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Habitual physical activity and its determinants – experiences from the perspective of children using wheelchairs

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ABSTRACT

Physical activity (PA) has numerous health benefits for children using wheelchairs. Therefore, this qualitative study aimed to get a comprehensive overview of their PA behaviour and its determinants. Seven boys and five girls aged 7–11 years participated in semi-structured interviews, exploring type, duration, setting and intensity of weekly PA. Using a qualitative content analysis determinants and participants' PA were identified and categorized into organized and unorganized settings based on a socioecological model (SEM). Main Barriers included inadequate physical environments, acceptance from peers and insufficient competence of teachers and coaches. Public places and schools need to be more accessible and should increase offers of inclusive sports programmes. The study provides novel insights into PA patterns and influencing factors and highlights the need for more supportive and inclusive environments. Future research should further explore therapy as an additional source of PA.

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Introduction

Around 10% of all children worldwide live with a disability, which can be defined as a long-term physical, mental, intellectual, or sensory impairment (Linden, 2015; Olusanya et al., 2022). Among them, children using wheelchairs, due to mobility impairments such as cerebral palsy, spinal cord injuries, or neuromuscular disorders face unique challenges when it comes to participating in physical activity (PA) (O'Brien et al., 2016). For these children, sufficient PA, which has numerous health benefits, is of enormous importance (Lee et al., 2012), including reduced risk of non-communicable or chronic diseases, improved mental health, and better overall well-being (Lee et al., 2012).

As inactivity in this population is more likely to lead to increased health issues, the World Health Organization (WHO) has developed PA recommendations for people with and without disabilities (Carty et al., 2021). According to this, children

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using wheelchairs should do at least an average of 60 minutes per day of moderate to vigorous PA across the week. However, several studies state that children using wheelchairs are less active than their ambulatory peers (Bloemen et al., 2019; Claridge et al., 2019).

Children using wheelchairs have opportunities to be active in several different ways that can help improve their PA levels and health status. They can engage in active transport, active play, or sports clubs, among other opportunities. These different opportunities can be categorized into organized (OPA) and unorganized PA (UPA). OPA is defined as structured and supervised (e.g. sport clubs) (Howells et al., 2019), whereas UPA includes all non-structured activities such as playground games or informal sports (e.g. in a park or in the own garden) (Emeljanovas et al., 2022). OPA can enable great integration community experiences for children using wheelchairs (Spencer-Cavaliere & Watkinson, 2010) and is of high importance for daily PA levels (Mooses & Kull, 2020) as it takes place regularly and often includes activities with high intensity levels (Guagliano et al., 2013). For instance, OPA correlates stronger with higher cardiorespiratory fitness than UPA (Silva et al., 2013). Furthermore, UPA is less dependent on time constraints, social support and available and accessible sport facilities than OPA (Breuer et al., 2011).

However, OPA and UPA each involve distinct factors that influence participation for children with disabilities. Previous research has largely focused on barriers to OPA among children with disabilities in general, with limited attention to the specific experiences of children using wheelchairs (Jaarsma et al., 2014; Shields et al., 2012). Many institutions such as sport clubs or schools aiming to enable inclusion of children with disabilities. Nevertheless, these efforts do not have satisfactory success. Barriers to participation arise through inadequately adapted activity programs (Verschuren et al., 2012) as well as time constraints, financial burdens and a lack of opportunities (Ballas et al., 2022). In addition, several studies show barriers to the exercise in UPA such as a lack of accessible playgrounds as well as intrinsic and extrinsic motivation (Perry et al., 2018).

There are hardly any specific studies on participation of children using wheelchairs across OPA and UPA. Although the Global Matrix of Para Report Cards indicated low PA prevalence in children with disabilities (Ng et al., 2023), studies do not have a specific focus on children using wheelchairs. Existing studies analysing the participation of children using wheelchairs revealed 75% of children participate in OPA and several different types of sport such as archery, climbing or basketball (Seemüller et al., 2023). However, in-depth data providing an overview on PA in different settings in children using wheelchairs is missing. There is little comprehensive data on the types, frequencies, intensities, and determinants of PA across both OPA and UPA settings. Given the complexity of PA participation in children using wheelchairs, which is shaped by a range of interrelated factors, the social-ecological model (SEM) as described by Sallis, Cervero (Sallis et al., 2006) and Giles-Corti, Timperio (Giles-Corti et al., 2005) offers a comprehensive framework for analysis. It highlights how individual, social, environmental, and policy-level jointly affect behaviour. This framework was used to inform both the design of the interview guide and the interpretation of the findings in this study. Given the qualitative nature of the research, we adopt a constructivist epistemological stance, aiming to explore how children using wheelchairs experience and interpret their PA participation in everyday life.

Moreover, to the best of our knowledge no study to date has explicitly explored facilitators and barriers to participation in both PA domains from the perspective of

children using wheelchairs themselves. Therefore, to develop programmes to promote PA for children using wheelchairs, it is important to get an overview on their OPA and UPA behaviours and identify determinants such as possible barriers and facilitators.

Thus, the present study aims to provide an overview of types, frequencies, durations, and intensities of UPA and OPA as well as to explore facilitators and barriers for participation in these settings among children using wheelchairs. By identifying setting-specific determinants of PA, this study aims to inform the development of inclusive programmes and evidence-based policy interventions.

