DISABILITY AND REHABILITATION: ASSISTIVE TECHNOLOGY
2026, VOL. 21, NO. 5, 2008–2021
https://doi.org/10.1080/17483107.2026.2623466

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

Learning powered mobility: caregiver perceptions of young children's capabilities and device impact

Heather A. Feldner[a,b], Kiana Keithley[a], Kimberly A. Ingraham[b,c], Anna Fragomeni[a], Nicole Zaino[d], Liesbeth Gijbels[e], Alexis Sinclair[e], Andrew N. Meltzoff[e], Patricia K. Kuhl[e] and Katherine M. Steele[b,d]

[a]Department of Rehabilitation Medicine, University of Washington, Seattle, WA, USA; [b]Center for Research and Education on Accessible Technology and Experiences, University of Washington, Seattle, WA, USA; [c]Department of Electrical and Computer Engineering, University of Washington, Seattle, WA, USA; [d]Department of Mechanical Engineering, University of Washington, Seattle, WA, USA; [e]Institute for Learning and Brain Sciences, University of Washington, Seattle, WA, USA

ABSTRACT

Purpose: Self-initiated mobility experiences are critical for young children with disabilities and may be augmented through powered mobility (PM). However, access to PM for young children (<3 years old), remains limited due to multiple environmental, design, and attitudinal factors. The purpose of this study was to understand caregiver perceptions of PM intervention following a 12-session trial of a novel PM device.

Materials and methods: Ten caregivers (4 M/6F) of children with cerebral palsy (Gross Motor Function Classification System IV-V) and other developmental disabilities (21.8 ± 5.9 months). Children participated in 12 in-lab driving sessions (exploratory or goal directed) using the Explorer Mini (Permobil AB, Sweden). Exit interviews were conducted with caregivers at the final visit, transcribed verbatim, coded inductively, and analysed until themes emerged.

Results: Four themes emerged from the data: (1) *Changing views of capability and adaptability;* (2) *Emerging autonomy*; *new skills in and out of the device*; (3) *Clear need and benefit with some drawbacks;* and *(4) Lingering stigma and uncertainty.*

Conclusion: PM trial positively shifted caregiver's perceptions of both PM in general and their child's capabilities, with a desire for greater access to PM at home to support development. These beliefs remained juxtaposed with lingering stigma for some caregivers about PM devices, and a stated desire for more modifiable PM options for children with different positioning or access needs.

IMPLICATIONS FOR REHABILITATION

- Powered mobility intervention in young children with motor disabilities may be a powerful tool to shift caregiver perceptions of their child's strengths and capabilities.
- Powered mobility intervention is perceived to be a key means of developing agency and control as well as a means of self-initiated mobility in young children.
- Despite enthusiasm and perceived benefits of powered mobility intervention, caregivers may still display stigmatised attitudes towards powered mobility use longer term, or outside a research trial.
- Caregiver perceptions of their child's powered mobility use are critical in understanding subtle changes in behaviour or developmental skill that may not be recognised or observed by researchers during lab-based trials or in clinical settings.

ARTICLE HISTORY
Received 22 November 2025
Revised 15 January 2026
Accepted 21 January 2026

KEYWORDS
Powered mobility; pediatric; motor disability; young children; on-time mobility; qualitative research; caregiver perspectives

Introduction

Self-initiated mobility is important for all children; it is not only a key means of getting from place to place, but also an important catalyst for development in communication, socialisation, play, interpersonal participation, and neurobiological growth [1–7]. Self-initiated mobility is defined as movement controlled by oneself and encompasses: (1) forms of ambulation such as walking, crawling, scooting or (2) the use of assistive devices such as walking aids, manual wheelchairs, or powered devices like powered wheelchairs or battery-operated ride-on toy cars [8–10]. A child's achievement of self-initiated mobility is a significant

CONTACT Heather A. Feldner hfeldner@uw.edu Department of Rehabilitation Medicine, University of Washington, 1959 NE Pacific St Campus Box 356490, Seattle, WA, 98195, USA.

milestone and expected within the first two years of life for typically developing infants [11]. For children with motor disabilities, however, self-initiated mobility is often delayed compared to typically developing peers [10,11]. Further, while self-initiated mobility is a common goal of early intervention services, mobility interventions in contemporary clinical practice have chiefly focused on the attainment of walking, despite the inclusive definition of self-mobility noted above [12–15]. This practice can delay critical access to self-initiated mobility experiences during foundational developmental stages. For example, in children with disabilities such as cerebral palsy, depending on Gross Motor Function Classification System (GMFCS) Level children may be expected to walk (GMFCS I-II), walk with aids (GMFCS III), or take some supported steps (GMFCS IV). However, the average age of walking onset is 3–4 years, highlighting a significant experiential gap [16–18].

Children with motor disabilities who cannot mobilise independently or efficiently have a high likelihood of secondary disabilities that affect their autonomy, education, and recreation/leisure [19,20]. These secondary disabilities may also lead to negative impacts on caregiver physical and mental health and productivity [10,19]. Further, a lack of self-initiated mobility means the child must rely on others for passive mobility, which constrains both the frequency and variability of their social and environmental interactions [10]. We hypothesise that powered mobility intervention may be a promising solution to provide self-initiated mobility and exploration at similar stages to typically developing peers and counteract these potentially negative impacts on young children with disabilities and their families, even if used temporarily until other motor skills emerge [10,21].

Powered mobility (PM) for children under the age of 5 years has been shown for decades to be safe and lead to improvements in both psychosocial and locomotor behaviours [19,22]. A 2012 randomised controlled trial of year-long PM use in infants and toddlers 14–30 months old demonstrated that children in the treatment group had significantly improved receptive communication, functional mobility, and self-care skills when compared to their matched controls [23]. In a recent randomised crossover clinical trial, children 12–36 months with cerebral palsy (GMFCS II–V) showed significant improvements in cognitive, communication, adaptive behaviour, social-emotional, and fine and gross motor domains following a 4-month PM intervention [24]. Other research suggests PM use in young children leads to improved sleep/wake cycles and increases in participation such as cooperation with others, greater interaction and quality of play during indoor and outdoor games, and independence [25–29].

