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# Factors that affect powered wheelchair use for an adult population: a systematic review

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## ABSTRACT

**Purpose:** The purpose of the review was to explore current factors affecting the use of a powered wheelchair for an adult person with a disability.

**Materials and Methods:** This review followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement. Information about the characteristics of the studies (type, setting) and perceived barriers and facilitators to powered wheelchair use were extracted using a data extraction sheet. Data synthesis was achieved using narrative synthesis. The quality of the included studies was assessed using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (SQAC) and the CASP checklist (Critical Appraisal Skills Programme), Centre for Evidence-Based Medicine, SIGN (Scottish Intercollegiate Guidelines Network).

**Results:** Fifteen studies qualified for inclusion in the review. The narrative synthesis produced a conceptual map of reported factors affecting the usability of a powered wheelchair.

**Conclusions:** This review demonstrates that powered wheelchair use is a multifaceted and multidisciplinary phenomenon that is dependent on numerous interconnected factors including individual adjustment, stakeholder cooperation, societal attitudes, functional performance, and environmental features. Based on the review findings, there are several applied learning outcomes and practical applications to the powered wheelchair prescription and provision.

## ARTICLE HISTORY

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## KEYWORDS

Powered wheelchair; barriers to use; facilitating factors; assistive technology

## > IMPLICATIONS FOR REHABILITATION

- The rejection, misuse or damage of a powered wheelchair can result in condition deterioration and loss of independence for the user.
- Adult powered wheelchair prescription, maintenance, and use is a multi-faceted process spanning social, individual, environmental, technical and functional, and organisational factors.
- Individuals in this stakeholder network should aim to account for these interdisciplinary factors when engaging with people who use powered wheelchairs.

## Introduction

Global disability prevalence is steadily increasing, it is estimated that more than one billion people in the world live with some form of disability [1]. An estimated 16.0 million people in the UK reported a disability in 2021/22, this represents 24% of the total population [2]. Specifically, mobility and problems with ambulation is the most frequently reported impairment type (47%) [2].

There are many different possible therapies or interventions to support people who have mobility problems to preserve or improve participation and function [3]. These interventions can include the provision or prescription of mobility solutions to maximise mobility and independence and improve the quality of life [4]. Mobility solutions can include wheelchairs, powered wheelchairs, electric scooters, walking frames, and walking sticks [3]. The type of mobility solution an individual is prescribed, or purchases, can be dependent on a number of factors including demographics, environment, mobility goals, and motor function [3]. Specifically, powered mobility solutions can provide a viable and valuable solution to individuals varying group of individuals in terms of age, disability, and circumstance. Powered mobility solutions largely consist of powered wheelchairs and electric scooters. People who use powered mobility

solutions tend to meet the following criteria; they are unsafe walking within the home; often unable to propel a manual wheelchair around the home, they have not previously diagnosed with from epilepsy or other causes of loss of consciousness, and has a residential environment compatible with powerchair use [4].

Comprising numerous technical components including: a motor, controls system, associated seating function, base and batteries, in the U.K a powered wheelchair is classified as a Driver and Vehicle Licensing Agency (DVLA) class 2 or 3 vehicle. This means that while you do not need a licence to drive a mobility scooter or powered wheelchair, you may have to register it. For class 2, these cannot be used on the road (except where there is not a pavement) and have a maximum speed of 4mph. Class 3 can be used on the road and have a maximum speed of 4mph off the road and 8mph on the road. Essentially, powered wheelchairs are complex pieces of technology requiring cognitive awareness and dexterity to operate them [5] effectively and safely.

Many positive outcomes have been documented for individuals who use both manual [6, 7] and powered wheelchairs, for instance they have the potential to promote independence, maintain dignity, improve wellbeing, and remove barriers from everyday life

[8]. However, literature suggests barriers and negative outcomes for both. For manual chairs, perceptions of skill, self-efficacy and wheelchair confidence can be barriers [6, 7]. The literature also shows that some people can also experience negative outcomes from using a powered wheelchair. For instance, there is evidence indicating that some people who use a power wheelchair have worse physical function, mobility, lower employment rate, and higher BMI [8–10]. Despite those challenges, power wheelchairs may be necessary for long travel distances and to relieve the pressure from upper limbs. Further, many persons with disabilities can initially be reluctant to use powered wheelchair solutions [10, 11]. The resultant rejection, misuse or damage of a wheelchair can result in a high financial cost to the local healthcare system [12]. Likewise, there can be a high personal cost to the user, leading to a deterioration in condition and loss of independence [13]. Additionally, applied research into powered wheelchair use indicates end user noncompliance with prescribed functions and manufacturer directions could incur personal consequences for the end user including unnecessary faults and breakages and poorer physical health [14]. Therefore, when matching individuals with appropriate assistive technologies, it is important to understand the complexity of factors that must be optimized to enhance their performance and satisfaction [15]. Selecting, designing, or modifying the correct assistive device for an individual are complex but necessary elements for maximizing function among users of assistive products and technologies [1, 16]. Thus, given the potential positive impact of a powered wheelchair but also the associated loss of outcomes when not used or not used in compliance with clinical guidelines, it is essential to understand the factors that affect powered wheelchair use [16].

This review therefore aims to synthesise and systematically review the literature relating to factors affecting powered wheelchair use for an adult population with a disability. This will provide information that could influence practice and present a base for future research enquiry. The development of a conceptual framework from synthesised evidence could be used to guide wheelchair service development in an evidence-based manner. No existing systematic reviews which address these issues were found prior to conducting this review.

## Materials and method

The overarching aim of this review was to explore current factors affecting the use of a powered wheelchair for an adult person with a disability; to develop a conceptual framework to inform future research and wheelchair service development in the UK. Three objectives were developed to direct searching, management, and interpretation of studies:

- to identify and present all studies that explore or document factors that affect the use of powered wheelchairs for adults with a disability.
- to better understand all stakeholder perspectives including service user and professional perspectives regarding wheelchairs for adult persons with a disability.
- to draw conclusions about the current state of enquiry into factors that affect powered wheelchair use.

### Planning the review

An initial scoping search of the literature was conducted. The aim of the scoping search was to 1) identify the most appropriate search terms, 2) determine the resources to be searched (including

databases and specific journals) and 3) to refine the criteria for inclusion/exclusion of studies in the review. Synonyms for powered wheelchair were identified in the literature. Abbreviations were also commonly used extending the terminology pool further. This resulted in a long list of search term combinations included in this systematic review (Table 1).

### Search strategy and resources searched

As is common practice the search was conducted by two independent researchers, with search results being compared at every stage: title screening, abstract screening and full text screening [17]. This was done to maximise the number of studies identified for inclusion in the review. The inclusion and exclusion of studies was discussed between the searchers at every stage for each database search. Whether studies were included or excluded was dependent on their compliance with the inclusion and exclusion criteria. Any disagreements were addressed through researcher discussion.