Method

Study design

The present qualitative interview study aimed to analyse habitual PA in children using wheelchairs. It is part of the ActiWheel study (Habitual physical activity and movement behaviour of children using wheelchairs) conducted in Germany. The study protocol was approved by the Local Ethics Committee (Ref. No. 23–177-S) of the Friedrich-Alexander Universität Erlangen-Nürnberg (Germany) and is in accordance with the Declaration of Helsinki (Version of 2013). This study was conducted from a constructivist epistemological perspective, assuming that knowledge is co-constructed through interaction. Accordingly, the interviews sought to explore subjective experiences and meanings, and analysis was aimed at interpreting these constructions rather than uncovering objective facts. The SEM of Sallis, Cervero (Sallis et al., 2006) and Giles-Corti, Timperio (Giles-Corti et al., 2005) was used as the guiding theoretical framework, as it considers the multiple, interacting influences on behaviour at individual, social, environmental, and policy levels. This model is particularly suitable for understanding PA behaviours in children using wheelchairs, as their participation is shaped by both personal capabilities and contextual barriers or supports. The model informed the categorization of PA settings and determinants during analysis.

Participants and recruitment

For the present study, children aged 7–11 years with a diagnosed physical disability (PD), (e.g. cerebral palsy, spina bifida, spinal muscular atrophy) and primarily using their manual wheelchair for mobility were eligible for inclusion. Participants needed to have sufficient cognitive and communicative abilities to engage in an interview without parental assistance. Children using electric wheelchairs or those with primarily intellectual disabilities were excluded. Only children using active, self-propelled manual wheelchairs without power assistance (e.g. Smart Drive) were included, as the focus was on analyzing PA patterns that require upper-body propulsion and manual wheelchair use. In summary, 12 children aged 7–11 (7 male and 5 female) years living in Germany participated in the study. Participants were recruited through various associations (e.g. German Wheelchair Sports Association), youth leisure and social institutions as well as sports clubs and other leisure time instances in Germany using theoretical sampling methods (Nagl-Cupal, 2013). This ensured that the sample contained a wide diversity with respect to socioeconomic status, migration background, sex/gender, and environmental conditions (e.g. urban and

rural living locations). Our final sample size was formed regarding qualitative research principles (Francis et al., 2010). All participants gave written informed consent to participate in the study and received 10 Euro as an incentive.

Data collection

Test interviews were conducted in advance to ensure the appropriateness of the interview guideline. Data collection occurred between June and November 2023. Interviews were performed via online sessions to ensure participants could conduct their interview from any location, provided they had a stable internet connection and a conducive environment. After obtaining written consent from participants and their parents and scheduling appointments, each participant received an individual link. The researcher (S.S.) conducted the interviews with the participants without the presence of parents to minimize social desirability bias. This approach was approved by the ethics committee and deemed appropriate for the children's age and communicative abilities. All participants provided verbal assent. Prior to recording, the purpose and process of the interview were reiterated, and participants were informed of the voluntary nature of their participation and their right to refuse answering any questions. Socio-demographic characteristics (e.g. age, sex/gender, type of school, migration background, height and body weight) of the participants were gathered through verbal inquiry before the interview began. Participants' weight status (BMI) was calculated, as it may influence mobility, self-perception, or environmental barriers in the context of PA (Atlantis et al., 2008).

The online setup enabled the participants to complete the interview wherever they wanted and enabled us to recruit the participants nationwide. Before the interview started, participants received information about the procedure and got the possibility to ask questions. They were also allowed to refuse answering any question during the interview. After clarifying all formalities, the interview and the recording of audio files started. At the end of the interview, the recording was stopped and saved. All interviews were conducted in accordance with the interview guideline, with durations ranging from 26 to 41 minutes.

Interview guideline

The semi-structured interview guidelines focused on PA of young people using wheelchairs within both a typical day and week (see Supplement 1). A 'decision tree' was used to structure the interviews. At the start of each interview, participants were asked about a typical day ('When you think back to the day today/yesterday. I would like to understand your typical daily routine. You get up in the morning. What happens then?'). This includes detailed reports of their PA engagements across various settings (active commuting to school, school, leisure, everyday life). The aim was to obtain a thorough comprehension of their PA, including the determinants influencing their activity levels in different situations. To achieve this, different interview paths were pursued to understand both, activity throughout the day and inactivity in different settings (e.g. activity in a setting: 'Who decided that you do this activity?'). Further, deviations of this day over a habitual week and finally regular weekly activities were asked (e.g. 'Are there certain other activities that are coming up every week?').