Qualitatively, caregivers of older children have reported lower physical and emotional stress levels following introduction of PM, in addition to beliefs that the general public more readily accepts their child [30,31]. Caregivers have described a varied process of acceptance of PM devices and navigating tensions between supporting their children's self-initiated mobility and feelings of loss- both related to loss of control as well as loss related to their child's potential to walk, often expressing feelings of powered mobility as a "last resort" [31–35]. Older children who use PM self-report the need for "fit" between self, their device, and the environment, but overall have described positive contributions to mobility, self-esteem, and confidence through PM use [36–38]. These perspectives are critical, however, there is a lack of qualitative inquiry focused specifically on caregiver perceptions of children 3 years and under who are learning to use PM. Of the few studies that have explored caregiver perceptions in this age group, themes of inclusion, self-initiated mobility success, and hope for the future are juxtaposed with barriers to access and familiar hesitancies related to ongoing motor skill development [9,34,39].

It is important to gain a deeper understanding of how caregivers perceive the process of PM learning in children 3 years and under, during the period when children are in critical stages of self-initiated mobility acquisition. This is timely, because rapid changes in technology now present new opportunities for PM intervention for this age group. Thus, the purpose of this study was to understand caregiver perceptions of PM learning, device design, and their child's perceived capabilities during a short-term intervention using a novel PM device.

Materials and methods

Design

This descriptive qualitative study was part of a larger, prospective, mixed-methods cohort study investigating powered mobility learning and use in young children, ages 1–3 years, during a short-term mobility

intervention. Ethics approval was received by the University of Washington (UW) Human Subjects Division (STUDY00014879) and all participants provided written consent prior to conducting any research procedures.

Participants

Purposive sampling was conducted to recruit participants. Participants were recruited by the research team through emailing known rehabilitation professionals in the Western Washington area, posting on local listservs, posting fliers to local healthcare clinics and hospitals, and through the UW Communication Studies Participant Pool registry. Additionally, previous research participants who had agreed to be contacted about future studies were approached. Potential participants then self-selected to contact the research team to learn more about the study and determine interest. Interested participants were screened for eligibility by a member of the research team. Screening information was shared *via* caregiver report. Sampling estimates were derived from previous qualitative studies prioritising depth of caregivers' experiences following powered mobility intervention for children with disabilities, with recruitment continuing until data saturation was reached rather than a predetermined numerical target.

Inclusion criteria for children in the study were: (1) Age between 12 and 36 months; (2) Have a diagnosed motor disability, or developmental delay that impacts self-initiated movement; (3) Able to maintain a seated position with or without support; (4) Able to tolerate upright sitting with or without support while moving through space for 15 min. We intentionally recruited a broad range of children with diagnoses that may or may not lead to long-term PM use, but whose self-initiated mobility was limited at the time of participation, due to the lack of data currently available for PM users 3 years and under. Inclusion criteria for adults in this study were: (1) Age 18 years or older; (2) A legal caregiver for the child participant, (3) Able to communicate proficiently enough in English to participate in a study interview.

Device

All driving sessions were conducted using the Permobil Explorer Mini. The Explorer Mini (Permobil AB, Sweden) is a commercially available, FDA approved powered mobility device intended for young children between 12 and 36 months of age with mobility limitations. It is lightweight and fits in most automobiles. The Explorer Mini runs on a 12-volt battery with a driving range of 3.5 miles and a maximum speed of 1.5 mph, is controlled *via* a joystick with a 360-degree turning radius, has proportional speed control with 5 speed options, and can be used in a seated or standing position (Figure 1).

Procedures

The children participated in 12 intervention visits at the Amplifying Movement and Performance Lab (AMP Lab) at UW. Visits were scheduled at the family's convenience; on average this ranged between 1 and 2 visits weekly. Each visit included 2, 15 to 20-min driving sessions, dependent on the child's tolerance. Driving sessions included guided exploratory play, games, and goal-directed driving, depending on the child's current powered mobility learning stage and phase as measured by the Assessment of Learning Powered Mobility (ALP) tool v2.0 [40]. All driving sessions were child-led, and based on the child's current ALP level, which was assessed by a trained and experienced paediatric physical therapist. Facilitating strategies for PM learning were provided by trained research team members and tailored individually for each child according to the companion ALP facilitating strategies and the *Guideline for Introducing Powered Mobility to Infants and Toddlers* [41,42]. Exploratory play was defined as the child's exploration of an enriched play environment which included interactive toys, engaging with visual (digital and non-digital) displays, and tactile sensory experiences positioned at the child's eye-level and within reach. For a child in the early learning stages of the ALP, an example activity was joystick hide and seek with stacking cups to draw attention to the joystick. For goal directed activities, an example was asking the child to perform specific training activities (e.g., "go get the yellow blocks from Mom!").

B	Specifications of the Permobil Explorer Mini
Age	12-36 months
Weight	35 lbs. maximum
Height	39.4 inches maximum
Unit Dimensions	length: 25 inches; width: 19 inches; adjustable height: 29-37 inches Weight: 52 lbs.
Driving Range	3.5 miles
Speed Range	5-speed proportional joystick up to 1.5 mph maximum

Figure 1. (A) A child participant driving the Permobil ® Explorer Mini (photo courtesy of the IMPACT Collaboratory). (B) Specifications of the Explorer Mini device.

Table 1. Semi-structured exit interview guide.

1.	What do you see as the relative advantages of a device like the Explorer Mini?
2.	What do you see as the relative disadvantages of a device like the Explorer Mini?
3.	Prior to this study, had you ever considered powered mobility for your child, either temporarily or long term? - Has this experience changed your mind? Why or why not?
4.	How has this experience impacted your perception of your child's abilities?
5.	What feedback would you like to share about your or your child's experience in the study? - This could be things like study logistics (frequency and clarity of communication), or in-study events and experiences (such as your child's reactions to driving, toys, or interactions with the team).

Analysis

This study employed descriptive qualitative analysis. This is a methodologically accessible and foundational qualitative approach that aims to produce a straightforward, low inference summary of the phenomena being studied, articulated in everyday terms and staying true to participants' own words [43]. By interviewing caregivers following the completion of a 12-visit PM intervention arc, the research team was able to gather rich and insightful perspectives not widely represented in current PM literature [44]. These perspectives serve as an important complement to quantitative outcomes that are emerging for young PM users.

