeted by information campaigns and heat warnings, to develop heat measurement plans and/or to introduce preventive and immediate adaptation measures (Knowlton et al., 2009; UBA and RKI, 2013; WHO, 2021; Zivin and Shrader, 2016; Blättner et al., 2021). However, the question of whether and to what extent this actually occurs remains largely unanswered, as Malmquist et al. (2021) note that "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." Insights, so far, often focus on thermal comfort and show that children in care facilities feel (slightly) warmer and thus prefer cooler temperatures compared to adults (Yun et al., 2014; Nam et al., 2015; Fabbri, 2013; Lamberti et al., 2021). Furthermore, air conditioning in childcare centers was studied e.g. during heat periods concluding that air conditioning needs to be more child-adjusted instead of being aligned to the thermal comfort of the educators (Yuan and Ryu, 2022). Furthermore, Yuan and Ryu (2022) reason that with air conditioning more attention needs to be paid to uneven temperature distributions indoors due to solar radiation at windows, density of children e.g. while playing or cold air breeze from the air conditioning.

In the literature, both buildings and outdoor areas of childcare facilities were found to need enhancements, such as more greenery and shading to prevent heat related health risks (Antoniadis, Katsoulas, and Papanastasiou, 2020; Bäcklin et al., 2021; ThINK, 2017). Evidence from Sweden for facilities without air conditioning suggests a high heat exposure. This causes frequent health impacts among children and educators and the challenge of carrying out pedagogical activities during heat, along with a lack of a coordinated response (Bäcklin et al., 2021; Malmquist et al., 2021). Furthermore, a "double sensitivity" affects children in the childcare setting, as the educators are also suffering from the heat and the state of their health and ability to work indirectly influences the children as well (Malmquist et al., 2021). In summary, there is an urgent need for more knowledge in order to better generalize findings on heat-health effects and management in childcare facilities (Malmquist et al., 2021), e.g. using a quantitative survey approach (Bäcklin et al., 2021) to ultimately enhance the protection of this vulnerable group. This need is in line with a general call by Peek et al. (2017) for more research on organizations and institutions such as childcare centers instead of just focusing on an individual level in relation to children's education and disasters.

To gain insight into this research gap, we collected qualitative and quantitative data on heat impacts, prevention and responses in childcare centers in three mid-sized German cities. This study aims to answer the following questions: 1) How is heat experienced in the investigated childcare centers, and which heat-health impacts are reported? 2) What actions are taken in case of a heat wave? 3) How well are childcare centers prepared in terms of non-structural measures, such as developing heat action plans or informing staff members, and structural measures, such as insulating the building or using shade-sails? In order to answer these questions, we used a mixed-method approach, which included semi-structured interviews, a survey and workshops and aggregated data from three municipalities. The data is presented jointly for all three cities without a comparison between them.

2. Background on childcare in Germany

In Germany, there has been a legal right to attend daycare – regardless of the working situation of the parents – for children at least three years old since 1996 and for children one to three years old since 2013. The childcare centers are mostly either public (run by the municipality) or run by welfare or church-related organizations, while comparably few private institutions exist (Hillmert, 2007). In 2021, about 34 % of all children at the age of one to three years attended daycare and about 92 % of children aged three years up to school age. The need for childcare is much higher than availability in many localities (BMFSFJ, 2022) and there is a huge need for qualified staff, which is already hampering good pedagogical quality in childcare (Bock-Famulla et al., 2021; Klusemann et al., 2020). The costs of daycare differ greatly depending on federal state rules.

During summer, most childcare centers close for a few days up to a few weeks. Whether and how alternative care is organized differs profoundly between the facilitating organizations. Fixed alternatives are not as institutionalized as, e.g., in Sweden (Malmquist et al., 2021). The buildings, indoor and outdoor areas are very diverse (ThINK, 2017). Furthermore, air conditioning is uncommon in German childcare centers (or in residential apartments) (O'Sullivan and Chisholm, 2020). Thus, the exposure to heat can vary depending on physical pre-conditions. Besides this, written rules on how to prevent and manage heat in childcare settings do not exist, and only recently have information brochures been developed (e.g. JUH, 2020; BildungsCent e.V., 2022; LUA, 2020; see for a longer list of materials: Otto et al., 2023), although distribution of those among facilities is unclear. Recommendations for the development of local heat action plans consider informing childcare facilities about heat prevention and immediate adaptation, as well as warning them in the case of heat waves (Blättner et al., 2021; GAK, 2017), but up to now there are only very few urban heat action plans in place in Germany (Kaiser et al., 2021b; Mücke and Litvinovitch, 2020). Exchange between cities and childcare centers on heat topics was reported to be scarce in a workshop with municipal representatives (Otto, Ullrich, and Thieken, 2021).