Data analysis

All interviews were transcribed verbatim using the software F4transkripts (audiotranskription.de) based on a guideline (Dresing & Pehl, 2015) and double-checked by two researchers each (S.S, F.Bü.). The subsequent coding process was conducted using the same software. Data analysis adhered to the content-structuring qualitative content analysis (Kuckartz, 2018), resulting in a mixed form of deductive and inductive category formation. Deductive codes were derived from the interview guideline and theoretical assumptions, while inductive codes emerged from repeated reading of the transcripts. In the understanding of consensual coding (Kuckartz, 2018), the entire research process took place within the authors and was characterized by discursive negotiation of the codes and categories – often after prior independent coding by at least two evaluators. The evaluation was carried out by the authors (S.S., F.Bü.) and a trained research assistant student. To achieve high quality we used measures of quality as well as we applied the Consolidated criteria for Reporting Qualitative research checklist (Tong et al., 2007). In the first step, main categories were determined on the basis of theoretical considerations and taking into account the guidelines and the research question, which were concretized with the help of category definitions and anchor examples (Kuckartz, 2018). While the primary focus of the study was qualitative research, a basic quantification of reported PA duration and intensity was included to provide information on participants' activity patterns. These estimations were derived from participants' verbal descriptions of daily routines and weekly activities. Although subject to recall bias, these data were not treated as objective measurements, but as self-reported perceptions supporting the qualitative content. In the second step, the transcribed interviews were transferred into weekly schedules for the present analysis in terms of PA type, duration, setting and intensity for each day as well as weekly activities. The aim was to obtain a descriptive representation of the PA habits by counting the countable (Seale, 1999) like in the sense of a summative content analysis (Hsieh & Shannon, 2005). An analytical separation of the PA settings was analysed deductively across the categories of active commuting to/from school, school breaks, PE, sport (club) activities and leisure time PA. The setting therapy was identified inductively. The identified PA settings were categorized into OPA and UPA. In the subsequent third step, the material was coded again in order to inductively identify the determinants of the individual PA settings. Furthermore, the identified determinants were subcategorized and assigned to the main categories. The SEM served as a guiding framework throughout the analysis, particularly in the categorization and interpretation of PA determinants. By structuring the identified facilitators and barriers according to the SEM's levels – individual, social, environmental, and policy – we were able to systematically capture the multi-layered and interacting influences on PA participation among children using wheelchairs. The data analysis process is summarized in Figure 1.

Results

In total 12 children (7 boys and 5 girls) using manual wheelchairs with a mean age of 9.7 years (range: 8–12 years) participated in the study. One child attended a special school for PD whilst the remaining participants attended regular schools with the school profile of inclusion. Further, only one child lived in a rural area whilst the

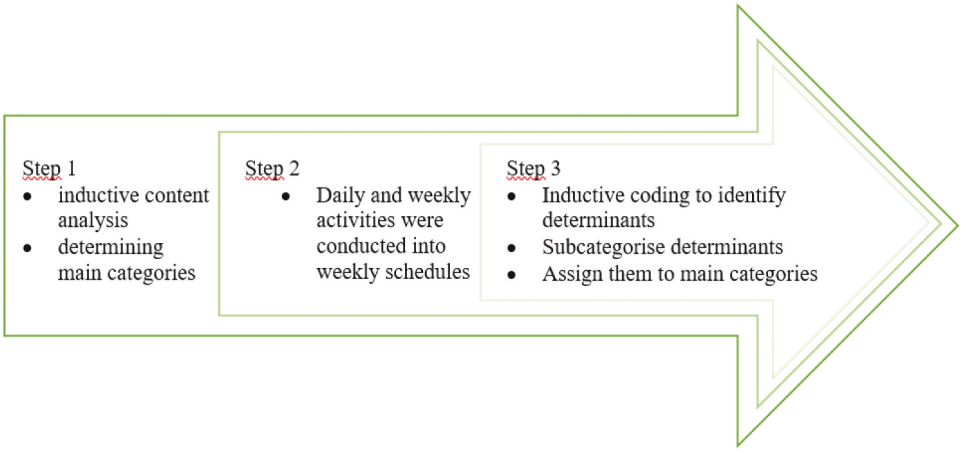

Figure 1. Stepwise process of data analyses.

Table 1. Children's sociodemographics.

Participant	Sex	Age	School type	Residential area	Body-Mass-Index (BMI) (kg/m^2)	Migration background* (MB)
1	male	7	Elementary school	Small town	14.21	No MB
2	male	11	High school	Small town	19.13	No MB
3	female	9	Elementary school	Medium-sized town	17.85	No MB
4	female	8	Elementary school	Small town	15.12	No MB
5	male	12	Middle school	Rural area	15.38	No MB
6	female	11	Middle school	City	23.12	No MB
7	female	10	Special school	Medium-sized town	18.37	No MB
8	female	9	Elementary school	City	13.09	No MB
9	male	8	Elementary school	City	19.83	No MB
10	male	9	Elementary school	Medium-sized town	23.67	No MB
11	male	11	Middle School	Medium-sized town	35.44	One-sided MB
12	male	11	Elementary school	City	15.2	No MB

Note: Rural area < 5,000 inhabitants; small town: 5,000–20,000 inhabitants; medium-sized town: 20000–100,000 inhabitants; city > 100,000 inhabitants.
*Defined as child or at least one parent not born with German citizenship.

majority (N = 8) lived in medium-sized towns and cities. Children's average weight status was 19.12 kg/m^2 (SD = 6.13, min = 15.12, max = 35.44). This constitutes overweight. Sociodemographic characteristics of the participants are summarized in Table 1.

The present study provides insights into the PA levels of participating children across their habitual daily and weekly activities. The identified settings were categorized into OPA and UPA: sport (club) programmes, physical education (PE) and therapy as OPA settings as well as active travel to school, school breaks, leisure time as UPA settings.

PA values

To identify children's PA values, OPA was analysed per week to better understand their habitual PA behaviour, whereas UPA was analysed per day. To better analyse children's overall PA, mean OPA values per day were calculated. Details about participants PA behaviour can be seen in Table 2.