Following the final driving session, a trained researcher led semi-structured interviews with caregivers using an interview guide (Table 1) developed based on results from previous PM studies led by our research group. This guide foregrounded the need to better understand caregiver observations of their child's use of the Explorer Mini during driving sessions, discussing advantages and disadvantages of the device, and describing how their perceptions of their child's capabilities evolved throughout the study. During the interviews, the research team employed bias-mitigating strategies such as use of an interview guide with neutral and open-ended questioning and unconditional positive regard (active listening without judgement) [45]. All interviews were audio recorded.

Interviews were transcribed verbatim and coded using an inductive coding scheme until data saturation was reached [45]. Open codes were labelled independently by two researchers; these were subsequently refined and collapsed into focused codes and grouped into overarching themes. A codebook was created to ensure transparency about the coding process, and an audit trail was maintained which included emails and notes from meetings among the researchers during later coding rounds.

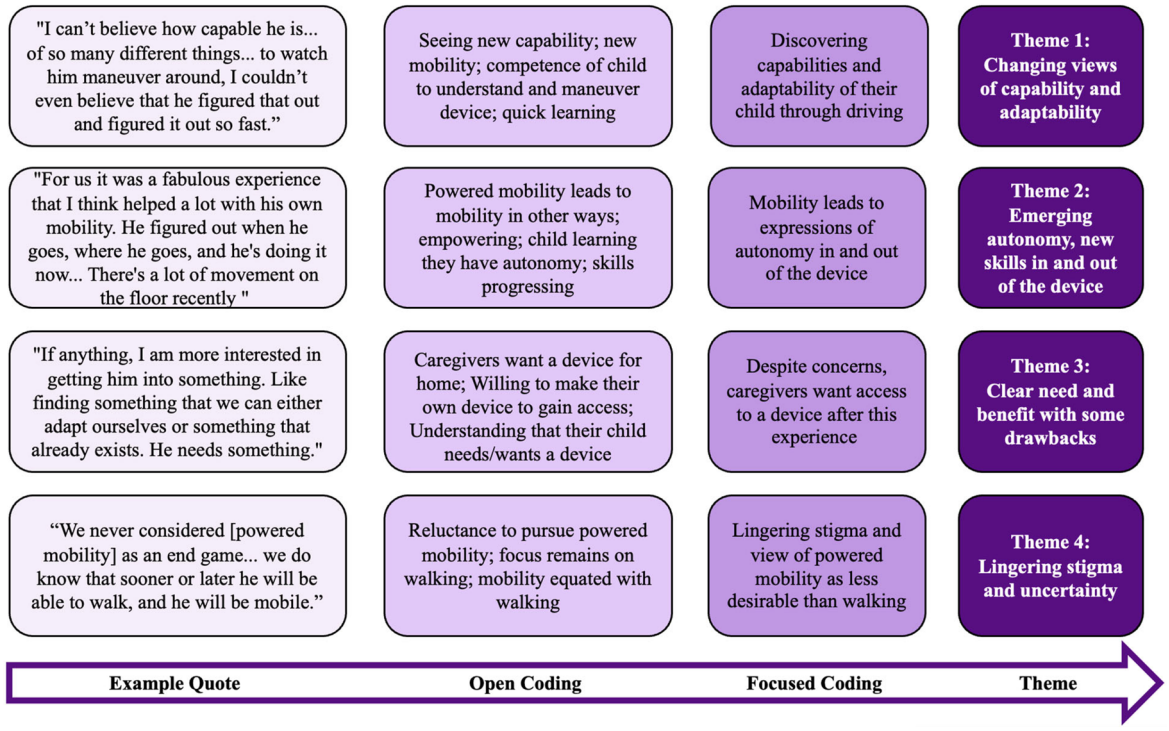

Figure 2. The qualitative coding process. Example of the coding process from left to right, starting with direct quotes from caregivers, followed by independent open coding, joint focused coding, and emergence of the overarching themes. One example quote per theme is provided.

Disagreements were resolved *via* discussion until 100% agreement was reached between the two researchers, and a third research team member was consulted to confirm the reliability of the emergent themes. Analysis continued until data saturation was achieved, when continued analysis yielded no new themes, codes, or insights beyond those already identified. Participants were also offered the opportunity to view their interview transcripts for accuracy or receive a summary of emergent themes as a form of member checking to avoid misinterpretation. A visual representation of the coding process is included in Figure 2.

Positionality of the research team

The research team intentionally included people with a range of backgrounds and interdisciplinary skills: a PhD-trained physical therapist with expertise in qualitative research methods; a research physical therapist with a paediatric clinical specialist certification and over 20 years of experience; PhD-trained engineers, psychologists, and speech-language pathologists; as well as doctoral students, and research assistants. All team members had previous PM research expertise or were trained in the operation and use of the Explorer Mini, as well as the delivery of semi-structured interviews. Several of the research team members had lived experience of disability, including childhood-onset disability and use of mobility aids. Based on these experiences, the research team was well-positioned to conduct this study and were aware of their own positionality regarding the interpretation of the data and the potential biases that may be present during analysis. Researcher reflexivity was essential in enhancing the trustworthiness and credibility of the study.

Results

Ten children and families participated in the study. Tables 2 and 3 provide demographic details for the caregivers and their children.

Table 2. Caregiver demographics.

Caregiver	Age	Gender	Relationship to child	Ethnicity	Hispanic/Latino?
C001	34	M	Father	Asian	No
C002	32	F	Mother	White	No
C003	36	F	Mother	White	No
C004	38	F	Mother	Did not report	No
C006	Did not report	M	Father	Did not report	Did not report
C007	35	M	Father	White	No
C009	39	M	Father	Mixed	No
C010	42	F	Mother	Black	No
C011	33	F	Mother	White	No
C012	36	F	Foster Mother	White	No

Table 3. Child demographics.