3. Methods

3.1. Study areas

This investigation focuses on the accumulation of data from three medium-sized cities – Potsdam, Remscheid and Würzburg, whereas single results for each city are not described and compared. Despite the (slightly) different climatic conditions, differences between cities appeared too marginal to justify a comparative approach. These three cities were chosen for conceptual reasons, as they are located in different federal states (see Fig. 1) and are part of different climate area types, with Potsdam and Würzburg in drier

No.	City	Federal state	Inhabitants[1]	Heat warnings[2] 2005–2022 per yr
1	Potsdam	Brandenburg	183,154	10.1
2	Remscheid	North Rhine-Westphalia	111,770	7.8
3	Würzburg	Bavaria	126,993	12.2

[1] *Federal Statistical Office (numbers from 2021)*
[2] *German Weather Service – DWD (2022); definition of a heat warning: perceived temperature above about 32 degrees Celsius on two days in a row, additionally only slight cooling at night*

Fig. 1. Information on the three cities in focus.

climates and Remscheid in a low mountain climate (UBA, 2021). Nevertheless, all three cities experienced heat waves in the past years (s. Fig. 1), whereas Würzburg is especially affected by heat due to its location in a basin. All three municipalities are expected to experience warmer temperatures in the near future (UBA, 2021). There were practical considerations as well, as there existed a project partnership with these cities on adaptation issues.

At the time of this research (2019–2021), all three cities had already implemented heat-related measures, such as urban planning measures or the development and distribution of information material for the general population on how to cope with heat. Besides this, various heat-related measures are mentioned in their climate adaptation plans in which children are identified as a vulnerable group. However, among the listed measures, only in Potsdam's adaptation plan are childcare centers targeted explicitly in one heat-related measure. As in most German cities (Mücke and Litvinovitch, 2020), specific urban heat action plans had not yet been established by the time of the investigation. However, Würzburg published one in mid-2023, and Potsdam and Remscheid plan to establish one in the next few years.

3.2. *Mixed-method approach: interviews, survey and workshop discussions*

Mixed-method approaches can combine the advantages of generating more generalized findings with quantitative data and achieving a more detailed understanding from qualitative data (Creswell, 2015). In order to investigate heat prevention, as well as heat impacts and responses among childcare facilities, we triangulated three methods: 1) explorative semi-structured interviews, 2) a survey with a structured questionnaire and 3) workshop discussions (see Table 1). The semi-structured interviews were conducted to deliver initial insights into the topic and an overview of which aspects are relevant. For example, it was of interest if heat is a problem at all, if it is relevant indoors and outdoors, if any (and if yes, which kind of) adaptation measures were already implemented and what barriers exist (see Supplementary Material 1). The survey was aimed at collecting extended information on the issues raised in the interviews in a structured way from numerous institutions to derive tentative generalizations on coping with heat in childcare institutions (see Supplementary Material 2). Finally, workshops were conducted with representatives from childcare centers and facilitating organizations to discuss specific issues that were not clear from the data in more detail (see Supplementary Material 3). During the workshops, broad and complex issues such as experiences with heat stress, already implemented or possible actions and related problems could be raised and underlying issues could be better understood. As an advantage of conducting further individual interviews, the chosen group-setting dynamic revealed immediately topics with controversial opinions (e.g. heat action plans) or experiences (e.g. attention to employees' own well-being during heat) and allowed to follow-up on these issues with further questions.

In the summer of 2019, explorative semi-structured interviews were conducted in each of the three cities. In total, three interviews with five staff members of childcare centers and one facilitator responsible for several centers were interviewed using a guideline (see Table 1; Supplementary Material 1). There was already contact to the childcare centers and facilitating organization that were interviewed due to organizational affiliation to the Johanniter-Unfall-Hilfe e.V. or the municipality. In one case, a facilitating organization was asked for an interview which then invited further representatives of their childcare centers, leading to a group interview with four people. Regarding heat, the interviews covered the following topics: experiences with emergency situations, existence of heat plans, experiences with heat waves, structural heat prevention measures, coping with heat, and support from the city, as well as general characteristics of the facility (building, number of children, etc.). Two interviews were recorded and afterwards transcribed, in one case notes were taken during the interview (see Table 1). We applied a qualitative content analysis (Flick, 2014; Mayring, 2003). Relevant parts of the interview transcripts were paraphrased and sorted according to the questions and main issues within the responses. The information derived in this way from two interviews and the notes from one interview were brought together and further condensed. Based on this, the information was analyzed to answer the research questions.

From October to November 2019, a survey was conducted in the three cities. Previously, the contact details of all childcare facilities were researched (as well as further institutions as mentioned in Table 1). The questionnaire and accompanying information were sent directly by mail to all 220 researched childcare facilities on September 30th, 2019, and were followed by a reminder four weeks later. In November 2019 non-responding facilities were called and given the opportunity to take part via phone. Thus, the questionnaire could be answered via mail, online or by telephone. The questionnaire contained inter alia questions about heat risk awareness, heat warnings and heat experiences, various adaptation measures within the institution, the city's heat management and adaptation, measures taken during a heat wave, the building and outdoor area, the number of children cared for and the number of staff members, as well as the respondent's demographic characteristics (see Supplementary Material 2 for more details). In total, we received 51 completed questionnaires from the 220 childcare facilities contacted (23.2 % response rate). Descriptive analyses were conducted using IBM Statistical Product and Service Solutions (SPSS), version 28.0.0.1. In all three cities, workshops were held with staff from childcare and eldercare establishments and their overarching facilitating organizations. All researched facilities in 2019 were invited

Table 1
Overview of the three methods employed in the study.