Further, due to the multidisciplinary nature of the field investigated (assistive technology, psychology, occupational therapy, rehabilitation, human factors and physical disability), searches were conducted through a range of databases. The relevant databases identified in the scoping review included; MEDLINE, PubMed (NCBI), PsycInfo, PsychArticles, Academic Search Complete, EMBASE, and SCOPUS. After studies had been identified, their references and articles citing that research were also checked to see if any further studies qualified for inclusion in this review. Two searches were conducted on each database: one including barriers and synonyms and the other search containing facilitators and associated synonyms. This was to prevent the positive and negative phases cancelling each other out in a Boolean phrase search. An example search is featured below (Table 2).

Inclusion and exclusion criteria were used to refine searches. To be included, studies had to: be peer-reviewed articles (quantitative, qualitative, or mixed methods) written in English; include participants 18 years of age and older who were users of a powered wheelchair, there was no maximum age for inclusion. Studies were excluded if they included individuals who used other forms of Assistive Technology e.g., scooter, walker, cane, and crutches or were systematic reviews or policy and program evaluations. Any studies which did not report on factors affecting powered wheelchair use were also excluded from the review (i.e., those focused on setting evaluation).

As wheelchair interventions have developed significantly in recent decades it was deemed appropriate to restrict the

Table 1. Systematic review included search terms.

	Search terms Included
Population	"Adult services" OR "adult" OR "person" OR "disabled person" OR "disabled adult" OR "disabled person" OR "older adult" ("Spinal cord injury" OR "spine injury" OR "multiple sclerosis" OR "MS" OR "amputation" OR "amputee" OR "stroke" OR "cerebral palsy" OR "CP" OR "muscular dystrophy" OR "Parkinson" OR "Alzheimer" OR "diabetes" OR "diabetic" OR "arthritis" OR "spina bifida" OR "amyotrophic lateral sclerosis" OR "brain injury")
Intervention	"powered wheelchair" OR "mobility technology" OR "mobility aid" OR "electric wheelchair" OR "powered mobility" OR "Electric-powered Indoor outdoor" OR "wheelchair service" OR "motorised" OR "mobility training" OR "EPIOCs"
Outcome measures	"Barriers" OR "challenges" OR "limitations" OR "limiting factors" OR "criticism" OR "critique" OR "response" OR "comment" OR "report" OR "negatives" "Facilitating factors" OR "facilitators" OR "positives" OR "factors" OR "opinion" OR "feedback" OR "usability"

**Table 2.** Boolean search phrases for systematic review example search from PubMed.

Barriers search	Facilitators search
("Adult services" OR "adult" OR "person" OR "disabled person" OR "disabled adult" OR "disabled person" OR "older adult") AND ("powered wheelchair" OR "mobility technology" OR "Electric-powered Indoor outdoor" OR "mobility aid" OR "electric wheelchair" OR "powered mobility" OR "wheelchair service" OR "motorised" OR "mobility training" OR "EPIOC") AND ("Barriers" OR "challenges" OR "limitations" OR "limiting factors" OR "criticism" OR "critique" OR "response" OR "comment" OR "report" OR "negatives") AND ("Spinal cord injury" OR "spine injury" OR "multiple sclerosis" OR "MS" OR "amputation" OR "amputee" OR "stroke" OR "cerebral palsy" OR "CP" OR "muscular dystrophy" OR "Parkinson" OR "Alzheimer" OR "diabetes" OR "diabetic" OR "arthritis" OR "spina bifida" OR "amyotrophic lateral sclerosis" OR "brain injury") Apply equivalent subjects	("Adult services" OR "adult" OR "person" OR "disabled person" OR "disabled adult" OR "disabled person" OR "older adult") AND ("powered wheelchair" OR "mobility technology" OR "Electric-powered Indoor outdoor" OR "mobility aid" OR "electric wheelchair" OR "powered mobility" OR "wheelchair service" OR "motorised" OR "mobility training" OR "EPIOC") AND "Facilitating factors" OR "facilitators" OR "positives" OR "factors" OR "opinion" OR "feedback" OR "usability") AND ("Spinal cord injury" OR "spine injury" OR "multiple sclerosis" OR "MS" OR "amputation" OR "amputee" OR "stroke" OR "cerebral palsy" OR "CP" OR "muscular dystrophy" OR "Parkinson" OR "Alzheimer" OR "diabetes" OR "diabetic" OR "arthritis" OR "spina bifida" OR "amyotrophic lateral sclerosis" OR "brain injury")

intervention, opinion, and economic literature searches to the last 15 years (1997 to 2020). Reference list and hand-searching supplemented electronic searching [17]. Grey literature was also included to limit publication bias. Only studies written or translated into English (UK and international) where full text was available were considered for inclusion in the review.

### Study selection

Titles and abstracts were screened for eligibility in the present review by two independent researchers. Any studies that appeared relevant were extracted for a full text review. This screening process was repeated a second time on all searches to ensure that all eligible articles were identified. References of identified studies were then checked to identify any further relevant studies.

### Data extraction and quality assessment

To standardise and facilitate data extraction, the following information was extracted from each included study: First author, year of publication, location, study design, participant characteristics (age, gender, disability), details of aims, outcomes and conclusions. Individual accounts were set up on database sites (where available) and searches saved along with search alerts activated. Database searching was conducted in July 2023.

Similar to other reviews about facilitators and barriers for rehabilitation [18, 19], the quality of the included studies was assessed using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (SQAC) [19] and the CASP checklist (Critical Appraisal Skills Programme) [20], Centre for Evidence-Based Medicine, SIGN (Scottish Intercollegiate Guidelines Network). The quality scores of the SQAC and CASP comments were used to classify the quality of included studies. All studies were independently assessed by two researchers and disagreements were resolved through discussion.

### Data synthesis and conceptual mapping

A narrative synthesis of the results was then constructed according to Noyes, Booth, Moore, Flemming, Tunçalp & Shakibazadeh [21]. Key results were contrasted across all included studies using a thematic approach. A conceptual map of reported factors affecting the usability of a powered wheelchair was then constructed. The conceptual map follows the framework established by Popay, Roberts, Sowden, Petticrew, Arai, Rodgers, Britten, Roen & Duffy [22].

## Results

### Study selection

The database searches generated 3233 unique abstracts. After screening titles and abstracts, 27 full texts were reviewed, of which 15 studies met the inclusion criteria. Twelve studies were excluded at this stage as they were either a review of service, or not specific to powered wheelchair use (Figure 1).

### Study characteristics

The included studies comprised adults who used a powered wheelchair ( $N=509$ ), wheelchair associate members (family and care givers) ( $N=7$ ), and health professionals ( $N=15$ ). The studies originated from the U.S.A. ( $N=2$ ), U.K ( $N=4$ ), Canada ( $N=3$ ), Sweden ( $N=2$ ), Denmark ( $N=2$ ), Germany ( $N=1$ ), and Italy ( $N=1$ ). Nine studies used a qualitative design, five studies used a quantitative design, and one study used a mixed-method design. Neither the quantitative nor the mixed-methods studies conducted statistical analysis regarding the barriers and facilitators, they all reported the perceived barriers and facilitators in a qualitative way.

### Quality assessment

The included studies table shows the quality assessment scores of the included studies. All included studies scored  $> 0.55$  (11/20) (SQAC) [19] and thus met the quality standard (Table 3).