Child participant	Age (mo) at consent	Sex	Medical diagnosis	Caregiver-reported delays in mobility	Current mobility aids
P001	31	F	SNAP25 (genetic disorder) Epilepsy Global Developmental Delay	Non-mobile	Stander Walker
P002	14	M	Loss of function Recessive Piezo 2 mutation	Hypotonia Gross motor delays	Small wheelchair (GoBro/Frog Mobility) - not able to use yet
P003	16	M	Congenital vertical talus (left) foot Torticollis	Delayed walking	Splint on left foot
P004	21	M	Wolf-Hirschhorn Syndrome (also known as 4P-) Epilepsy	No walking or crawling	None
P006	28	M	Cerebral Palsy GMFCS IV eosinophilic esophagitis	No Sitting, walking, crawling	Walker Stander
P007	27	M	Cerebral Palsy GMFCS V	Did not answer	Stroller
P009	16	M	Spinal Myleopathy	lacks core strength, delayed sitting and crawling	GoBabyGo car
P010	18	F	Brain injury Cerebral palsy GMFCS V Lennox-Gastaut syndrome (LGS)	No sitting, crawling, walking, standing	Rifton chair Monkey stander Braces
P011	24	M	Campomelic dysplasia Scoliosis kyphosis Club feet Short stature	Not sitting up or standing on his own Not talking	Not reported
P012	23	M	Hypoxic ischaemic encephalopathy Cortical visual impairment	Global developmental delays	AFOs, stander, tomato chair

Four themes emerged from the data, which are summarised in Table 4: (1) *"Changing views of capability and adaptability"*; (2) "*Emerging autonomy, new skills in and out of the device"*; (3) *"Clear need and benefit, with some drawbacks"*; and (4) *"Lingering stigma and uncertainty"*.

Theme 1: Changing views of capability and adaptability

The first theme describes the caregivers' pride, and often surprise, in their child's ability to use the device. Caregivers discussed how meaningful it was to actively witness their child learning and experiencing self-initiated mobility success. This shifted many caregiver perspectives and expectations regarding their child's overall capabilities:

> [This experience] made me realize he is way more capable than I thought he was. There's a lot going on and he can do more than… I imagined –C012

Another caregiver echoed:

> I can't believe how capable he is… of so many different things… to watch him maneuver around, I couldn't even believe that he figured that out and figured it out so fast. It took me a long time learn to parallel park and this kid is going to parallel park on the first try –C003

Caregivers reflected on the unique opportunity of having access to a PM device as a toddler, and how this can impact learning:

Table 4. Summary of themes.

Theme	Description
Theme 1: Changing views of capability and adaptability	Caregivers expressed emerging understanding, and often changing views, of their children's abilities. Caregivers were often surprised by their child's capability for powered mobility learning.
Theme 2: Emerging autonomy, new skills in and out of the device	Caregivers described new opportunities and emerging autonomy that were facilitated by powered mobility for children to make choices about their play and mobility. Caregivers described how they saw changes in developmental skills at home in addition to improved driving skills during sessions.
Theme 3: Clear need and benefit with some drawbacks	Caregivers described their recognition of the benefits of powered mobility intervention, and desire to have more access to devices, despite simultaneous recognition of some device design concerns. Some caregivers wanted to adapt or create their own devices.
Theme 4: Lingering stigma and uncertainty	Some caregivers described the lasting resistance they felt about their child using powered mobility outside the study, viewing walking as a primarily desired form of mobility, reflecting ongoing stigma towards wheeled mobility.

[This experience] just showed us how smart [he is] learning how to use all the different things. Kids aren't going around in little motorised vehicles at his age –C002

Also noted by caregivers was their child's adaptability to being in a new environment and interacting with new people, in a new device:

> I think he's pretty adaptable. I know the first time we were here he was pretty upset the first half [of the session]. [Now] he seems excited when we get here, and he likes being in the Explorer Mini –C007

Theme 2: Emerging autonomy, new skills in and out of the device

The second theme illustrates caregivers' recognition of the independence the Explorer Mini gave their child to make their own mobility decisions and express their newfound autonomy. For example, one caregiver stated:

> [A] definite advantage is he has control over his environment a little bit, which he doesn't get a lot of.–C012

Another caregiver echoed:

> Instead of thinking of himself in that infancy stage where, "the adults take you places." [Moving himself in the device] allows for him to bridge that gap to, "I take me places" –C006

Caregivers also noted the importance of autonomy regardless of their child's diagnosis and perceived level of ability:

> I want [P006] to have some degree of autonomy in his life. Regardless of what we can't overcome, to the degree that we can give him some control over the quadriplegic spastic cerebral palsy –C006

Families familiar with powered mobility and other modes of assistive devices before the study noted the advantages of the Explorer Mini comparatively.

> [The advantages of the Explorer Mini are] mobility and independence for [him]… we tried other types of devices… but this has given him the most independence of anything we have tried –P011

This theme also centred around caregivers' observations of their child's confidence and developmental gains, whether during driving sessions or at home, especially in areas that had been previously more challenging for the child:

> For us it was a fabulous experience that I think helped a lot with his own mobility. He figured out when he goes, where he goes, and he's doing it now… There's a lot of movement on the floor recently –C004

Another caregiver noted:

> Everything he's done in this program has trickled into all the other areas of his life and it's made him more confident. He scoots around the house more, he will sit in his highchair, all these things we have [had] to really focus on are all of a sudden becoming easier for him. Because he sees there is a purpose for it and a reward at the end –C011

Theme 3: Clear need and benefit, with some drawbacks

The third theme showcases the overarching desire caregivers had for access to PM for their child, whether it be through a device at home or more research or trial driving sessions. One family noted how important they felt it was for their child to continue to use PM, sharing their skills and creativity in creating a bespoke PM device at home:

> We actually built her own [mobility device] out of some stuff… We just didn't want her to lose that skill before we get her to an actual motorized wheelchair. She seems to be taking to it. – C001

Caregivers also sought out additional community resources to support their children's mobility:

> Yeah so, we got a new Go Baby Go [car] just because of the amount he was able to use [the Explorer Mini] here. – C009

Additionally, many caregivers noted that despite the need and desire for PM, there were concerns about limited access to devices, cost, insurance coverage barriers, and adaptability:

> [Mobility devices] are not necessarily easily available for kids that have got some special needs, so it would be good to have maybe a bit more of that available to use at home… that's affordable as well… and more adaptive – C010

Another caregiver described:

> We had the choice between a basic wheelchair and an adaptive stroller and chose a basic wheelchair because we think he's at that stage, however, we would love a powered chair, but it's not covered by insurance. – C006

Specific design constraints of the Explorer Mini were noted by some caregivers relevant for their child and their specific needs:

> For her it's mostly the posture seating… I think maybe she was using more energy to try and stabilize her core… I think it seemed like it was very fixed in terms of its position of the tray relative to the seat even though it had some up and down… the joystick could move further out. Maybe just the support and some of that flexibility could be of help especially for her – C001

Theme 4: Lingering stigma and uncertainty

All caregivers expressed that they felt the experience of their child using powered mobility was beneficial, regardless of whether they believed it was a temporary or potentially more long-term mobility solution. However, evidence of stigma and resistance to PM persisted in several caregivers. For example, some caregivers continued to make distinctions between mobility in the Explorer Mini and walking mobility.

> We never considered [powered mobility] as an end game… we do know that sooner or later he will be able to walk, and he will be mobile. –C004

Caregivers shared the complexity of their views about PM, including instances where they questioned the competence of their child's physical therapist for suggesting powered mobility for their child, while continuing to affirm the positive nature of the short-term PM intervention for the study:

> I was very opposed [to powered mobility]. It was suggested very early on by one of his physical therapists. Honestly in my opinion, it was just her lack of ideas on how to work with the child other than anything else, and I opposed it. I said no way. He was like 9 months… 10 months. Ridiculous. And no, I still do not think we need [powered mobility] as a solution at home or outside. We are not there yet. Hopefully we won't be. But as an activity, it was awesome –C004

Some caregivers expressed a gradual shift in their perceptions of PM. Preferences for a different method of mobility were often framed as "hope" that their child wouldn't need that level of assistance, however, early successful experiences helped families begin to think of PM in a new light:

> We were hoping that we wouldn't need [powered mobility] but as he gets older it seems like he might need it in the future. So, we're kind of coming around to it… [If powered mobility] makes it easier for him to move then I think it could become fun for him and us too –C007

Discussion

This study examined caregiver perceptions of PM learning, device design, and their child's perceived capabilities following a short-term PM intervention with young children 3 years and under with motor disabilities. Children participated in 12 visits using the Explorer Mini, and caregivers participated in a semi-structured exit interview at the final research visit. Understanding caregiver perspectives of children's PM learning in this age group is critical to help fill the gap in current evidence to support PM intervention during crucial developmental stages and ensure equitable access to self-initiated mobility for all children.

Caregivers in this study viewed the experience with PM as positive for their child. They noted the experience provided new opportunities for their child to move independently, explore their environment, and develop autonomy. Caregivers expressed that their child's PM use allowed them to better understand their child's capabilities and noted that carryover from the driving sessions was observed in their child's mobility and motivation at home. Most caregivers expressed a desire for additional access to PM intervention for their child, some taking the steps to create their own device or pursue additional devices beyond the study. This, however, also reinforced the current limitations in access to PM for this population, due to cost, lack of insurance coverage for a device for a child 3 and younger, and limitations in adaptability with currently available devices. These findings are consistent with current literature that reflects these benefits and challenges, even for older children with disabilities seeking access to PM [6,9–11,19,24–26].

Caregivers specifically highlighted that short-term PM intervention, regardless of whether their child would go on to walk, use other mobility aids, or be a long-term PM user, was perceived as beneficial to support their child's development in mobility-related areas and beyond. These findings mirror and add to the current quantitative literature describing the developmental cascades that co-occur with self-initiated mobility. Butler was one of the first to describe this developmental carryover to other areas in her seminal work with young children using PM, observing that once children gained independent movement, they showed improvements in cognitive, social, and perceptual development that had previously been underestimated because of their limited mobility [22]. Further, drawing from developmental dynamic systems theory, Iverson describes, "*Developmental changes in one domain can have far-reaching, cumulative, cascading effects on development in others—even those that are seemingly unrelated—and on the environment in which development in those domains occurs*" (p. 230) [46,47]. The caregivers in this study noticed this relationship between driving sessions with PM and exploration of other mobility such as floor scooting. In our research team's previous work, we have also observed how self-initiated mobility leads to greater than expected changes in cognition, communication, motor skills, and socio-emotional development [24,29].

Caregivers also described the need for greater access to and adaptability of PM devices. While the Explorer Mini was specifically designed for young children ages 1–3 years, it is the only FDA-cleared device available for this age group in the United States, and, even when combined with other PM options such as ride-on toy cars or larger PM devices that can accommodate a younger child's seating needs, access to these devices are not yet standard of care in early intervention practice. For example, in a 2021 clinical practice guideline for children 0–2 with motor disabilities such as cerebral palsy, there is no inclusion of PM [15]. In a similar study with 430 children ages 1–4 years only 1.2% ($n = 5$) of children used PM, and therapy sessions were least frequently focused on mobility devices/equipment [48]. Caregiver perceptions in this study similarly reflect those of other recent qualitative studies as well, noting the need for more individualised solutions for postural and head support, flexible location for controls (joystick or switches), more adjustable seating, smaller device footprints and weights that support ease of transport, and child-friendly aesthetics [9,35,39]. There is only one study to our knowledge, also published by our research team, that quantifies joystick activations in this young age group to better understand child-device interaction with PM [49].

Not surprisingly, though caregivers in this study noted the benefits of PM driving sessions for their child, including how much their child enjoyed using it, many caregiver responses remained influenced by stigma that has historically been associated with PM use. Several caregivers described that they were initially resistant to the idea of PM, needed to check with their therapy providers about whether there was potential for PM to interfere with motor skill development, or that it was simply not an option they need or would consider outside of their study participation. Despite emerging evidence to the contrary,

these perceptions align with previous literature describing common initial concerns upon considering PM [19,32–35]. However, caregivers in other studies indicate that these perceptions receded quickly once they experienced the benefits that a PM device provided for their child. For the caregivers in this study, a 12-session intervention may not have been long enough to shift caregivers' prior beliefs about wheelchairs.