	Explorative semi-structured interviews	Survey	Workshops with group discussions
Topic(s)	Heat and pluvial flooding	Heat	Heat antd pluvial flooding
Aim(s)	Initial insights, gaining an overview	Data collection in order to derive tentative generalizations on heat experiences and coping in childcare centers	Discuss and understand specific issues in their complexity and diversity; awareness raising, evaluation of a leaflet, exchange between institutions
Selection of participants in childcare institutions	Selection of easily accessible childcare centers and facilitating organization	Research of as many childcare centers as possible in 3 cities and contact all of them	Research of as many childcare centers as possible in 3 cities and contact all of them
Number of participants in childcare institutions	5 representatives of childcare centers, 1 from a facilitating organization	220 childcare facilities contacted 51 responses (23.2 % response rate)	21 people from childcare centers or facilitating organizations
Number of participants from childcare institutions in each city	Number of interviews: Potsdam: 1 Remscheid: 1 group interview with 4 representatives Würzburg: 1	Potsdam: 24 of 94 contacted facilities (25.5 % response rate) Remscheid: 10 of 60 contacted facilities (16.6 % response rate) Würzburg: 17 of 66 contacted facilities (25.8 % response rate)	Potsdam: 4 Remscheid: 6 Würzburg: 11
Target groups next to childcare institutions[1]	Elderly care, hospitals	General practitioners, paediatricians, pharmacies, retirement homes, services for treatment at home	Elderly care
Implementation	Face-to-face; Recorded: 2 interviews Notes taken: 1 interview	Online, via mail, via telephone	In presence: in Remscheid (notes taken) Online: in Potsdam and Würzburg due to the Covid-19 pandemic (recorded)
Time	July – August 2019	October – November 2019	2020 (Remscheid) and 2021 (Potsdam and Würzburg)
Responsible for conducting the method	Johanniter-Unfall-Hilfe e.V. (a humanitarian organization: St. John Accident Assistance) in exchange with the University of Potsdam	University of Potsdam	Johanniter-Unfall-Hilfe e.V. (a humanitarian organization: St. John Accident Assistance) with support from the University of Potsdam
Analysis	Qualitative content analysis of transcribed interviews or notes	Descriptive analyses with SPSS	Qualitative content analysis of partly transcribed workshops and notes
Responsible for analyses in regard to this article	One of the authors; University of Potsdam	One of the authors; University of Potsdam	One of the authors; University of Potsdam
Supplementary material	1	2	3

[1]In this article, we focus on childcare centers to keep the article information and structure concise, and since we received the most information from this group (e.g., we received only 14 survey answers from eldercare facilities and in the workshops two-thirds of the participants represented childcare institutions).

to the workshops. While the workshop in Remscheid could be conducted face-to-face in 2020, the workshops in Potsdam and Würzburg had to be organized in a digital format due to Covid-19 restrictions. In total, 31 individuals took part, with two-thirds of them representing childcare institutions. As in the interviews and survey, descriptions of each facility's size, building type and outdoor area were very diverse. Each workshop took about two hours and followed a similar agenda, including an overview of the related research project and activities on climate adaptation in the specific city, a dialog about experiences with heat in the participating institutions and a discussion to evaluate information leaflets developed in the project for social care institutions on how to cope with heat (see Supplementary Material 3). The workshops in Remscheid and Potsdam tackled pluvial rain in addition to heat. The two online workshops (in Würzburg and Potsdam) were recorded and the main points transcribed afterwards. Notes were taken during the face-to-face workshop. The workshop documents were analyzed applying a qualitative content analysis (Flick, 2014; Mayring, 2003) comparable to the analysis of the interviews. Special attention was paid to consent and dissent in regard to reported experiences, perceptions or opinions.

3.3. Description of the participating people and facilities

The five childcare centers we interviewed care for 53 to 90 children, aged two years and older. They are partly public and partly run by welfare organizations. The buildings differ, including container constructions, newly redeveloped and insulated buildings and one building listed as a heritage site. The descriptions of the outdoor areas are likewise very diverse. In three childcare centers, the interviewees reported little green space or shade. In the other two facilities trees and shade-sails provided shade.

The staff members of the childcare centers taking part in the survey are characterized as follows: Most of the respondents are female (88.2 %) and all have worked for at least five years – 56.9 % even more than 20 years – in the social sector. The facilities show a wide range of sizes, the largest with a capacity for 240 children. About half of the childcare centers or their facilitators own the buildings, the

other half rent them. 56.9 % use a complete building, 23.6 % use only parts of a building and 15.7 % make use of multiple buildings. The buildings differ profoundly in terms of their age and renovation status. All 51 facilities have some sort of outdoor space (80.4 % garden, 37.1 % courtyard, 21.6 % terrace and 15.7 % balcony).

About 20 heads of childcare centers and representatives of facilitating organizations took part in the workshops, being responsible in some cases for up to 25 centers with very diverse conditions regarding outdoor and indoor areas. Municipally run centers as well as facilities run by churches and welfare organizations took part in the workshops.