### Narrative synthesis and grouping of results

Employing narrative synthesis guidelines outlined by Noyes et al. [21, 22] key results were compared across all included studies using a thematic approach. One of the purposes of narrative synthesis is to organize findings from included studies to identify and list the strategies supporting implementation, as well as exploring the relationship between the reported barriers and the facilitators. Through this process, a conceptual map of reported factors affecting the usability of a powered wheelchair was constructed. The conceptual map includes the main themes, social factors, individual factors, environmental factors, technical and functional factors and organisational factors (Figure 2).

### Social factors

#### Barriers

Social barriers were classified as factors that negatively affected powered wheelchair. Namely, the effects of disability stigma and

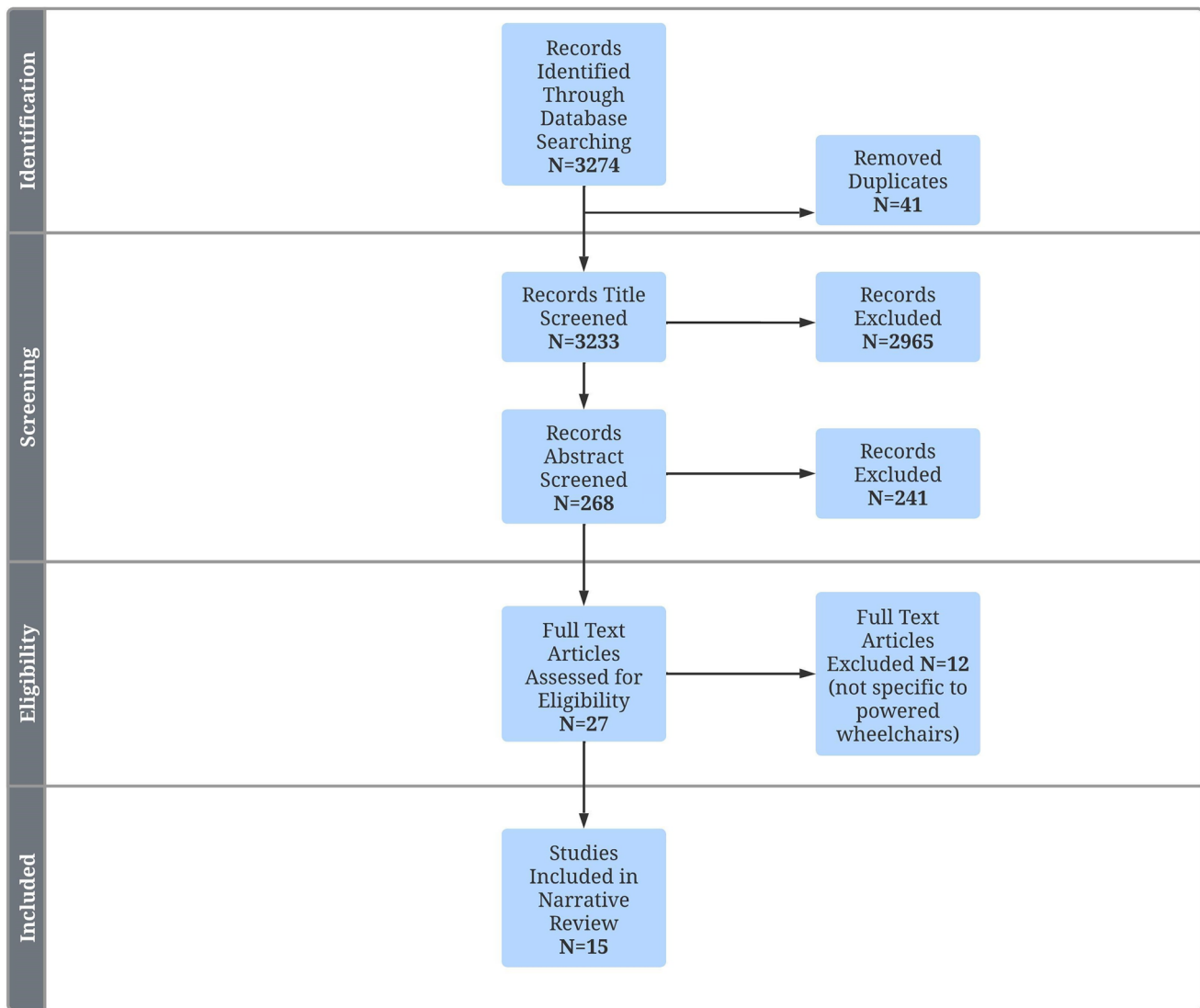


Figure 1. PRISMA flow chart for systematic review.

how people perceived wheelchairs was reported to influence how individuals felt about using their powered wheelchair.

**Effect of disability stigma.** Disability stigma is a complex phenomenon, people with disabilities encounter stigma and experience social exclusion, which involve 'inaccessible education systems, working environments, inadequate disability benefits, discriminatory health and social support services, inaccessible transport, houses and public buildings and amenities, and the devaluing of people with a disability through negative images in the media. Powered wheelchair users often report a common prejudicial assumption that presence in a powered wheelchair is an indication of illness, accident and that the person is therefore "sick", "ill" and less that normative in terms of bodily functioning [23].

Within this review powered wheelchair users described feeling prejudice and stereotypic views from others, for instance that they should be grateful, happy, heterosexual, and less intelligent [24, 25]. In one included study a PWC user described an experience where they were not offered a menu in a

restaurant and felt like it was a sign of prejudicial assumptions about their abilities [25]. Likewise, users emphasised feeling that people saw them as different from others and less capable or gifted because they were in a wheelchair [26]. Users therefore found socialising frustrating and caused feelings of inequality [26]. Some individuals even reported desiring a smaller wheelchair so they would be less noticeable in public environments [26]. Largely, these studies show a pattern of powered wheelchair users being negatively affected by disability stigma and public perception of powered wheelchairs. However, while disability stigma seemed to adversely affect powered wheelchair use in the included studies, engagement with a community network seemed to have a supportive and positive impact on powered wheelchair use. The impact of a community network is further discussed below.

#### **Facilitating factors**

**Community network.** Belonging to a community network was noted to affect how powered wheelchair users felt towards their wheelchair and wheelchair use. In this instance community

Table 3. Systematic review table of included studies characteristics.