Participation in organized sport (club) programmes included both training in sport clubs and private sport lessons. In summary, the children were active in a total of eight different kinds of sports, e.g. swimming and wheelchair-basketball. Across all PA settings children revealed highest intensity levels during PA in organized sport with 35.9 minutes of PA per day (251.3 minutes per week) across all activity levels. Further, 11 children (91.6%) participated in PE lessons at school and revealed 109.5 minutes of OPA per week, while PE was perceived on average with a light to moderate intensity across all children. Almost all children participated in different therapies such as physiotherapy. This setting represents an additional opportunity for PA with a mean duration of 68.6 minutes per week in light to moderate intensity. Across all unorganized settings children revealed a mean of 94.7 minutes per day. Almost all participants (N = 11) were active in at least one UPA setting per day. Highest intensities and durations were reached in leisure time in several different activities. In active travel to/from school children cumulated less time in PA, whereas highest participation in UPA were revealed in school. In summary, children using wheelchairs were active 130.6 minutes per day on average across all intensities as well as 46.1 minutes per day on average in moderate to vigorous intensity.

Barriers and facilitators

In order to a better understanding of PA behaviour, determinants were analysed for both OPA and UPA setting according to the SEM (Giles-Corti et al., 2005; Sallis et al., 2006). The categorization of the results is based on four major themes: (1) individual factors; (2) factors of the social environment; (3) factors of the physical environment and (4) political factors. The determinants of each level are summarized in Table 3.

Individual factors

Regarding individual factors, many children see their disability itself as an obstacle that prevents them from being active and participate in PA, for example, during school breaks. They report that they often cannot entirely participate in several games such as soccer. In inclusive school settings children often reported, that they were the only child using a wheelchair.

Further, the wheelchair itself is a main barrier regarding active travel to school. Most children came to school in a passive way supported by their parents or by using private buses, even if the distances to schools are short. They mentioned doubts towards their own abilities to safely steer with their wheelchair through the traffic.

Interviewer: *'When school is not far away, why do you travel by car with your mum?'*

Child: *'I honestly have to admit that I don't feel that safe on the road either.'*

Table 2. Physical activity in organized and unorganized settings.

Type of activity	N (% of all participants)	Duration of activity in minutes (range)	Frequency in days per week (range)	Intensity Mean (range)
		Organized PA per week		
		Organised sport (club) programs		
Swimming	6 (50)	75 (45–90)	1.2 (1–2)	2.2 (1–3)
Basketball	1 (8.3)	60 (60)	0.5 (0.5)	3 (3)
Wheelchair-basketball	1 (8.3)	120 (120)	1 (1)	1.5 (1–2)
Wheelchair-skating	1 (8.3)	120 (120)	1 (1)	2 (2)
Frame Running	2 (16.7)	90 (90)	1 (1)	2.5 (2–3)
Handball	1 (8.3)	90 (90)	1 (1)	2 (2)
Handbike	1 (8.3)	120 (120)	1 (1)	3 (3)
Wheelchair-ball-school	1 (8.3)	90 (90)	1 (1)	1.5 (1–2)
Mean/Overall	10	112.7	1	2.2
Mean/Overall across all participants per day	12	13.4	1	2.2
		Physical education		
Sport activities	10 (83.3)	90 (45–135)	1.9 (1–2)	1.7 (1–3)
Swimming	3 (25)	100 (30–135)	1 (1)	2.2 (2–3)
Mean/Overall	11	109.5	1.7	1.7
Mean/Overall across all participants per day	12	14.3	1.7	1.7
		Therapy		
Physiotherapy	9 (75)	42.3 (30–60)	1.5 (1–3)	2.3 (1–3)
Occupational therapy	4 (33)	40.0 (30–45)	0.9 (0.5–1)	1 (1)
Equestrian therapy	2 (16.7)	67.5 (45–90)	1 (1)	1 (1)
Mean/Overall	10	68.6	1.5	1.7
Mean/Overall across all participants per day	12	8.2	1.5	1.7
		Unorganized PA per day		
		Active travel to/from school		
Wheelchair-propulsion	3 (25)	15 (10–20)	1.3 (1–2)	1.2 (1–1.5)
Mean/Overall	3	15	1.3	1.2
Mean/Overall across all participants per day	12	3.8	1.3	1.2
		School break		
Active play	9 (75)	35.5 (10–60)	2 (1–3)	1.1 (1–2)
Wheelchair-propulsion	1 (8.3)	15 (15–15)	2 (2)	1 (1)
Acting	2 (16.6)	75 (30–120)	1.5 (1–2)	1 (1)
Playground-equipment	1 (8.3)	15 (15–15)	1 (1)	1.75 (1.5–2)
Table tennis	1 (8.3)	20 (20–20)	3 (3)	1 (1)
Basketball	1 (8.3)	27.5 (25–30)	3 (3)	1 (1)
Mean/Overall	11	49.7	2.1	1.2

(*Continued*)

Table 2. (Continued).