4. Findings: Heat experiences, prevention and adaptation in childcare facilities

In the following, the results of all three methods conducted in three municipalities are shown in detail in an integrated manner covering the topics heat experiences and impacts, heat prevention and immediate heat actions.

4.1. Heat experiences and impacts

In the interviews, workshops and survey, the childcare staff reported various heat experiences in the last couple of years. The situation is very diverse, with some centers being particularly exposed to heat. One interviewee referred to very high temperatures indoors during a heat wave in 2019, which saw record-breaking temperatures in Germany. There were days with 28 °C indoors in the morning and 32 to 34 °C at noon, which the respondent described as unbearable even though cooling measures were taken. Another

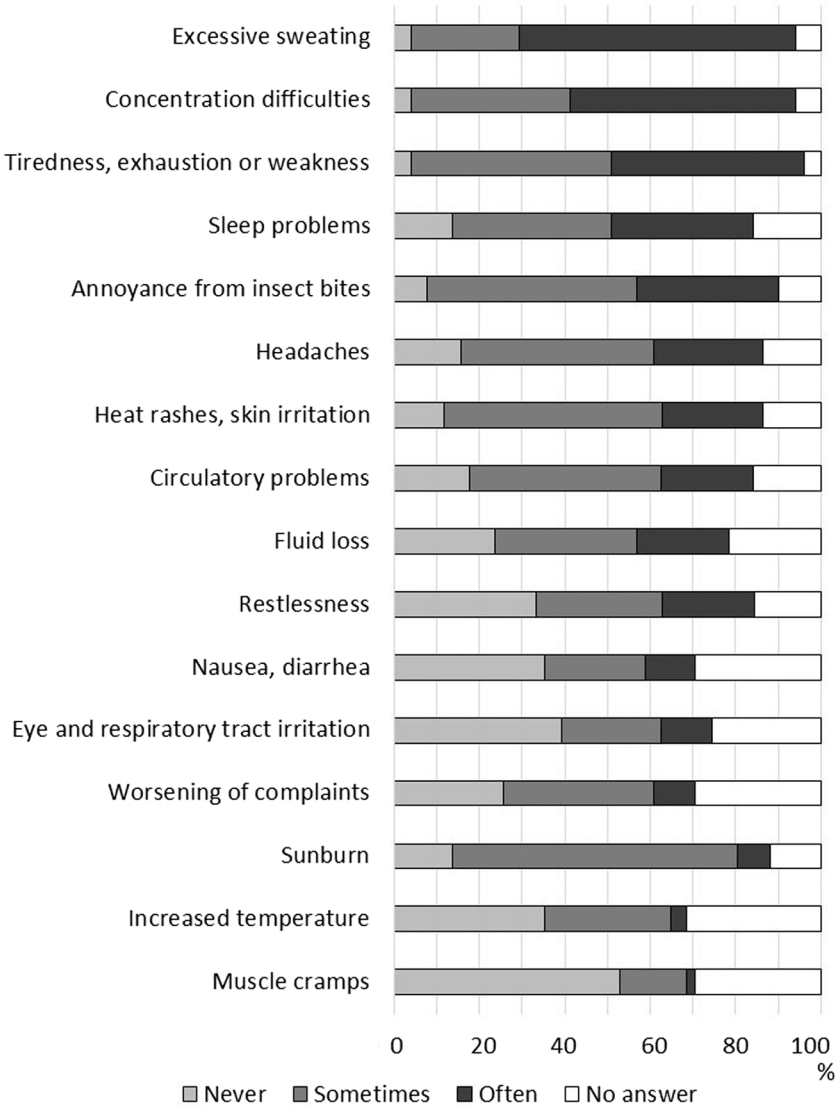

Fig. 2. Health impacts on children (survey data, n = 51).

person even reported in a workshop being exposed to 40 °C in a facility with 100 children. In contrast, few facilities were quite cool, e.g. due to shutters on windows, and describe their experiences as positive during hot days.

Out of 51 people who took part in the survey, more than 60.8 % experience their workplace as (very) burdensome during hot days and a further 19.6 % perceive their workplace as rather burdensomely hot. Only 3.9 % say their workplace is pleasant and cool. Thus, heat is seen as challenging in the majority of cases and only in a few childcare centers does it not cause any heat stress.

There are several consequences of heat described by the childcare workers. In the survey, almost all people say that they themselves or colleagues sometimes or often feel more stressed while working on hot days (often: 47.1 %; sometimes: 43.1 %). This was further illustrated in the workshops: The staff needs to be even more cautious about the well-being of the children and – next to their normal tasks – take cooling measures. Furthermore, worries about e.g. heat impacts were said to add to the stress level. The workshop participants are aware that their personal mood and health condition also affect the children. Some educators are unsatisfied with their work because they expect themselves to do pedagogical work in addition to care tasks, which is difficult especially during heat waves.