First Author/ year/ location	Design/participants	PWC (powered wheelchair) characteristics	Outcome measure	Results	Methodological Quality SQAC score
1. Arthanat et al 2009 USA [23]	Descriptive Analysis Participants (N=70) were PWC users between the ages of 18-65. Participants were male N=40% and female (N=60%).	Participants who used their wheelchair in the community and outdoors were included. Individuals in homes and institutions were excluded from the study.	The usability scale for assistive technology: Wheeled mobility.	Descriptive analysis of the data revealed usability issues with the use of power wheelchairs in all contexts. Users confronted far more significant issues within the community and outdoor environment compared with those at home and in the workplace.	SQAC score: 18/22 (x3 N/A items)
2. Cullen et al 2008 U.K [24]	Prospective follow up study. Participants were adult (27+) PWC users (N=103). There were a mix of males (55%) and females (45%).	PWC users from powered wheelchair assessment clinics. Indoor PWC (33%) Outdoor PWC (67%)	Main outcome measures: rate of day- to-day PWC use and users' perception of how well the PWC allowed them to perform functional tasks.	This study concluded that indoor powered wheelchair use was predicted by verbal recall and other cognitive factors including figure copying and global cognition. Participants in this study also reported that the PWC met their functional needs.	SQAC Score: 19/22 (x3 N/A items) Further comments: All participants were recruited from a single centre and there was a small sample size.
3. Pettersson et al 2006 Sweden [25]	Pre and post assessment design using Wilcoxon signed ranks test. Participants were 32 adults (43+) with stroke using PWC. There were a mix of males (69%) and females (31%).	Outdoor PWC users	This study used several outcome measures. Study specific questions (13 items) based on PIADS (Psychosocial Impact of Assistive Devices Scale). Checklist of life events (17 items), Individually prioritized problem assessment (IPPA), The World Health Organization Disability Assessment Schedule II (WHODASII). Wilcoxon signed ranks test was used to determine significant changes between baseline and follow-up.	This study reported that a powered wheelchair enabled most participants activity. Participation problems were solved by the provision and use of a powered wheelchair between baseline and follow up. Life events were reported as barriers including lack of care staff to help transfer, effects of an operation an becoming healthier. The IPPA showed that all participants experienced a positive outcome associated with PWC use. Within the IPPA participants also reported a number of barriers including difficulties with self-care, domestic life, environmental navigation and interpersonal interactions and relationships. Regarding the WHODAS all participants reported difficulties at baseline and follow up in getting around and participation in society.	SQAC Score: 19/22 (x3 N/A items).
4. Salatino et al 2016 Italy [1]	Observational study utilizing surveys. Participants were adult (+20) PWC users (n=79). Mix of males (N=49) and females (N=30).	PWC prescribed obtained from regional health service.	QUEST (Quebec User Evaluation of Satisfaction with Assistive Technology) PIADS (Psychosocial Impact of Assistive Devices Scale) FABS/M (Facilitators and Barriers Survey Mobility) SCAI (Siva Cost Analysis Instrument).	The results of this study indicated positive outcomes of wheelchair use especially regarding user satisfaction and psychosocial impact. Several barriers and facilitating factors for powered wheelchair use were also reported. Barriers to powered wheelchair use included home characteristics (e.g. stairs, carpets, doors), climatic factors, crowded situations and transportation. Reported facilitators included having a support network, familiar public spaces and use of seating positioning systems.	SQAC Score: 21/22 (x3 N/A items).

(Continued)

Table 3. Continued.

First Author/ year/ location	Design/participants	PWC (powered wheelchair) characteristics	Outcome measure	Results	Methodological Quality SOAC score
Mixed methods 5. Brandt et al 2004 Denmark [26]	Cross sectional interview study. Participants were (N = 111) powered wheelchair users over 65 years of age. The mean age of participants was 77years (median 76, range 65–92 years). 33% of participants were male.	Experienced powered wheelchair users. On average the users had used a wheelchair for 4.5 years (Range 1–22 years).	The study-specific questionnaire used in the interviews was a structured questionnaire constructed on basis of the aims of the study. It aimed to collate practical experiences of participants. A Wilcoxon's signed rank test was used to analyse differences between frequency of use in the summer and winter.	The nearly all of this study indicated that powered wheelchair as very important or somewhat important. A large proportion of participants also stated that the powered wheelchair gave them freedom to get about independently, some partly agreed and only a few disagreed. However, participants over 76 years of age were more likely to report that they did not think that the powered wheelchair could be used for prioritized activities. Likewise, the users' physical abilities had some impact: when the users could not transfer without assistance or to walk at all, the risk that they would not think that they could use the wheelchair for prioritized activities was much increased.	SOAC/CASP comments SOAC Score: 19/22 (x3 N/A items). CASP Comments: there were clear aims stated and the methodological choices were systematic and clearly explained. Ethical approval was obtained and associated with relevant institutions. However there was limited evidenced researcher reflexivity.
Qualitative 6. Bowers et al 2020 U.K [16]	Phenomenological approach using semi structured interviews. Theory led latent thematic analysis. Participants were 15 British powered wheelchair users (N = 7 males and 8 females; mean age = 54 years and SD of age = 18.17)	Participants were PWC users with a range of NHS clinically prescribed Assistive Technology/seating functions. In this study no restrictions were placed on the age and gender of the participants, nor on the condition that underpinned their powered wheelchair use.	Semi structured interviews were conducted using a pre-designed interview framework consisting of several categories; demographic information, knowledge of wheelchair features, barriers and facilitators, motivation and understanding benefits and support.	Explaining why participants engaged with the functions on their powered wheelchairs, this study found three central themes: clinical benefits and functional alternatives, expectations vs reality and the impact of other people. The study also reported a diversity in the perceptions that users had of their equipment. For instance, positive views of features were linked to users' experience of functional benefits and matches between equipment and prior expectations.	SOAC Score: 19/20 CASP comments: Clear statement of the aims within the research and the method was supported by robust theoretical framework with justification for that chosen framework. The data collection procedures were explicit. However, there was little reference to researcher reflexivity. The study did link its findings and draw conclusions to inform current practice and made useful suggestions for future research.
7. Evans 2000 U.K [27]	Constant comparative induction approach. Participants (N = 8) were adult powered wheelchair users between the ages of 39–76. Participants were a mix of male (50%) and female (50%)	Experienced EPIOC users (prescribed EPIOC for over 6 months).	Semi structured interviews were conducted using an interview guideline to understand the effect PWC's have on the users occupation.	Results indicated that power wheelchair use provided a greater opportunity to participate in and control occupation and negative feelings prior to acquisition changed to positive feelings about themselves. However, the study also reported several facilitators to powered wheelchair use including: sense of purpose and less guilt and dependence.	SOAC Score: 18/20 CASP Comments: clear aims were stated and the methodological choices were systematic and clearly explained. Ethical approval was obtained and associated with relevant institutions. However, little researcher reflexivity was evident with no reference to the relationship between participants and the researcher.
8. Evans et al 2007 U.K [28]	Qualitative framework approach. Participants were (N = 17) adult powered wheelchair users between the age of 60 and 81. 53% were male and 47% were female.	EPIOC users in home environment.	Semi structured telephone interviews were conducted to examine older EPIOC's user satisfaction with their chair and service providers.	Participants reported a variety of EPIOC uses, including shopping and some social contact. Moderate satisfaction with the chair was reported. Use was compromised by indoor and outdoor environmental barriers; and the chair not meeting users' needs. Accidents were rare, but many users still experienced insecurity in the chair. High levels of satisfaction with the service were reported, although concern was expressed over length of waiting times.	SOAC Score: 14/20 CASP comments: The aims of the research were clearly stated. However, the justification for the chosen method was lacking and there was no evidence of considering other methods. It was also unclear whether the researcher adopted a theoretical positioning. Additionally, there was limited evidence of researcher reflexivity and consideration of bias. Lastly, although the report mentioned gaining ethical approval it was unclear if informed consent, confidentiality or the effects of the study on participants had been considered.