Type of activity	N (% of all participants)	Duration of activity in minutes (range)	Frequency in days per week (range)	Intensity Mean (range)
Mean/Overall across all participants per day	12	45.6	2.1	1.2
		Leisure time		
Active play at home	4 (50)	36.5 (30–90)	0.7 (0.5–1)	2.2 (1–3)
Active Play at playground	2 (16.6)	30 (30–30)	0.9 (0.8–1)	1.5 (1–2)
Table tennis at home	1 (8.3)	67.5 (45–90)	1 (1)	1 (1)
Basketball at playground	1 (8.3)	90 (90–90)	0.8 (0.8)	2.5 (2.5)
Hanging out with friends	3 (25)	50 (30–60)	0.9 (0.5–1)	1.3 (1–2)
Wheelchair propulsion	1 (8.3)	30 (30–30)	1 (1)	1 (1)
Mean/Overall	8	67.9	1.3	1.3
Mean/Overall across all participants per day	12	45.3	1.3	1.3
Total minutes of PA per day on average across all participants		**130.6 (±17.1)**		**1.6**
Total minutes of MVPA per day on average across all participants		**46.1 (±8.9)**		**>2**

1 = LPA; 1.5 = LPA-MPA; 2 = MPA; 2.5 = MPA-VPA; 3 = VPA.
*across participants.

Table 3. Determinants in organized and non-organized physical activity in children using wheelchairs.

Barriers	Facilitators
(1) Individual factors	
• Fear of injury (OPA) • No desire to be physically active (UPA) • Lack of self-confidence in traffic (UPA) • Lack of time (UPA)	• Desire to be active (OPA; UPA) • Own idea of inclusion (OPA; UPA) • Acceptance for support (OPA; UPA)
(2) factors of the social environment	
Emotional: • Demotivation due to reservations concerning social inclusion of children with disabilities in non-inclusive settings (OPA) Instrumental: • No provision of appropriate tasks for children using wheelchairs due to lack of competence of trainers/teachers (OPA) Lack of Companionship: • Lack of offers to do sports together due to negative societal attitudes towards disability (UPA)	Emotional: • Appreciation of participation in physical activities by parents (OPA) Informative: • Parental perseverance (in exploring sport options/adaptations) (OPA) Instrumental: • Hands-on support by assistance (UPA) Companionship: • Offers to partipate in joint activities with the peer-group (UPA)
(3) factors of the physical environment	
• Inadequate accessibility (OPA) • Long distances to school (UPA) • Lack of wheelchair-friendly infrastructure (UPA) • Lack of adapted play equipment (UPA)	• Adapted play equipment for wheelchair-users (UPA)
(4) political factors	
• No provision of sports wheelchair due to its high costs (OPA) • Restricted practised inclusion at school (OPA) • Lack of inclusive and wheelchair sport opportunities (UPA)	• Existing Physical activity opportunities through school (OPA) • Consideration for individual needs at special schools (OPA) • High quality of existing inclusive and wheelchair sport programs (OPA)

Interviewer: *'Could you make that clearer?'*

Child: *'With my wheelchair I am slower than pedestrians. And then, when a car wants to cross the street I am too slow. And I struggle with doing both, controlling my wheelchair as well as pay attention on traffic.'*

(Child 12, 11, male)

These abilities can be improved during sport lessons. Due to individual tasks given by the coaches, every child can train individually and improve own skills. However, this is only possible, when participating in an inclusive sport lesson with both children with and without disabilities. Three children reported individual training in small groups, which offered the opportunity to take part in organized sport.

Interviewer: *'But do you do something together or does everyone swim for themselves?'*

Child: *'We are each given our own task because we all have different disabilities. We are just a mixed group.'*

(Child 6, 11, female)

Factors of the social environment

Most children were supported by educational assistants on their way from classroom to the gymnasium as well as on their way to and from school. The hands-on support of these assistants was necessary mainly due to the lack of accessibility of the schools and in particular the gymnasiums. Further, they help them to overcome barriers of the physical environment and pay attention on their health. Due to this support the children can participate in PE and develop skills to become more independent. Schools endeavour to take the children's needs into account when possible. Nonetheless, schools can rarely adapt building structures, such as a missing lift.

Child: *'So now they've organised it so that we only have lessons in the classroom and the art room. They are on the ground floor, where the entrance is. I don't have to go up there. But before I had to crawl up the stairs and stuff.'*

Interviewer: '*Do you have an educational assistant with you?*'

Child: *'Now, only on sport days. I can't get to the gym on my own in my wheelchair because of the stairs. He [the educational assistant] helps me with that.'*
(Child 2, 11, male)

Further, several children described being assisted by educational staff during transitions at school or for outdoor breaks.

During school breaks, most participants were socialized as they regularly play with their friends. Especially because they support each other to be active and to play various games.

Interviewer: *"What do you do during your break?*

Child: *'I actually meet up with my friends and play a bit of basketball on the basketball hoop'*

(Child 11, 11, male)

Nevertheless, children are sometimes excluded from peer-activities due to their disabilities as peers doubt their abilities and have negative societal attitudes towards disability. As a consequencefor example, when playing catching they can not play with their peers as they think they are too slow.

Interviewer: *'Why didn't you play with them?'*

Child: *'Because I drive too slowly. Therefore, they won't let me play with them in games such as catching.' (Child 9, 8, male)*

In addition, two children competed in sport clubs in heterogeneous groups with predominantly adult participants. This was deterrent for one child, as he was afraid of injury, due to the heterogeneity and the older participants.