In the interviews and workshops, the participants reported on health impacts for the staff members such as circularity problems, headaches and dizziness, while the children were reported to generally not show health impacts. However, the participants might have instead thought of heat-related emergencies, because these were introduced and discussed at the beginning of the workshop. One later statement during a workshop reveals this:

> "I have to admit that we did not have any negative experiences. We luckily never had to call an ambulance. But of course the children change during the heat and we always worry and make preparations to prevent this [negative health impact] as much as possible.".

Asked directly which health consequences appeared among children, given a list of 16 possible impacts in the questionnaire, several impacts were mentioned as appearing often (for details, see Fig. 2). Another impact mentioned in the workshops was that education of the children was no longer possible in some facilities due to the high indoor temperatures.

4.2. *Heat prevention – measures taken in preparation for heat periods.*

Heat prevention can contain non-structural measures, such as drafting an action plan or informing oneself about adapted/suitable behavior, as well as structural measures, such as improving green spaces or putting up blinds. In total, according to the survey data, actual prevention actions seem to need enhancement, as 35.3 % disagree (completely) that they are optimally prepared for the next heat wave, while fewer than 20 % agree (completely) with this statement. These results coincide with the impression from the workshops, in which the participants reported that they were already doing a lot but that there were still various measures that could be taken.

4.2.1. *Organizational and informational measures*

With regard to a heat action plan, the interviews, workshops and survey show the consistent result that formalized plans exist only in rare cases. Out of the 51 survey respondents, just seven (13.7 %) reported having such a plan. During the workshops, the challenges to developing heat action plans and keeping them up to date given limited time resources was a subject of discussion. Asked in an open-ended survey question from whom they would like to get support in developing such a plan, the respondents mostly named different departments of their city administration as well as their facilitating organizations. During the workshops, the suitability of heat action plans was assessed differently. While some thought a plan would be helpful in order to have clear and reliable agreements and information for new team members, others perceived heat measures as common sense and considered a written record as unnecessary or hindering flexible reactions to certain situations. One workshop participant explained:

> "I'm a bit ambivalent about having a written plan. It is important that one talks about it in the team and that everybody knows what has to be done and what the possibilities are. But I am hesitant to write it down because then there is the temptation to stick to it […] but there are days in which it is already hot in the morning and you need to react differently from days when it is still cool in the morning or there are days in which the children like to splash around or there are days when they just sit in the sand pit. Thus, there is a strong sensitivity necessary in the care of children and I think it is important that the staff have the ability to act, that they observe and that they react fast if they feel uneasy about anything […].".

Next to developing a heat action plan, informing oneself and the team members is one important non-structural measure that can be taken. The frequency with which heat adaptation measures are discussed differs among the facilities. In some childcare centers, adapted behavior is discussed independent of an actual event, e.g. at the beginning of summer or even more often as team members fluctuate, but in most facilities, it is a reactive rather than proactive measure as it only becomes an issue if a period of hot days is forecasted.

4.2.2. *Structural measures*

The results of all three methods show that in almost all facilities structural measures have already been taken. Survey data show that the centers have already implemented 2 to 4 of the structural measures listed in Fig. 3. Popular measures include sun protection on windows and greenery of the outdoor area, while air conditioning was not used by any person/institution that answered the survey (for details, see Fig. 3). During the workshops, just one facility worker mentioned that air conditioning was provided, albeit only in the

kitchen.

During the interviews and workshops, measures to be taken in the outdoor areas were discussed intensely. Shade-sails were mentioned as a very popular measure to provide shade for the short term. However, they were also reported as having several disadvantages, such as being expensive if professionally installed, inconvenient if put up as a mobile measure, shading but not cooling in contrast to trees, and easily broken. In some cases, temporary appliances such as tarpaulins were used due to financial restrictions. Possibilities for water play were mentioned by some of the interviewees and workshop participants, although these need to be constructed in such a way as to prevent any dangers to children playing with them. According to the survey data, childcare providers that own the rooms or buildings tend to implement more structural measures: on average, these facilities (n = 28) report 3.9 implemented measures compared to 3.0 measures implemented by providers renting their locations (n = 23). In particular, providers that own the space more often install fans and heat-insulating glazing or protective glass films and obtain greenery for their roof or facades.

4.2.3. Challenges to taking prevention measures

Whereas the survey respondents perceive prevention as important, as almost 85 % would recommend other facilities to prepare for heat, this is not always easy to carry out. As shown in Section 4.3, missing information, e.g. on temperature thresholds, is a common challenge in implementing non-structural measures. There seems to be no organized information campaign targeting childcare institutions in the three investigated cities, as no respondent completely agrees and only 7.9 % (somewhat) agree with the statement