(Continued)

Table 3. Continued.

First Author/ year/ location	Design/participants	PWC (powered wheelchair) characteristics	Outcome measure	Results	Methodological Quality SOAC score
9. Gillen 2002 USA [29]	Case Report	One participant, 40-year-old male with multiple sclerosis and EPIOC user for 6 years.	This case report summarizes the evaluation and treatment used to provide occupational therapy services to a man living with multiple sclerosis. The focus of this case study was on improving the client's ability to use powered mobility to access the community despite severe ataxia.	A task-oriented approach was used as a frame of reference to guide the evaluation and intervention process. The primary goals of intervention were to control the degrees of freedom required for task participation and simultaneously increase postural stability, resulting in independent control of a power wheelchair. A combination of occupational therapy interventions is illustrated, including assistive technology, positioning, orthotic prescription, and adaptation of movement patterns.	SOAC Score: 14/20 CASP comments: The aims of the research were clearly stated. However, the justification for the chosen method was lacking there was no evidence of considering other methods. It was also unclear whether the researcher adopted a theoretical positioning. Additionally, there was limited evidence of researcher reflexivity and consideration of bias.
10. Mortenson et al 2015 Canada [30]	Interpretive description Bourdieu's theoretical constructs. Participants included 13 older adult (50+) EPIOC users. Of the participants, 46% were female and 54% were male.	EPIOC users	Open ended semi structured interviews were conducted with the aim of understanding the mobility choices of community-dwelling, power wheelchair users	The results indicated that three main styles of power wheelchair use: reluctant use, strategic use, and essential use. Findings highlight the need to alter the power relationship that exists between prescribers and device users and to effect policy changes that enable people with physical impairments to make as wide a range of mobility choices as possible. The results also noted several barriers and facilitating factors to powered wheelchair use. Barriers included climactic factors such as weather, environmental factors such as curbs and identity issues such as feeling more disabled. Facilitators to powered wheelchair use included personalization and adapting to the wheelchair.	SOAC Score: 19/20 CASP comments: There was a clear statement of the aims within the research and the method was supported by a robust theoretical framework with justification for that chosen framework. The data collection procedures were also explicitly described. However, while there was reference to researcher reflexivity there was no reference to data saturation or how it was achieved. Likewise, while the researcher and participant relationship and the impact of the study was explored there was no reference to informed consent procedures or confidentiality. The study did link its findings and draw conclusions to inform current practice and made useful suggestions for future research.
11. Mortenson & Miller 2008 Canada [31]	Continuous Analysis There were 34 participants from across wheelchair provision stakeholder groups, including 13 wheelchair prescribers, 14 wheelchair users, and 7 wheelchair associates (family members and caregivers). Wheelchair prescribers included 1 male and 12 female. Wheelchair users included 7 male and 7 female across facility, community and home settings. Wheelchair associates included spouses, parents, professional care givers and one designer. Gender of this group was not recorded. Years of experience ranged from 2–26 years.	PWC users across facility, community and home settings.	Semi structured interviews explored the intricacies of the procurement process from the perspectives of clients and therapists.	The results of this study documented five main themes: 1. "Who decides?" described varying degrees of client involvement in the procurement process. 2. "Expert knowledge" reflected the expert knowledge that all parties possessed. 3. "Form versus function" captured the primary and, at times, conflicting outcomes that participants wanted to achieve. 4. "Fitting in" depicted the environmental factors that affected wheelchair procurement. 5. "(Re)solutions" illustrated strategies that participants felt improved the process. Barriers to powered wheelchair use therefore included: conflict between client and therapist, accessibility, stigma and funding. Facilitating factors included collaboration of stakeholders and a wheelchair trial.	SOAC Score 18/20 CASP Comments: There was a clear statement of aims and the research rationale was well established with reference to a theoretical positioning underpinning the research. There was also a triangulation of data collection methods to ensure trustworthiness and credibility. However, there was no reference to researcher consideration of bias and the researcher and participant relationship. The study was explicit about ethical considerations concerning informed consent, permission and confidentiality. However, the report did not include whether there was consideration of potential harm.
12. Rossen et al 2012 [32] Denmark	Thematic Analysis This study included 9 adult PWC users ages 35–77 years.	PWC users of any type.	This study used semi structured to explore how users of PWCs experience their everyday life and how their wheelchairs influence their daily occupation.	This study reported four main themes: the functionality of the wheelchair, the wheelchair as an extension of the body, the wheelchair and social life and the wheelchair and identity issues. Barriers to powered wheelchair use noted in this study included; stigma and powered wheelchair identity.	Score: 16/20 CASP Comments: The aims and qualitative nature of the research were clearly reported and justified. However, the report could have discussed an justified the decision to use thematic analysis more explicitly. Similarly, the study did not discuss data saturation or how it was achieved. Similarly, there was reflection or consideration of participant and researcher relationship. Research should also detail future directions of the research.

(Continued)



Table 3. Continued.

First Author/ year/ location	Design/participants	PWC (powered wheelchair) characteristics	Outcome measure	Results	Methodological Quality SQAC score
13. Stenberg et al 2016 Sweden [33]	Grounded Theory There were 15 adult PWC users in this study, 60% women and 40% men. Participant age ranged between 20–63.	PWC user of any type.	This study used thematic interviews to explore the experiences of using an electric wheelchair in daily living.	This study reported one core category: integrating the electric wheelchair – a manifold process. This theme describes the process from initial resistance against use of an electric wheelchair, to acceptance with various extent of integration. Six categories were reported that represent this core process: 6. incorporating the electric wheelchair into the self-identity process, 7. calculating functional consequences, 8. encountering the reactions of others, 9. facing duality in mobility, 10. using proactive strategies, 11. being at the mercy of the system. The study findings indicated that the integration of a powered wheelchair is a complex and manifold process. Practical, personal, and social dimensions were intertwined and significantly involved. Reported barriers included: stigma, climatic factors, being at the mercy of the system, fear of not being perceived as who they are and issues navigating outdoor environments. Facilitators included building relationships and personalization.	SQAC Score: 18/20 CASP Comments The aims of the study and the qualitative methodology was clearly described and justified. However, the theoretical positioning and type of grounded theory employed was not explicitly clear from the method. However, there was evidence of researcher reflexivity and triangulation of data collection methods to ensure trustworthiness and credibility. Further ethical issues were adequately described.
14. Torkia et al 2015 Canada [34]	Content Analysis A total of 12 adult PWC users participated (67% males, 33% females). Ages ranged between 20–90 years.	PWC users in the community.	The study used semi-structured interviews to explore the context of power wheelchair driving challenges from the perspective of the user	This study documented four main themes: 12. difficulties accessing and using public buildings facilities, 13. outdoor mobility 14. problems in performing specific wheelchair mobility tasks/maneuvers – no context specified 15. barriers and circumstances that are temporary, unforeseen or specific to a particular context	SQAC Score: 17/20 CASP Comments: The aims of the study and the methodology were sufficiently justified. The connection between research and data collection methods were also clear. However, there was limited reference to ethical issues and researcher reflexivity. Further, while there was reference to theoretical frameworks, there was no reflection on the theoretical positioning of the research. The implications and impact of the research were also not clearly reported.
15. Bottger et al (2022) Germany [35]	Participatory Photovoice	5 people living in the community using PWC and 2 occupational therapists.	The study used participatory photovoice to explore how people experience their community mobility in a powered wheelchair after a severe stroke.	Results indicated that an accessible environment can be a facilitator of community mobility. However, obstacles are often experienced in a built environment including cobbles, traffic, bus stop poles, and stairs. Active involvement in the provision of devices was also seen as a facilitator to PWC use. Participants also noted that they identified with their PWC i.e., through naming the device. Demands on a PWC user were also noted as barriers to use including the need for planning and preparation and lack of understanding from other people.	SQAC Score: 19/20 CASP comments: There was a clear statement of the aims within the research and the method was supported by a robust theoretical framework with justification for that chosen framework. The data collection procedures were also explicitly described. However, while there was reference to researcher reflexivity there was no reference to data saturation or how it was achieved. The study did link its findings and draw conclusions to inform current practice and made useful suggestions for future research.