Interviewer: *'Would you like to play in a basketball team?'*

Child: *'The risk of injury is too high in a team. Especially because there's no team for children here. And adults are more likely to play one-on-one.'*

(Child 11, 11, male)

Factors of physical environment

In order to provide opportunities to be independently active during free time, the children need a barrier-free environment. For example, this also includes barrier-free play equipment in playgrounds. If this is not available, the children are dependent on aid of others.

Interviewer: *'Does your mum help you or stay by your side?'*

Child: *'I can sit on the swing on my own and hold on tight. But I have to be pushed and I have to be put onto the swing from the wheelchair and put back again.'*
(Child 1, 7, male)

Other children reported that there is barrier-free playground equipment in their school or their neighbourhood accessible, where they can play independently.

Interviewer: *'Do you have accessible playground equipment at your school?'*

Child: *'We have a wheelchair-accessible roundabout at school where someone in a wheelchair can ride. And there's also a trampoline that I can get on with my wheelchair.'*

(Child 7, 10, female)

The most frequently reported physical environment barrier to UPA relates to the infrastructure. Many children reported that they have long distances to travel to their school, whereas it is not possible for them to get to school actively.

Interviewer: *'Could you come to school in an active way by your own?'*

Child: *'That would be a too long journey'*

Further, children reported that there are no separated walking and biking paths whereas it is hard for them to swerve quickly when cyclists approach. In addtition, these paths are often in damaged condition, not allowing the child to ride even short distances without getting the wheel stuck in a hole.

Interviewer: *'Could you also come to school by your own?'*

Child: *'So cyclists and pedestrians are both allowed on it. And that's difficult because there are a lot of people coming the other way and if a bike comes from behind, I don't know where to go. [. . .]. And then there's the fact that the paths are in bad condition and sometimes I get stuck and mum helps me.'*

(Child 4, 8, female)

Especially kerbsides pose a challenge for wheelchair users because both is difficult for them, to drive down without falling over and to get back up.

Additionally, in hilly regions it takes an enormous amount of effort for children to get up the hills on their own. Thereby, the children have to be pushed by an accompanying person.

Political factors

Most participants who visit an inclusive school are not graded in PE-lessons and they take part without a wheelchair because they have no sports wheelchair. Therefore, they do the activities they can do without relation to the curriculum. As a possible reason for this, children mentioned the teachers' lack of knowledge giving the children appropriate individual tasks regarding their wheelchair mobility:

Interviewer: *'What tasks do you have in PE lessons?'*

Child: *'Today, the others did long jump. I couldn't take part in that. Then I watched the others. She [the teacher] then also doesn't know which tasks she can assign to me.' (Child 8, 9, female)*

One of the 12 participating children visited special schools and received its therapy at school. In special schools, one child was graded and could participate holistically. The integrative settings enable the child to complete the therapy during school hours.

Child: *'So at school I have physiotherapy three times a week during lessons and occupational therapy once a week also during lessons.'*

Interviewer: '*Is it different every week?*'

Child: *'Not the number. But the time. Sometimes in the morning, sometimes in the afternoon, depending on how much time the therapists have.'*
(Child 7, 10, female)

By comparing the different PA settings, it becomes evident that barriers and facilitators differ substantially. OPA, such as PA in sport clubs and PE, was more structured and offered targeted individual support, especially when inclusive group settings were provided. In contrast, UPA settings like PA during school breaks or active travel often lacked tailored support and were more affected by environmental barriers such as inaccessible infrastructure or lack of supervision. While OPA fostered skill development, UPA provided more opportunities for spontaneous social interaction, but only when environments were accessible and supportive peers were present.

Discussion

The present study aimed to get a deeper understanding of PA behaviour in children using wheelchairs. For this purpose, children's PA was structured in OPA and UPA. The setting PE (OPA), sport (club) programs (OPA) and therapy (OPA) as well as active travel (UPA), school breaks (UPA) and leisure time (UPA) were

identified and analysed regarding the PA values as well as possible barriers and facilitators in each setting. To our knowledge, this is one of the first studies to examine habitual PA and contextual barriers and facilitators exclusively among children using manual wheelchairs. While previous research has addressed PA in children with physical disabilities, research focusing specifically on wheelchair use and distinguish OPA and UPA are lacking (Seemüller et al., 2023).

To interpret the findings within the SEM (Giles-Corti et al., 2005; Sallis et al., 2006), it is important to acknowledge that the different SEM levels do not operate in isolation but interact in complex ways to shape PA behaviour. Political, physical, social, and individual factors dynamically interact. For instance, long distances were reported as barriers, but parental support helped to overcome them. This illustrates how individual behaviour is shaped by the interplay between environmental constraints and social support systems, in line with the SEM. Moreover, following the principle of behaviour specificity, the relative importance of SEM levels may vary depending on the PA context. In OPA settings (e.g. PE or therapy), institutional and structural conditions tend to be more influential, whereas in UPA settings (e.g. leisure time or active travel), individual motivation and social support seem to play a more prominent role. By structuring the results into OPA and UPA, the present study reflects these distinctions and allows for a nuanced understanding of how different contextual factors affect PA behaviour among children using wheelchairs.