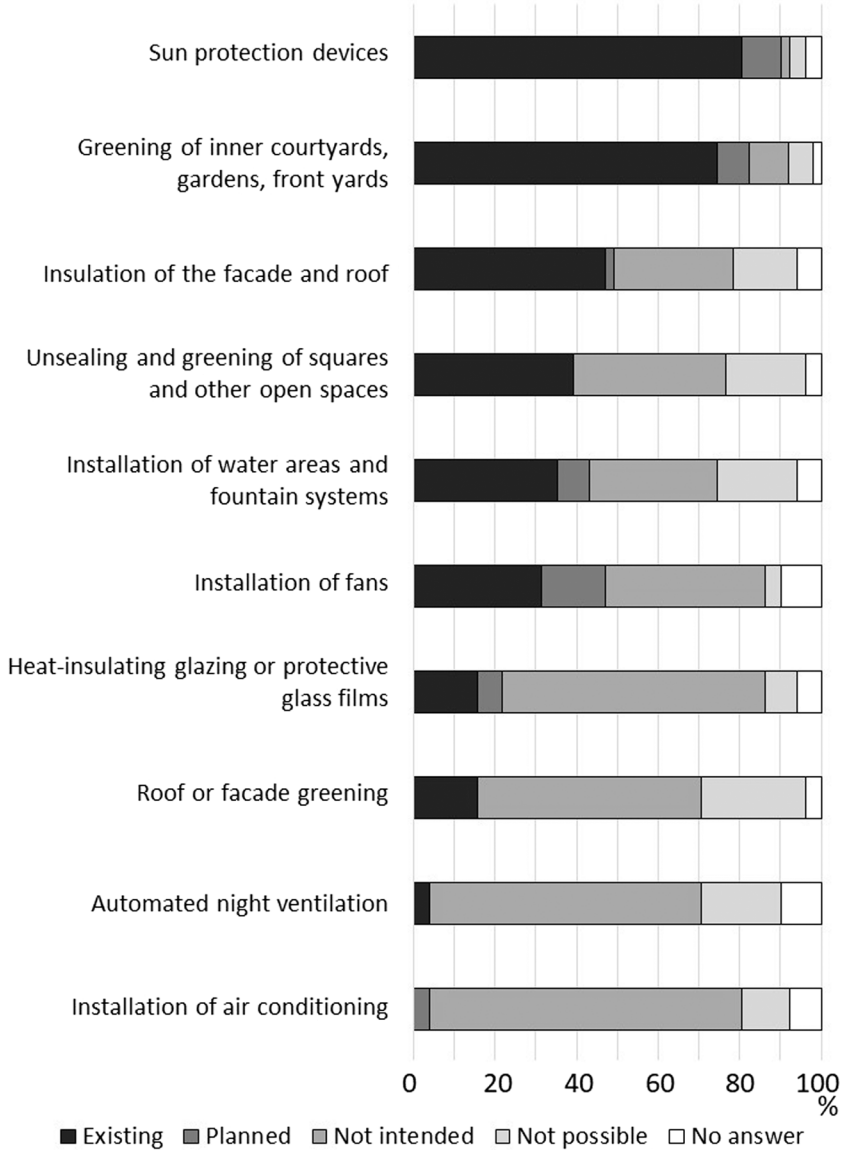

Fig. 3. Overview of structural measures already existing and planned or not intended or not possible (survey data, n = 51).

"The city in which I work informs us very well on heat threats and possible prevention measures." Furthermore, information from other sources seems to be scarce. More than two-thirds agree somewhat or completely that there are, in general, insufficient information and advice on heat prevention. During the workshops the lack of information came up repeatedly.

In the case of structural measures, people actually working in the centers often have to convince their facilitator of their need for heat prevention, because financial resources are very scarce. Thus, they report that financing structural measures as well as the competence to plan and supervise structural changes are challenging for them. In the survey, 45.1 % of all respondents agree (completely) that structural measures are too expensive. Often, these measures are only implemented during general building renovations. This situation was criticized during the workshops; one participant states:

> "It really requires investing money to renovate our buildings for us to end up well on hot days. […] Our buildings are constructed differently, with different priorities and a whole new view is needed for our older buildings to transform […]. We do everything to our breaking point but we really need another budget to be seen as essential […].".

In newly constructed buildings, heat prevention is sometimes implemented from the very beginning, e.g. with rooftop greenery. However, a systematic consideration of heat prevention during the planning and construction of new childcare buildings and outdoor areas has not been in place in the investigated cities up to now, as one of the workshop participants reports:

> "I remember an example. We constructed a new childcare facility together with the municipal real estate service and now we realized this summer – and this summer was not very hot – that they cannot go outside because there is no sun protection planned. […] In fact, sun protection is partially not considered in the plans when we rent a place and then we stand there and can't believe, that this is possible. Then we, of course, (…) finance the sun protection later, but it is not seen as a basic component of a childcare facility building during planning.".

Despite the current impairment from heat (see Section 4.1) and the broad agreement among the survey participants that the number of heat waves will increase (just 9.8 % do not agree and 17.6 % do not know), the priority given to heat considerations is rated very heterogeneously compared to other pressing issues in childcare facilities. Considering the statement "Heat is just one problem among others and just not a priority in our work," about one quarter of respondents agree (completely), one quarter agree somewhat, one quarter rather does not agree and one quarter does not agree (at all). This underlines that the implementation of heat prevention competes with other urgent matters.