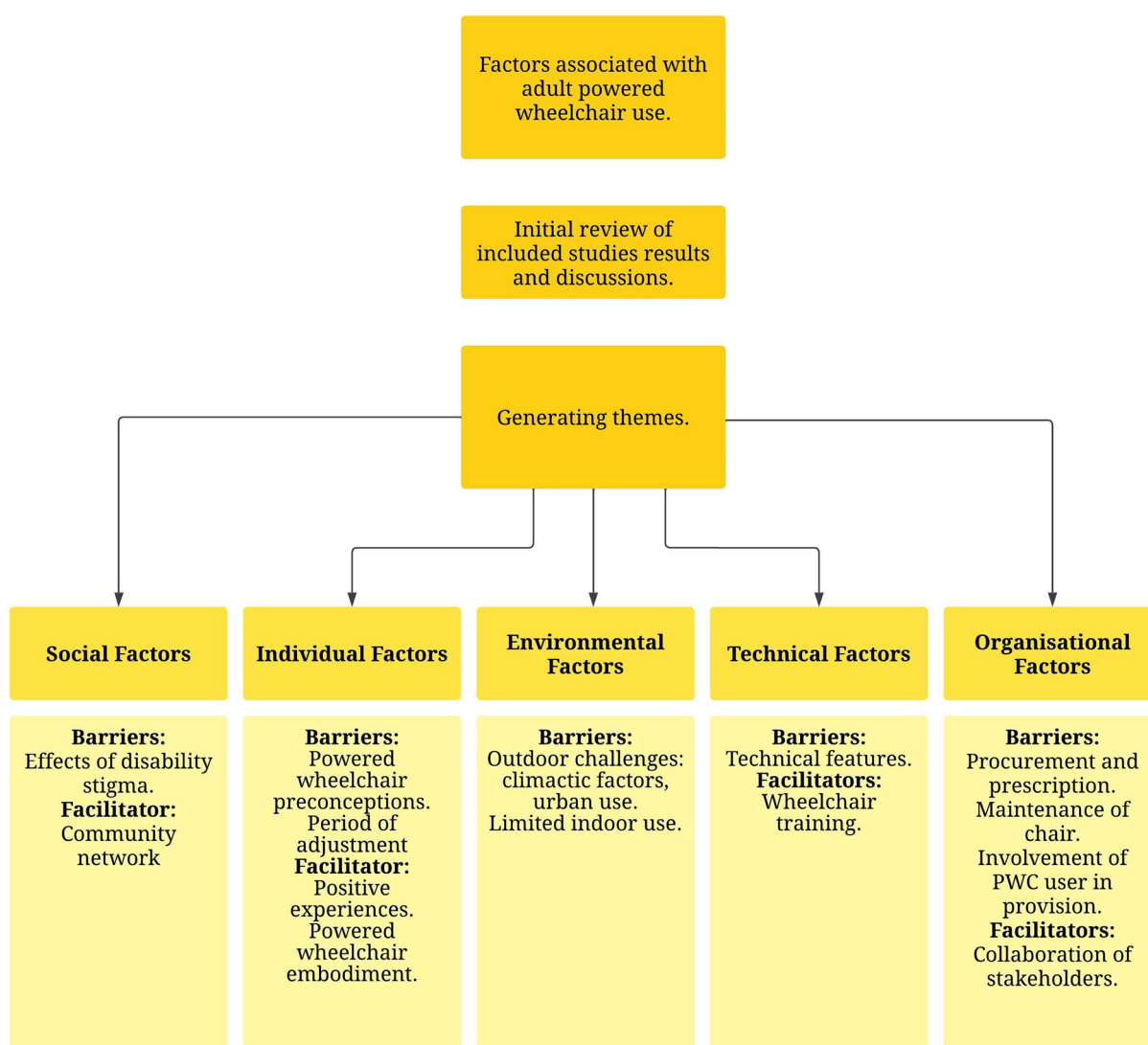


Figure 2. Narrative synthesis.

network is being used as an umbrella term to describe the reinforcing nature of social experience that appears to occur. For instance, a sense of value was felt by users who were able to attend and contribute to disability meetings and committees independently and that the powered wheelchair acted as a facilitator to engage in social activities [1, 27]. One user stressed that his EPIOC enabled him to get in and amongst people and helped him to realise that's he's a human being and should not be ignored [28]. Further, a powered wheelchair made it easier to socialise independently, find a partner, and spend time with friends [23].

### Individual factors

while the perceptions of others were seen to influence powered wheelchair use, this review also identified individual factors. Namely, a period of integration period was seen to influence powered wheelchair use.

### Barriers

**Powered wheelchair preconceptions.** As previously explored, there is arguably a stigma attached to being a powered wheelchair user

[25]. Many people in society make stereotypical assumptions about a person based on their presence in a powered wheelchair [25]. However, while the earlier section focused on the outsider attitudes this section discusses the powered wheelchair users' own preconceptions and attitudes towards powered wheelchair use. From this review it was evident powered wheelchair users also harboured preconceptions around powered wheelchair use and were concerned about the implied consequences a powered wheelchair would have on their self-perception. For instance, prior to and while starting to use a powered wheelchair, users often tried to postpone the use of a powered wheelchair as they reported seeing a powered wheelchair user as a group they could not identify with [26]. One user emphasised that using an electric wheelchair was a sign of being one of "those" [26]. In this instance, individuals did not associate with being a powered wheelchair user and appeared to perceive powered wheelchair users as a separate group.

Further, there was a pernicious a perception among individuals that using their wheelchair would make them appear more disabled [29] and represented a progression of their disability [23]. Evans et al. [28] also discussed a participant who believed that their level of disability had superseded any benefit the chair could offer, the participant stated "I can't do anything much anyway, so I don't deal with it (the chair)".