Clinical implications

The data from this study may help inform clinicians engaging in early conversations about mobility-related assistive technologies with families, as well as planning powered mobility interventions for young children with motor disabilities. Current literature suggests that some clinicians still hesitate to consider PM for toddlers due to concerns about cost, space, "readiness," or fear of labelling [33]. A 2018 study of over 600 paediatric clinicians indicated that while they had positive views towards PM, very few actually integrate it into their practice, with the average age that therapists *first consider* initiating power mobility being 2.8 years, which is more than a year after typically developing peers are walking independently [14]. Discussions with clinicians offer one of the first opportunities for caregivers to better understand options related to mobility technologies such as PM. However, clinician hesitancy can unintentionally reinforce ableist expectations about mobility (i.e., as a "last resort" or as a failure of motor interventions) and reduce early participation opportunities [10]. Data from this study show that regardless of a child's long-term mobility needs, caregivers are observing positive perceived changes in their child's mobility during device use that carries over into other motor exploration and development at home. These perspectives are valuable to counteract clinician hesitancy and foster on-time mobility.

Study limitations

There are several limitations to this study. First, this study included a small, mostly white, and geographically localised sample, which may impact transferability of the data. Second, participants represented a wide variety of mobility-related disabilities. Some of the participants were taking independent steps by study completion, while others were likely long-term PM users. Although this heterogeneity may be helpful for transferability, further research is needed to pinpoint caregiver perceptions based on children with more homogenous mobility presentations. Third, research team members who conducted the interviews were present during driving sessions, which may have increased potential for acquiescence bias. However, the research team attempted to mitigate this factor by using a consistent research team member as the lead facilitator of the driving sessions who was not routinely involved in the interviews. Fourth, the children's therapy providers were not part of the study, clinician perspectives on the PM learning process are important to include as gatekeepers to mobility equipment. Finally, a 12-visit PM intervention in a lab-based setting, though enriched with toys, games, and interactions with caregivers and the research team, may not be long enough, or in the most natural environment necessary to fully capture caregiver perspectives about their young children's PM use.

Future research

Further quantitative and qualitative data across diverse geographic and demographic populations describing the PM learning process is needed to inform clinical decision making and policy as well as improve evidence-based access to technologies for young children with disabilities. It is especially important to continue evaluating the effects of PM across natural environments, and with clinician involvement. Continued work on the impacts of ableism and stigma on stakeholder perceptions of PM, access and accessibility, and development is warranted.

Conclusion

Caregivers in this study reported benefits spanning their child's mobility, autonomy, and developmental gains in other areas, while simultaneously highlighting design and access challenges, and some lingering

stigmatised views of PM. The findings add valuable qualitative data to the literature to support clinical decision making during early intervention for children with motor disabilities, particularly describing the ways in which caregivers see their child's capabilities differently after PM intervention. Continued research with children in this critical developmental stage is needed to capture how PM intervention affects developmental trajectories, reduce stigma-driven delays, shape child-friendly device design, and provide the evidence base that families and clinicians need to advocate for timely access to self-initiated mobility.

Acknowledgements

We would like to acknowledge the children and caregivers that took part in this study, and other members of the research team that were instrumental in study activities: Mia Hoffman, Katie Landwehr-Prakel, Julia Mizrahi, and Bo Woo.

Author contributions

CRediT: **Heather A. Feldner**: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft; **Kiana Keithley**: Data curation, Formal analysis, Investigation, Writing – original draft; **Kimberly A. Ingraham**: Data curation, Investigation, Project administration, Writing – review & editing; **Anna Fragomeni**: Formal analysis, Investigation, Writing – review & editing; **Nicole Zaino**: Data curation, Formal analysis, Investigation, Writing – review & editing; **Liesbeth Gijbels**: Investigation, Writing – review & editing; **Alexis Sinclair**: Investigation, Writing – review & editing; **Andrew N. Meltzoff**: Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing; **Patricia K. Kuhl**: Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing; **Katherine M. Steele**: Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

Disclosure statement

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

Funding

This work was supported by Anonymous private donor through the University of Washington Center for Research and Education on Accessible Technology and Experiences (CREATE) .

Notes on contributors

Heather A. Feldner is a pediatric physical therapist, an Associate Professor in the Department of Rehabilitation Medicine, an adjunct Associate Professor in the Department of Mechanical Engineering, and an Associate Director for the Center for Research and Education on Accessible Technology and Experiences (CREATE) at the University of Washington. She leads the IMPACT Collaboratory, where her research situated at the intersections of mobility, disability studies, and assistive technology.

Kiana Keithley is a physical therapist at Virginia Mason Franciscan Health Rehabilitation Hospital in Tacoma, WA, and a graduate of the University of Washington DPT program.

Kimberly A. Ingraham is an engineer and Assistant Professor in the Department of Electrical and Computer Engineering at the University of Washington. She is an affiliate faculty in the Center for Research and Education on Accessible Technology and Experiences. She leads the Ingraham Lab, where her research is focused on advancing human mobility using assistive robotic devices, such as exoskeletons, prostheses, and powered wheelchairs.

Anna Fragomeni is a physical therapist and board-certified clinical specialist in pediatrics. She has a clinical appointment at the Institute of Human Development and Disability at the University of Washington and serves as a research PT in Rehabilitation Medicine and Mechanical Engineering.

Nicole Zaino is a research scientist for LUCI, a smart wheelchair technology company, and a graduate from the UW PhD Mechanical Engineering Program.

Liesbeth Gijbels is a speech-language pathologist and a recent PhD graduate from the College of Arts & Sciences at UW. She is currently a postdoctoral researcher in the UW Speech and Hearing Sciences Department.

Alexis Sinclair is a research assistant at the UW Institute for Learning and Brain Sciences. She graduated in 2021 from the University of Oregon with a bachelor's degree in Psychology.

Andrew N. Meltzoff is a developmental psychologist, Professor, and Co-Director of the UW Institute for Learning and Brain Sciences, where he leads the Infant and Child Studies lab, with research interests in social cognition, learning, and behavioral expression.