PA behaviour

Overall, children using wheelchairs participated in PA in typical settings, also known from children without disabilities. The participating children were active especially in PA types such as swimming and ball games. Further, only few children were engaged in active mobility to school. Active mobility to other destinations was not mentioned. In contrast to peers without disabilities, therapy plays a central role in PA behaviour. Across this setting they accumulate a relevant proportion of their PA time. Across all settings, participants were active with a mean of 130.6 minutes per day across all intensities and 46.1 minutes in MVPA in OPA and UPA. Similar values are indicated for children with PD in general (Sit et al., 2019). Compared to children without disabilities from Germany the PA values from the participating children are low: Burchartz, Oriwol (Burchartz et al., 2022) indicated up to 451 minutes of MVPA per week (64.4 minutes per day) across children in a national survey of the same age group.

The low MVPA values in the present study may be due to the fact that the children using wheelchairs could often not fully participate in physical activities. In this context, swimming was the most frequently reported PA, which is notable as it does not involve wheelchair use.

However, that swimming is frequently practised by children using wheelchairs is also confirmed in other studies (Jaarsma et al., 2014). In the water, physical limitations and assistive devices become less relevant, which may enhance feelings of autonomy and inclusion. Swimming may also be more accessible than other activities, especially if wheelchair skills or equipment pose limitations (Roche, 2022). This finding highlights the importance of offering sports that provide equal opportunities for children with and without disabilities. However, the identified low levels of MVPA should be confirmed in

a greater sample of children using wheelchairs in future research. In addition, interventions should counteract and promote PA in children using wheelchairs. Therefore, barriers and facilitators must be taken into account to identify possible determinants. In the present study, both barriers as well as facilitators were identified and were categorized into individual, social, physical and political factors.

Individual factors

Having their own idea of inclusion as well as their desire to be active motivated the children to be physically active. In contrast, a lack of time, a lack of self-confidence in their own skills as well as a lack of desire to be active was mentioned as individual barriers by participants. These are also the most common factors having an impact on PA identified in several other studies in children with and without disabilities (Shields et al., 2012; Zabinski et al., 2003). Further, participants mentioned their fear of injuries as well as their acceptance for support as determinants to PA. The fear of injury as barrier to PA was also indicated in a systematic review across children with disabilities (Shields et al., 2012). Children using wheelchairs need awareness of their own abilities and limits. These individual factors underline the need for interventions to build self-efficacy and reduce perceived risks. Encouragement and active participation in physical activities can boost children's confidence regarding active travel as well as strengthen their conscience for a healthy lifestyle.

Social environment factors

In our study we identified several different forms of social support. These were categorized into the social support scale on an emotional, informative instrumental and companionship level (Reimers et al., 2012). Children using wheelchairs have to be able to demand people and accept this support. Teachers, parents, and coaches should be involved to improve support skills. Parents and caregivers also play a vital role in fostering a positive attitude towards PA (Niermann et al., 2018). Further, facilitators and barriers were equally reported by participants. For example, on an emotional level, children reported that they were motivated to be physically active by their parents as well as demotivated by their peers. Further, due to the (lack of) companionship children were active with their peer groups or experienced negative societal attitudes due to their disability. Thus, for children using wheelchairs, their social environment is of enormous importance (Ajzen, 1991). Therefore, they need a competent and supportive social environment that is able to deal with their disability. An incompetent environment can create barriers due to false prejudices.

Physical environment factors

Across the physical environment children reported of long distances to school, which makes it hard for them to travel actively. However, this barrier to active travel is common in children with and without disabilities (Shields et al., 2012). Almost all participants mentioned the negative impact of inaccessibility of playgrounds, play equipment and facilities such as gymnasiums and a lack of wheelchair-friendly infrastructure on the one

hand and the positive impact of play equipment adapted for their own needs on the other. These are also well-known barriers in children with physical disabilities (Shields et al., 2012). Collectively, these barriers limit the mobility and PA participation of these children compared to children without disabilities, including PE, activities in sport clubs and engaging in play, which are crucial for their physical and social development (Shikako-Thomas et al., 2008). Therefore, PA-friendly environments, such as schools, playgrounds and play equipment have to become adapted for every child using a wheelchair, especially in the light of the fact that accessibility for children with disabilities is enshrined in law in Germany (Hoffmann-Wagner & Jostes, 2021). However, the current state of physical accessibility in Germany remains inadequate, and the significance of material-spatial accessibility barriers has been highlighted (Bükers & Wibowo, 2020). Addressing these issues requires improvements in infrastructure and accessibility to create an inclusive environment that supports the needs of children using wheelchairs. These findings align with the SEM by emphasizing how the environmental level interacts with broader contextual factors such as social support, individual self-efficacy accessibility and political framework conditions.

Political factors

The participation in PA of participants was determined by the offer and the quality of inclusive and wheelchair friendly opportunities at school or during sport programmes. Further, the high costs of sports wheelchairs due to restricted inclusion practices in schools significantly hinder participation. The lack of provision of sports wheelchairs directly limits the ability of children using wheelchairs to participate in sports and PE. For children using wheelchairs it is important to get their own sports wheelchair because standarized wheelchairs are not designed for sports activities (Bragg & Pritchard-Wiart, 2019). They can limit mobility and the ability to perform specific movements required in sports. Standard wheelchairs can be unsafe. Thus, sports wheelchairs are crucial for full participation (Bragg & Pritchard-Wiart, 2019). In the present study, only one child visiting a special school reported of available sport-wheelchairs for PE and sport offers at school. This difference between both inclusive and special schools leads to inequality. Although Germany is pushing for an increasingly inclusive school system, the exclusion quotes, which is the proportion of pupils attending special schools, across all children with PD in Germany increase (Klemm, 2022). Further, it is important to ensure that inclusive schools promote equal participation in sport for all children and create a more inclusive environment. In addition, awareness and funding for such provision needs to be increased to bridge the gap between special schools and inclusive schools. We also acknowledge that our emphasis on the importance of sport-specific wheelchairs must be interpreted with caution, as we did not systematically assess what type of wheelchairs participants were using during the study period.All participants used self-propelled manual wheelchairs. However, we cannot provide detailed information on their configuration (e.g. frame weight, wheel type, adjustability), nor whether participants had access to wheelchair skills training. This limits our ability to draw definitive conclusions about the relationship between equipment and experienced barriers. Future studies should investigate whether mobility limitations stem from suboptimal wheelchair setup or insufficient training rather