However, attitudes can change and be shaped by people's experiences [30]. Concerning powered wheelchair use many people reported a "period of adjustment" that enabled them to experience the usefulness of the technology and adjust to the powered wheelchair.

**Period of adjustment.** A period of adjustment was frequently described wherein powered wheelchair users perception of their powered wheelchair, and consequently their self-perception as a person who uses a powered wheelchair, evolved with use and familiarity with the technology. This process was described as integrating the electric wheelchair [23]. Stenberg et al. [23] summarised this process, stating that participants originally saw their wheelchair as an overt proof of a negative life change and a concrete symbol of severe disability. However, once users started using their wheelchair, and experience its benefits, many users reported feeling more positively towards their powered wheelchairs and came to see it as a symbol of freedom [1, 23, 26, 31].

However, a number of dimensions could obstruct this process of powered wheelchair acceptance and integration [23]. Namely, participants described a fear of being overshadowed and disappearing as unique individuals in their wheelchair [23]. Likewise, for some users, the process of integration also involved processing that they had to give up being a walker or a manual wheelchair user [23, 32]. This realisation was also linked to a fear of feeling more disabled.

#### **Facilitating factors**

**Positive experiences.** As stated above, positive experiences while using the powered wheelchair could contribute to; changing perception of the technology, increased self-efficacy in the chair, and a greater feeling of independence [23, 26, 33]. For instance, users described a strong feeling of freedom and movability once they started using the powered wheelchair [1, 23, 31]. The ability to move autonomously without a caregiver was valued and led to a sense of freedom [29]. As well as the freedom and independence, the feeling itself was highly valued and was seen as a positive aspect of wheelchair use [27]. Evans et al. [27] described how positive experiences led to users valuing their wheelchair as an opportunity to experience life. Positive experiences of using the powered wheelchair were therefore seen to help challenge the users' negative attitudes towards powered wheelchairs and accepting their use [29].

**Powered wheelchair embodiment.** A sentiment of embodiment was commonly expressed wherein the technological function of the powered wheelchair was personified. For instance, many users felt like they adopted surrogate legs [28]. One user explicitly referred to the chair as an extension of herself, "They're my legs without that I wouldn't be able to do anything" [28]. In another study, the naming of a PWC was seen as a way to identify with the device [25]. These positive embodiment feelings seemed to give users confidence in their wheelchairs and consequently tried new things which led to a sense of achievement [27]. Echoing this, many users desired more space for personalisation including options for upholstery colour and wheelchair functions [23, 25, 32]. Therefore, personalisation and autonomy over the appearance of the chair was seen as a facilitating factor to accepting and adjusting to the use of a powered wheelchair.

#### **Environmental factors**

Within this review powered wheelchair technology was a valued tool for effective independent manoeuvrability, nevertheless there were instances where individuals felt restricted by non-accessible features in their community. Essentially, environmental factors

describe physical features and landscapes that have affected a powered wheelchair users use of their powered wheelchair.

#### **Barriers**

**Climactic factors.** Firstly, adverse weather conditions were frequently reported to be a deterrent to using a powered wheelchair outdoors. From snow, rain and wind to intense sunshine, there were many reported climactic factors that users frequently took into consideration before driving their powered wheelchair outside [1, 25, 29, 34]. Winter weather, especially, posed additional dangers of body temperature regulation and using electronics in wet conditions, both of which were a deterrent for wheelchair use [29].

**Urban features.** Also, specific public features were noted to cause a significant challenge to powered wheelchair users. Public features that cause concern for powered wheelchair users included heavy traffic and lack of crossings [24, 25]; public toilets, and public transport facilities [1]; ramps, store lay outs and lifts [34]; stairs [25]; and traffic blocking the road [25]. Typical difficulties associated with these inaccessible features largely related to accomplishing challenging manoeuvres in a confined space [35]. These structural barriers were associated with an increased emotional toll of using the powered wheelchair. One user described being forced to use an alternative entrance to a theatre, the alternative entrance was further away causing both inconvenience and a feeling of being different [29].

Further, types of terrain and surface conditions were frequently reported to be a significant challenge or issue; crowded pavements, curbs, gravel and uneven terrain were all avoided [1, 28, 35]. Uneven terrain and negative health consequences for the user were also reported. For instance, uneven surfaces regularly caused issues with limb spasticity [29].

**Limited indoor use.** While outdoor use was often reported as challenging, certain indoor features were also noted as a barrier for powered wheelchair users. Regarding their homes and immediate environment, users reported accessibility issues that either affected the type of chair prescribed or involved required environment modifications [29]. Specific challenging indoor features included; door ways, stairs, carpets and temperature [23, 29, 35]. Evans et al. [28] noted that indoor use was generally challenging because of the size and bulk of a chair. Arthanat et al. [36] concluded that 14% of participants included in their study felt that their home environment was inaccessible to very inaccessible in terms of space available to use their powered wheelchairs.

#### **Facilitating factors**

**Structural change.** Most references to environmental factors reported the challenges powered wheelchair users experienced. However, [23] emphasised that accessibility to public facilities was international issue as well as a local issue. Travelling by bus, train or plane depends on international regulation. Stenberg et al. [23] reports that these added challenges make powered wheelchair users feel like second rate citizens. Stenberg et al. [23] suggests that accessible environmental changes are dependent on and can be facilitated by changes the legislation and building regulations to make them more accessible.

#### **Technical factors**

Within the review there were several key concepts that emerged around the use of technical features and the use of a PWC. These

specific technical features or PWC characteristics seemed to affect the use of the PWC. These concepts form the technical factors that affect powered wheelchair use.

### **Barriers**

**Specific technical features.** Batteries were often reported as a specific technical feature that caused an anxiety for users. The main battery concerns related to; the life of the battery, fear of battery failure; the substantial weight of the battery; and the time the battery took to charge [26, 29]. Users reported having to plan their day around battery charging times [29].

Other than battery concerns, malfunctions with functional features were often a worrying concern for users [29, 32]. One participant noted that a fault with their tilt and recline function left them vulnerable to pressure sores and made mounting curbs challenging as the foot pedals would catch [26].

The lack of certain accompanying equipment or technology was also noted as a barrier to powered wheelchair use. Specifically, Brandt et al. [31] noted that without a wheelchair adjusted car older adults found it challenging to use their wheelchair away from the home. Likewise, Bowers et al. [16] states that an individual's expectation of how their wheelchair may function can be at odds with the experience. Specifically, Bowers et al. [16] highlights the use of the tilt in space function and how a participant experienced a discrepancy between the expectation of a smooth and responsive tilt-in-space experience and the reality of something which is more difficult to operate.

### **Facilitating factors**

**Wheelchair training.** Within this review individuals that received some form of wheelchair training reported feeling more secure in their chair [27]. However, training was unique amongst the included studies. One participant received explicit training from the local bus authority on how to use the local bus system safely, because of this, they reported feeling more confident using the chair on local transport [29]. Regardless of training, users often felt that information could be communicated more effectively [23, 28]. Further, users often wanted more information but were unsure of where to access information [29].