Patricia K. Kuhl is a speech-language pathologist, Bezos Family Foundation Endowed Chair in Early Childhood Learning, Professor, and Co-Director of the Institute for Learning and Brain Sciences. She leads the Speech Research Lab, which is focused on early language learning, brain development, and bilingual learning.

Katherine M. Steele is an engineer, the Arvid & Marianne Peterson Endowed Professor in Mechanical Engineering, and an Associate Director of the Center for Research and Education on Accessible Technology and Experiences (CREATE). She co-directs the Amplifying Movement and Performance Lab, and directs the Neuromechanics and Mobility Lab, researching mobility and assistive technology use through motion analysis, wearable sensing, and musculoskeletal simulation.

References

[1] Zablotsky B, Ng AE, Black LI, et al. Diagnosed developmental disabilities in children aged 3-17 years: United States, 2019-2021. NCHS Data Brief. 2023;473:1–8.
[2] Walle EA, Campos JJ. Infant language development is related to the acquisition of walking. Dev Psychol. 2014;50(2):336–348. doi: 10.1037/a0033238.
[3] Uchiyama I, Anderson DI, Campos JJ, et al. Locomotor experience affects self and emotion. Dev Psychol. 2008;44(5):1225–1231. doi: 10.1037/a0013224.
[4] Anderson DI, Campos JJ, Witherington DC, et al. The role of locomotion in psychological development. Front Psychol. 2013;4:440. doi: 10.3389/fpsyg.2013.00440.
[5] Campos JJ, Anderson DI, Barbu-Roth MA, et al. Travel broadens the mind. Infancy. 2000;1(2):149–219. doi: 10.1207/S15327078IN0102_1.
[6] Iverson JM. Developing language in a developing body: the relationship between motor development and language development. J Child Lang. 2010;37(2):229–261. doi: 10.1017/S0305000909990432.
[7] Babik I, Cunha AB, Srinivasan S. Biological and environmental factors may affect children's executive function through motor and sensorimotor development: preterm birth and cerebral palsy. Infant Behav Dev. 2023;73:101881. doi: 10.1016/j.infbeh.2023.101881.
[8] Plummer T, Logan SW, Morress C. Explorer mini: infants' initial experience with a novel pediatric powered mobility device. Phys Occup Ther Pediatr. 2021;41(2):192–208. doi: 10.1080/01942638.2020.1819935.
[9] Sloane BM, Kenyon LK, Logan SW, et al. Caregiver perspectives on powered mobility devices and participation for children with cerebral palsy in Gross Motor Function Classification System level V. Dev Med Child Neurol. 2024;66(3):333–343. 2024; doi: 10.1111/dmcn.15718.
[10] Sabet A, Feldner H, Tucker J, et al. ON time mobility: advocating for mobility equity. Pediatr Phys Ther. 2022;34(4):546–550. doi: 10.1097/PEP.0000000000000939.
[11] Currier BA, Jones MA, DeGrace BW. Experiences of Families with young power wheelchair users. J Early Interv. 2019;41(2):125–140. doi: 10.1177/1053815118819204.
[12] Feldner HA, Logan SW, Kenyon LK. In the driver's seat: a randomized, crossover clinical trial protocol comparing home and community use of the Permobil Explorer Mini and a modified ride-on car by children with cerebral palsy. Phys Ther. 2022;102(7):1. doi: 10.1093/ptj/pzac062.
[13] Kenyon LK, Schmitt J, Otieno S, et al. Providing paediatric power wheelchairs in the USA then and now: a survey of providers. Disabil Rehabil Assist Technol. 2020;15(6):708–717. doi: 10.1080/17483107.2019.1617358.
[14] Kenyon LK, Jones M, Livingstone R, et al. Power mobility for children: a survey study of American and Canadian therapists' perspectives and practices. Dev Med Child Neurol. 2018;60(10):1018–1025. doi: 10.1111/dmcn.13960.
[15] Morgan C, Fetters L, Adde L, et al. Early intervention for children aged 0 to 2 years with or at high risk of cerebral palsy: international clinical practice guideline based on systematic reviews. JAMA Pediatr. 2021;175(8):846–858. doi: 10.1001/jamapediatrics.2021.0878.
[16] Novak I, Hines M, Goldsmith S, et al. Clinical prognostic messages from a systematic review on cerebral palsy. Pediatrics. 2012;130(5):e1285–e1312. doi: 10.1542/peds.2012-0924.
[17] Morgan C, Badawi N, Boyd RN, et al. Harnessing neuroplasticity to improve motor performance in infants with cerebral palsy: a study protocol for the GAME randomised controlled trial. BMJ Open. 2023;13(3):e070649. doi: 10.1136/bmjopen-2022-070649.
[18] Begnoche DM, Chiarello LA, Palisano RJ, et al. Predictors of independent walking in young children with cerebral palsy. Phys Ther. 2016;96(2):183–192. doi: 10.2522/ptj.20140315.
[19] Bray N, Kolehmainen N, McAnuff J, et al. Powered mobility interventions for very young children with mobility limitations to aid participation and positive development: the EMPoWER evidence synthesis. Health Technol Assess. 2020;24(50):1–194. doi: 10.3310/hta24500.