than from environmental or institutional constraints alone. Such information could be critical for tailoring effective interventions.

Strengths & limitations

This study has several strengths noteworthy. First, this study provides an in-depth picture of PA behaviour in children using wheelchairs. We explored PA behaviour across both organized and unorganized settings (OPA and UPA), including barriers and facilitators. Therefore, duration, frequency and intensity of each activity was analysed and in relation to that predictors were provided for each setting. In addition, the focus on children using manual wheelchairs addresses a research gap, especially since they face unique physical and social barriers. Lastly, the exploratory-qualitative method offers vital insights into the habitual PA of children using wheelchairs that could be a starting point for further quantitative studies addressing larger samples.

This study also has some limitations that should be mentioned. The type of wheelchair and its equipment can significantly impact mobility, perceived effort, and participation in PA. Focusing solely on children using manual wheelchairs ensured a consistent sample but also limited broader insights. Children with powered or power-assisted wheelchairs may experience different barriers and opportunities for PA. Including them in future studies could offer a fuller picture, especially since few participants in our study mentioned 'wheeling' as an activity. This may suggest limitations in wheelchair setup, propulsion skills, or confidence. Other research shows that wheelchair configuration and targeted skills training can significantly improve mobility and participation (Routhier et al., 2017). Future studies should consider assessing both equipment and user skills to better understand these dynamics. Some of the identified barriers may therefore also be due to equipment limitations. In Germany, wheelchair provision depends on medical need and insurance, affecting access to lightweight or sport-specific models. In retrospect, follow-up contact with participants to collect this information would have been valuable, but is not feasible at this point due to anonymization and time elapsed. The sample was deliberately narrow, excluding children with complex or primarily intellectual disabilities. Future research should investigate how wheelchair configuration and assistive technologies shape PA behaviour and barriers, particularly in more diverse populations. Further, the sample size is quite small (N = 12). As a consequence, the data cannot be generalized and may not be representative for children using wheelchairs from Germany. Further, the determined PA values are based on self-reported PA which is prone to biases like recall biases and could be influenced by social desirability (Hukkanen et al., 2018). Furthermore, conducting interviews with children poses methodological challenges such as varying language comprehension (Harden et al., 2000). These factors may have influenced the children's reporting of their activity levels or barriers and facilitators. In this context, it is important to highlight that the data being discussed pertains to habitual behaviour, captured over a typical week which is particularly relevant from a public health perspective. However, reporting habitual behaviour is inherently challenging. Additionally, the significant variability in individuals' weekly activities should be recognized, as no 2 weeks are exactly alike. Therefore, the concept of a typical week should be understood as a theoretical construct.

Conclusion

The present study provided new insights into PA behaviour as well as its barriers and facilitators in children using wheelchairs. Children using wheelchairs accumulated more PA in OPA settings than in UPA. Overall, the study showed high rates of participation, but children were not holistically involved in activities. Children reported of a lack of supportive environments which often did not meet their special needs. From a practice perspective, inclusive schools should ensure provision of sports wheelchairs and accessible facilities, while training staff in adaptive PE methods. Therapists should integrate PA goals into daily routines collaboratively with the children. Sport clubs may benefit from guidelines and funding to develop inclusive programmes. Policy-level support is needed for inclusive participation. Further larger scale studies are necessary to get representative and generalizable data which is of high relevance to get a deeper understanding of the PA behaviour in children using wheelchairs as well as to promote their PA level. Future research could also employ mixed-methods or participatory designs to better capture children's perspectives and evaluate intervention outcomes. It may be particularly valuable to investigate how school policies, equipment access, or parental involvement influence PA behaviour over time.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Availability of data and materials

The data that support the findings of this study are available from the corresponding author, S.S., upon reasonable request.

Authors' contribution

Conceptualization: Conceptualization: Selina Seemüller, Franziska Beck, Frederik Bükers, Anne Kerstin Reimers; Methodology: Selina Seemüller, Franziska Beck, Frederik Bükers, Claus Krieger, Anne Kerstin Reimers; Formal Analysis: Selina Seemüller, Frederik Bükers; Writing – original draft: Selina Seemüller; Writing – review & editing: Selina Seemüller, Franziska Beck, Frederik Bükers, Claus Krieger, Anne Kerstin Reimers; Project administration: Selina Seemüller; Supervision: Anne Kerstin Reimers.

Ethics approval

The study was approved by the local Ethics Committee (Ref. No. 23–177-S) and was in accordance with the 1964 Declaration of Helsinki (Version of 2013).

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