However, Cullen et al. [35] concluded that some cognitive factors may affect an individual's acuity for the skills required to operate a powered wheelchair. For example, delayed verbal recall and overall cognition were predictive of powered wheelchair use [36].

### **Organisational factors**

There are different ways to obtain a powered wheelchair including private funding, third sector contribution or, in the U.K, National Health Service (NHS) provision [37]. This process involves the collaboration and communication between multiple stakeholder groups from manufacturers to prescribers and end users [37]. This review therefore noted several factors that relate to the communication and roles of different stakeholder groups and how they could influence powered wheelchair use.

### **Barriers**

**Procurement and prescription.** Users experiences regarding procurement and prescription varied greatly, however many felt that waiting times could be reduced [23, 28, 29]. One user reported waiting two years for their powered wheelchair [31]. As a result of waiting times and lack of service flexibility users frequently felt frustrated at their dependence on the system [23, 29].

Further Mortenson et al. [32], as well as interviewing end users, also directly interviewed clinicians in their study. All therapists, regardless of discipline, described involving end users in the outcome of the prescription decision making process. However, end users involved in this study stressed that users, as consumers, should ultimately be responsible for the equipment they receive [25, 32]. As such Mortensen et al. [32] further stressed that end users and clinicians each have a set of knowledge and experience that they bring the procurement process. However, conflicts can arise about the type of wheelchair to be acquired.

**Maintenance of chair.** Regarding maintenance or adjustment of the chair, lack of follow up or a delayed follow up often meant that participants waited a long time for appointments and consequently reported feeling stressed about needing adjustments and continued to use an uncomfortable chair [23, 28]. Because of delayed times for appointments, many users were concerned that they would not be assessed in time to account for their changing needs [28]. Consequently, some individuals preferred not to use their chair than deal with having their chair adjusted [28]. Delayed repairs and adjustments frequently meant the user was more dependent on others around them and resulted in limited access to their regular daily routine, this can have adverse health and occupational consequences for the user [26].

### **Facilitating factors**

**Collaboration of stakeholders.** There are many organisations and individuals involved with the prescriptions, delivery, adjustment, and maintenance of a powered wheelchair [30]. Improved collaboration between stakeholder groups, especially between the user and clinician could greatly improve the user experience and acceptance and adjustment process [23, 25, 32]. There is a need for improved support, dialogue, and information between stakeholder groups [23]. Essentially, all stakeholders in the prescription and procurement process should work collaboratively together to "have people happy with the things in the end" [28].

## **Discussion**

This review identified 15 studies reporting on the perceived barriers and facilitating factors of adult powered wheelchair use. This review demonstrates that powered wheelchair use is a multifaceted and multidisciplinary phenomenon that is dependent on numerous interconnected factors including individual adjustment, stakeholder cooperation, societal attitudes, functional performance, and environmental features. Based on the review findings, there are several applied learning outcomes and practical applications to the powered wheelchair prescription and provision process in the U.K.

Firstly, societal, and personal attitudes towards powered wheelchairs can have a pernicious effect on the use of a powered wheelchair [1, 23, 28, 31]. Therefore, individuals who are involved with powered wheelchair prescription should be aware of their own personal biases and cognizant of their patient's self-perception. Likewise, practitioners should anticipate a user "period of adjustment" to the technology and seek to facilitate this process. Namely, within this review, technology personalisation, powered wheelchair training positive experiences, and a supportive social network were seen as facilitating factors to wheelchair use.

Further indoor, and outdoor environmental challenges and certain technological features were a significant barrier to the use of the technology. For instance, batteries were reported as a specific technical feature that caused considerable anxiety for users []. Especially around the time it takes to charge batteries,

and fear of technical failure [16, 26, 29, 32]. Likewise, the use of powered wheelchairs in different settings and terrain also caused anxiety and challenges [29, 32]. For instance, outdoor use was often reported as challenging, certain indoor features were also noted as a barrier for powered wheelchair users [28, 32]. It is no doubt common sense that individuals involved in the design and prescription of powered wheelchairs should consider the environment and context of its use. However, arguably there is a wider concern over the accessibility of public spaces that should be addressed by governing bodies [23]. This review brings attention to the fact that structural barriers were associated with an increased emotional toll of using the powered wheelchair and feelings of being a second-class citizen [29].

Lastly, the organisational barriers highlighted in this review emphasise how the relationship between stakeholders can influence powered wheelchair prescription, maintenance and use. Mortenson et al. [32] was the only included study to account for the perspectives of other stakeholders involved in the powered wheelchair prescription, distribution, and maintenance process. Therefore, further study should also account for a diverse range of stakeholder perspectives to present a complete picture of powered wheelchair provision.

There are several inherent limitations to this review regarding the search strategy, included studies and narrative synthesis. Firstly, this review protocol was not registered prior to the review being conducted. While not currently mandatory, registering search protocols can be useful for transparency [38]. Regarding the search strategy, the included search terms attempted to account for varied terminology around powered wheelchair use. This inevitably meant many search terms were used. However, to strengthen the search “facilitators” and “barriers” searches were conducted separately on each data base to prevent the positive and negative terms cancelling each other out when using Boolean phrase searching. Future research in this area should standardise powered wheelchair technology terminology to make sharing research easier.

Further, this review included studies conducted in several countries. Especially regarding organisational factors and environmental factors, it is challenging to generalise and compare results as built environments and wheelchair procurement differs across countries. However, despite geographical location many studies reported similar barriers and challenges.

Also, powered wheelchairs of all types and specifications are included in this review, meaning conclusions related to specific power chair classification (indoor, outdoor, EPIOC's) cannot be drawn. Likewise, adults with any disability were included in this review. A person's wheelchair features and set up can vary depending on their functional needs. Every individual with a disability has a unique progression and prognosis, and individual and diverse responses may be required. For example, two individuals with the same disability may have very different experiences and needs.

From this systematic review several recommendations and considerations for future research can be presented. Further, some recommendations are also featured in the included studies. For instance, Mortensen & Miller [32] recommends the use of participant observations in combination with interviews to understand powered wheelchair prescription and use in greater detail. Therefore, further study should account for a diverse range of stakeholder perspectives to present a complete picture of powered wheelchair provision. Rossen et al. [26] echoes these sentiments stating that professionals involved in wheelchair provision have to be mindful of how they interact and their occupational requirement to fulfil the commitment in the UN CRPD.

A component of this initiative was to combat stereotypes, prejudices and harmful practices relating to disabled people [39, 40]. However, evidence from this review suggests that this may not reflect wheelchair users' experiences. Within this review, several studies emphasised the importance of including people with disabilities in the research process, especially when analysing results and drawing conclusions [23, 32]. Therefore, future research in this arena should aspire to approach powered wheelchair research inclusively and ethically. To conclude, adult powered wheelchair, prescription, maintenance, and use is a multi-faceted process spanning social factors, individual factors, environmental factors, technical and functional factors, and organisational factors. Individuals in this stakeholder network should aim to account for these interdisciplinary factors when engaging with people who use powered wheelchairs.

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### Data availability statement

The data set for this study is currently not available as it forms part of a larger doctorate research project that is currently ongoing.

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