[20] Feldner HA, Logan SW, Galloway JC. Why the time is right for a radical paradigm shift in early powered mobility: the role of powered mobility technology devices, policy and stakeholders. Disabil Rehabil Assist Technol. 2016;11(2):89–102. doi: 10.3109/17483107.2015.1079651.
[21] Novak I, Morgan C, Fahey M, et al. State of the evidence traffic lights 2019: systematic review of interventions for preventing and treating children with cerebral palsy. Curr Neurol Neurosci Rep. 2020;20(2):3. doi: 10.1007/s11910-020-1022-z.
[22] Butler C. Effects of powered mobility on self-initiated behaviors of very young children with locomotor disability. Dev Med Child Neurol. 1986;28(3):325–332. doi: 10.1111/j.1469-8749.1986.tb03881.x.
[23] Jones MA, McEwen IR, Neas BR. Effects of power wheelchairs on the development and function of young children with severe motor impairments. Pediatr Phys Ther. 2012;24(2):131–140; discussion 140. doi: 10.1097/PEP.0b013e31824c5fdc.
[24] Feldner HA, Logan SW, Otieno S, et al. Short-term powered mobility intervention is associated with improvements in development and participation for young children with cerebral palsy: a randomized clinical trial. Phys Ther. 2025;105(1):pzae152. doi: 10.1093/ptj/pzae152.
[25] Guerette P, Furumasu J, Tefft D. The positive effects of early powered mobility on children's psychosocial and play skills. Assist Technol. 2013;25(1):39–48. doi: 10.1080/10400435.2012.685824.
[26] Livingstone R, Field D. Systematic review of power mobility outcomes for infants, children and adolescents with mobility limitations. Clin Rehabil. 2014;28(10):954–964. doi: 10.1177/0269215514531262.
[27] Hospodar C, Feldner H, Logan S. Active mobility, active participation: a systematic review of modified ride-on car use by children with disabilities. Disabil Rehabil Assist Technol. 2023;18(6):974–988. doi: 10.1080/17483107.2021.1963330.
[28] Livingstone RW, Field DA. Exploring young children's activity and participation change following 6 months' power mobility experience. Br J Occup Ther. 2021;84(11):713–722. doi: 10.1177/0308022620973935.
[29] Logan SW, Sloane BM, Kenyon LK, et al. Powered mobility device use and developmental change of young children with cerebral palsy. Behav Sci. 2023;13(5):399. doi: 10.3390/bs13050399.
[30] Tefft D, Guerette P, Furumasu J. The impact of early powered mobility on parental stress, negative emotions, and family social interactions. Phys Occup Ther Pediatr. 2011;31(1):4–15. doi: 10.3109/01942638.2010.529005.
[31] Wiart L, Darrah J, Hollis V, et al. Mothers' perceptions of their children's use of powered mobility. Phys Occup Ther Pediatr. 2004;24(4):3–21. doi: 10.1300/j006v24n04_02.
[32] Kenyon LK, Mortenson WB, Miller WC. 'Power in mobility': parent and therapist perspectives of the experiences of children learning to use powered mobility. Dev Med Child Neurol. 2018;60(10):1012–1017. doi: 10.1111/dmcn.13906.
[33] Pituch E, Rushton PW, Ngo M, et al. Powerful or powerless? Children's, parents', and occupational therapists' perceptions of powered mobility. Phys Occup Ther Pediatr. 2019;39(3):276–291. doi: 10.1080/01942638.2018.1496964.
[34] Feldner H. Impacts of early powered mobility provision on disability identity: a case study. Rehabil Psychol. 2019;64(2):130–145. doi: 10.1037/rep0000259.
[35] Livingstone R, Field D, Sanderson C, et al. Beginning power mobility: parent and therapist perspectives. Disabil Rehabil. 2022;44(12):2832–2841. doi: 10.1080/09638288.2020.1842916.
[36] McMaugh A. En/countering disablement in school life in Australia: children talk about peer relations and living with illness and disability. Disability & Society. 2011;26(7):853–866. doi: 10.1080/09687599.2011.618740.
[37] Gudgeon S, Kirk S. Living with a powered wheelchair: exploring children's and young people's experiences. Disabil Rehabil Assist Technol. 2015;10(2):118–125. doi: 10.3109/17483107.2013.870609.
[38] Evans S, Frank AO, Neophytou C, et al. Older adults' use of, and satisfaction with, electric powered indoor/outdoor wheelchairs. Age Ageing. 2007;36(4):431–435. doi: 10.1093/ageing/afm034.
[39] Kenyon LK, Sloane BM, Beers LN, et al. Tiny drivers, big decisions: parental perceptions and experiences of power mobility device trials for young children with cerebral palsy. Disabil Rehabil Assist Technol. 2025;20(5):1566–1573. doi: 10.1080/17483107.2025.2459884.
[40] Nilsson L, Durkin J. Assessment of learning powered mobility use: applying grounded theory to occupational performance. J Rehabil Res Dev. 2014;51(6):963–974. doi: 10.1682/JRRD.2013.11.0237.
[41] Nilsson L, Durkin J. Powered mobility intervention: understanding the position of tool use learning as part of implementing the ALP tool. Disabil Rehabil Assist Technol. 2017;12(7):730–739. doi: 10.1080/17483107.2016.1253119.
[42] Feldner H, Plummer T, Hendry A. A guideline for introducing powered mobility to infants and toddlers; 2022 [cited 2025 June 10]. https://permobilwebcdn.azureedge.net/media/stwou5go/a-guideline-for-introducing-powered-mobility-to-infants-and-toddlers_v0122.pdf
[43] Colorafi KJ, Evans B. Qualitative descriptive methods in health science research. HERD. 2016;9(4):16–25. doi: 10.1177/1937586715614171.
[44] Stanley M. Qualitative descriptive: a very good place to start. In: Nayar S & Stanley M, eds. Qualitative research methodologies for occupational science and occupational therapy. London: Routledge; 2023. p. 52–67.
[45] Tisdell EJ, Merriam SB, Stuckey-Peyrot HL. Qualitative research: a guide to design and implementation. San Francisco: John Wiley & Sons; 2025.

[46] Iverson JM. Developmental variability and developmental cascades: lessons from motor and language development in infancy. Curr Dir Psychol Sci. 2021;30(3):228–235. doi: 10.1177/0963721421993822.
[47] Thelen E. Dynamic systems theory and the complexity of change. Psychoanal Dialogues. 2005;15(2):255–283. doi: 10.1080/10481881509348831.
[48] McCoy SW, Palisano R, Avery L, et al. Physical, occupational, and speech therapy for children with cerebral palsy. Dev Med Child Neurol. 2020;62(1):140–146. doi: 10.1111/dmcn.14325.
[49] Ingraham KA, Zaino NL, Feddema C, et al. Quantifying joystick interactions and movement patterns of toddlers with disabilities using powered mobility with an instrumented Explorer Mini. IEEE Trans Neural Syst Rehabil Eng. 2025;33:431–440. doi: 10.1109/TNSRE.2025.3528454.