4.3. Heat adaptation – immediate measures taken in the event of heat (periods)

4.3.1. Immediate adaptation measures taken

To act in a heat-adapted manner, it is important to know that it will be hot in the first place. Thus, heat-health warnings are published by the German Weather Forecast in Germany (Matzarakis, Laschewski, and Muthers, 2020) in case the perceived temperature is expected to be at least 32 °C with little cooling down at night (Heidenreich and Thieken, 2024). The survey asked whether the respondents had received heat warnings in 2018 or 2019. Approximately two-thirds indicated that they had received heat warnings, 23.9 % did not get any and 11.8 % did not know. In most cases, the educators received the warnings from their weather apps or through traditional media such as radio and TV; in a few cases, the facilitating organizations informed them. However, 84.4 % of survey respondents would appreciate a more direct form of warning, e.g. via e-mail (49 %), phone (15.7 %) or push-message (9.2 %) or in some other way (31.4 %). Besides knowing whether a heat wave is approaching, it is crucial to know how to cope with heat. However, only a quarter of all survey respondents feel (very) well informed about how to cope with heat in their institutions.

In the interviews and workshops, it was mentioned that the first heat wave of a year is quite stressful, while later in summer and during longer heat periods the staff are more experienced and thus more able to adapt to heat. In some childcare centers, team meetings are used to discuss immediate adaptation measures. The educators pay attention to children's clothes and also try to raise parents' awareness through conversations when children are dropped off or picked up, and by using printed information such as posters. Furthermore, cooling options like playing with water are often mentioned. Despite a lack of general diet instructions for children during periods of heat, the provided food is adapted by offering more cool and hydrating options. However, this is not always possible due to contracts with caterers or longer fixed purchasing lists. More water is offered, and in some childcare centers there are scheduled drink breaks during playtime. Further behavior brought up during the interviews and workshops included e.g. adapting the daily routine and staying inside or outside at specific times of day depending on what is more pleasant. Day trips tend to be cancelled during hot days.

Measures taken for indoor areas include airing the facility during cooler hours, closing window blinds and turning on fans. Another reported behavior is staying in cooler rooms such as a cellar, but cooler rooms are not always available or might not be big enough for all the children. Despite many actions taken, indoor areas seem to be even harder to adjust to heat conditions than outdoor areas, as one person from a facilitating institution responsible for many childcare centers reports during a workshop: "We often get the feedback from childcare management staff or teachers that there is still a very big need for adaptation measures indoors. The indoor areas are more problematic than the outdoor areas." Popular measures outside are to provide opportunities for shade and water play, although even small pools are sometimes not allowed due to drowning dangers or hygienic requirements. Paying attention to UV protection with sunscreen and hats is seen as important.

4.3.2. Challenges to taking immediate adaptation measures

The findings underline that many adaptive behaviors are implemented in the case of heat. Nevertheless, some childcare centers

have such an unfavorable building construction and outdoor area in terms of heat that they are thinking about closing the facility or reducing the opening hours because health threats to children and staff are likely. This itself is problematic, however, as there are no fixed temperature thresholds established and signed childcare contracts exist. Closing the facility for a few hours and monitoring the temperature frequently were mentioned as possible ways to pressure the facilitating organization to implement structural prevention measures.

The above-described heat-health impacts on staff members paired with the high work load limit the implementation of adaptation measures. Some staff members mentioned that carrying water to play with outside is a physically demanding task which is performed while being responsible for several children at the same time. Also, the staff members seem to sometimes forget or suppress their own needs due to their work load and aim just to care for the children. In an extreme case, one workshop participant reported just not having the time and personnel to take sufficient drink and bathroom breaks, which would be necessary during hot days.

> "If we feel good, the children feel fine. Then we can respond well to their needs. In summer it is like I am sometimes alone. I can drink something like half an hour before my break [starts] and then I can use the bathroom during my break, because during the [rest of my working] day I cannot use the bathroom. This is not possible. I cannot drink then. And the priority for me is simply the child.".

The cooperation with parents is seen as another challenge for taking immediate adaptation measures. Some interviewees and workshop participants reported that they need to consistently remind parents about light clothing and sun hats. In rare cases, heat adaptation is a topic discussed at the admission meeting, and one facility established the rule that there must be sun hats that must be kept in the center.

5. Discussion and conclusion

In this article, we present results on coping with heat in childcare institutions in three German cities based on interviews, a survey and three workshops. The mix of these three methods enables us to complement our findings and adds profound knowledge to this as yet underexplored topic. For a setting without the wide use of air conditioning, it is shown that heat exposure in childcare centers differs profoundly in its extent due to diverse pre-conditions, e.g. the building structure and the design of outdoor areas. Nevertheless, almost all respondents report diverse heat-health impacts among children as well as staff members and many report uncomfortably hot conditions. The health impairments for children mentioned most often are in line with other results from literature (Bäcklin et al., 2021; Malmquist et al., 2021) and include concentration difficulties, fatigue and sleep problems among children, whereas the most often mentioned health impact in this study, "excessive sweating," was not mentioned in the other studies because this might not be seen as a health impairment.

Like in other empirical studies, our study shows several limitations. One weakness results from the fact that one interview and one workshop were not recorded but notes were taken. Consequently, the issues raised during the interview and workshop for which only notes exist might be less present in the analyses and results. This applies especially to the interview since the person analysing the interviews for this paper was not present when they were conducted. Next to this, there might be a bias regarding the institutions participating in the interviews, survey and/or workshops, because especially people who have suffered from heat might be interested in taking part. Thus, our results could overemphasize heat stress in childcare institutions leaving out experiences of centers which have optimal structural pre-conditions and are already well prepared. Also, people which do not attribute importance to heat as a topic in childcare are not present in this study. To respond to this, questions about heat management could be included in more general empirical investigations, such as surveys targeting childcare facilities. A further promising empirical approach includes observations during heat days (following ethical standards), because with this method heat-health impacts and less visible and even subconscious activities minimizing health risks could be captured.

The "double sensitivity" described by Malmquist (2021), meaning that children are affected directly by high temperatures and also indirectly by heat-impaired personnel, can be confirmed in this study. Staff members feel more stressed during heat waves. They all implement diverse cooling measures indoors and outdoors to improve the well-being of the children on hot days. This is performed in addition to their usually high work load while sometimes ignoring their own needs. Therefore, it is crucial that every heat management plan in childcare centers focus on measures to ensure the well-being of not only children but also staff members. However, the problem of staff shortages in the German childcare sector (Klusemann et al., 2020) limits the scope of considering heat adaptation in general and in particular heat-minimizing actions aimed at personnel, such as enabling more breaks and cooling options.

In all facilities prevention and immediate adaptation measures are reported to have been taken. However, the self-assessed level of information and preparation and the access to information was found to be rather low. In line with findings from Sweden (Malmquist et al., 2021), our study reveals a lack of child-specific heat guidelines, thresholds e.g. for closing the institution, and heat-related contingency plans. The development of such plans for care facilities is seen as an important preparation for appropriately coping with heat (Malmquist et al., 2021, Zivin and Shrader, 2016). However, during the workshops it was also asked whether facilities could spare the time to develop and pursue such a plan, and the concern was discussed whether written plans tend to be too restrictive. Further inter- and transdisciplinary research and exchange on guidelines, thresholds and heat wave action plans seems necessary, as well as on how the actions of parents and children can be (better) integrated to minimize heat-health impacts. Furthermore, information on heat actions could become part of the general training program for childcare workers (UBA and RKI, 2013). Already existing information materials and educational offerings (e.g. JUH, 2020; BildungsCent e.V., 2022; LUA, 2020) need to be evaluated, updated on a regular basis, made available over the long term, and better promoted nationwide.

Considering the above-described impairments from heat, it is alarming that based on the survey data the knowledge of warnings is quite low at just 64.7 %. To improve this awareness, designating individuals in the facility responsible for subscribing to such warnings (e.g. as part of a heat action plan) could be one option. Besides this, informing and warning care institutions is often seen as part of municipal heat action plans (Blättner et al., 2021; GAK, 2017), whose importance for childcare centers is emphasized in this study. There are hardly any cities that have already published such a plan in Germany, although the current development is very dynamic, with more plans expected to be published in the next few years (Kaiser et al., 2021a,b; Mücke and Litvinovitch, 2020). Future research could analyse whether and how the information and warning for (child)care institutions is acknowledged in the developed municipal plans and actually implemented, keeping in mind that heat management is a new topic for many municipalities and does not fit into common departmental divisions.

Further ways of institutionalizing heat management could include obligatory consideration of heat prevention measures when constructing and renovating buildings and outdoor areas for children's use, or by considering heat issues during routine health and safety inspections of facilities to identify potential measures to be taken. The development of a standard approach to assess heat exposure and its consequences indoors and outdoors – drawing on current work in schools and childcare centers (Antoniadis et al., 2020; ThINK, 2017) – could be helpful e.g. to prioritize facilities for implementing costly measures. Next to this, establishing or expanding financial support for implementing measures is crucial, as was underlined by this study and by the high number of applications for the national funding program "Climate adaptation for social institutions" (BMUV, 2022). This program started in 2020 with a focus on hospitals, eldercare and childcare institutions was initially limited to running through 2023, but was extended.

This study shows that heat impacts the health of children and staff members in childcare facilities. At the same time, the number and intensity of hot days has already increased worldwide in the last few years and is projected to rise further (WMO 2022; Masson-Delmotte et al., 2021). Thus, it seems crucial that more effort be dedicated to appropriate heat management. This includes e.g that structural heat prevention measures are taken indoors and outdoors, that the organizational preparedness is enhanced and that heat stress minimizing activities suitable in the specific facility are well known by all staff members and coordinated in each facility (see Otto et al., 2023 for a list of information materials for the German context with more specific recommendations). However, as a precondition for organizational readiness and immediate adaptation actions, there is a need for more personnel and more time to act and thus, generally speaking, better working conditions in the childcare sector.

CRediT authorship contribution statement

Antje Otto:: Conceptualization, Data curation, Writing - original draft, Visualization, Investigation, Formal analysis, Methodology. **Annegret H. Thieken:** Conceptualization, Funding acquisition, Data curation, Writing - review & editing.

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.

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.crm.2024.100597.

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