

Systematic review of power mobility outcomes for infants, children and adolescents with mobility limitations

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Abstract

Objective: To summarize and critically appraise the evidence related to power mobility use in children (18 years or younger) with mobility limitations.

Data sources: Searches were performed in 12 electronic databases along with hand searching for articles published in English to September 2012 and updated February 2014.

Review methods: The search was restricted to quantitative studies including at least one child with a mobility limitation and measuring an outcome related to power mobility device use. Articles were appraised using American Academy of Cerebral Palsy and Developmental Medicine (AACPDM) criteria for group and single-subject designs. The PRISMA statement was followed with inclusion criteria set a priori. Two reviewers independently screened titles, abstracts and full-text articles. AACPDM quality ratings were completed for levels I-III studies.

Results: Of 259 titles, 29 articles met inclusion criteria, describing 28 primary research studies. One study, rated as strong level II evidence, supported positive impact of power mobility on overall development as well as independent mobility. Another study, rated as moderate level III evidence, supported positive impact on self-initiated movement. Remaining studies, rated evidence levels IV and V, provided support for a positive impact on a broad range of outcomes from ICF components of body structure and function, activity

and participation. Some studies suggest that environmental factors may be influential in successful power mobility use and skill development.

Conclusion: The body of evidence supporting outcomes for children using power mobility is primarily descriptive rather than experimental in nature, suggesting research in this area is in its infancy.

Key words: Child rehabilitation, Mobility, Systematic review, Wheelchair, Outcome Assessment (Health Care)

Introduction

Children with mobility limitations due to a motor impairment or movement disorder may have decreased opportunities for participation.[1] Power mobility (including powered ride-on toys or specialized powered devices as well as powered wheelchairs) is an intervention that can promote efficient and independent mobility and has been shown to trigger similar developmental change as the onset of crawling.[2] Despite the potential positive influence on development, survey evidence suggests that power mobility is rarely introduced in the preschool years.[3-7] In a survey of 424 early intervention professionals, less than 7% considered introducing power mobility below 24 months.[8] This is a concern, if children do not develop efficient mobility skills in early childhood they may be at risk for social and developmental delays.[9-11]

Professionals and parents may fear that power mobility will interfere with motor development and learning to walk, or see it as an intervention of ‘last resort’.[12] Some parents embrace the idea of using power mobility, while others are hesitant to explore alternate mobility options.[13] Some clinicians are reluctant to provide power wheelchairs for children who are not competent community drivers whereas others promote early adoption of power mobility experience for infants and preschool children.[14]

To date there are no systematic reviews [15] specifically related to power mobility use in children although there are several examining assistive technology outcomes. Henderson and colleagues [16] concluded that most studies (including seven articles describing power mobility outcomes [13][17-22]) supported positive change in the child’s activity, participation and personal-contextual factors. Another review [23] included six articles related to power mobility [13][17][22][24-26] and concluded that use of a wheelchair (manual or power) does not negatively impact motor development and can increase participation in play, inter-personal

relationships, mobility and personal care. A third review examining caregiver impact of assistive technology use in children [27] included the Henderson review [16] and one study related to power mobility.[28] They concluded that assistive technologies help increase child independence thereby decreasing effort for family caregivers. They stressed the need for education on use and benefits of assistive technologies.

These reviews suggest that assistive technologies in general have a positive impact on child development, and may help decrease family caregiver burden. However, a systematic review critically appraising evidence specific to power mobility use by children is needed to address questions raised by parents, therapists and funders regarding positive and negative impacts on health and to establish the current state of evidence in order to guide future research. The purpose of this systematic review was to summarize and critically appraise the evidence related to power mobility use by children (aged 18 years or younger) with mobility limitations and to identify and classify outcomes according to International Classification of Functioning (ICF) components.[29][30]

Methods

Search strategy

An electronic database search, conducted by two reviewers with graduate level training in rehabilitation, identified studies published from database inception to September 2012 and was updated June 2013 and February 2014. Electronic databases included: OT Seeker; Physiotherapy Evidence Database (PEDro); EBM Reviews: Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE), ACP Journal Club; CINAHL; Medline EBSCO; Medline OVID SP; EMBASE; PsychInfo; and ERIC. Search terms power* mobility, or power* wheelchair (where * indicated a

wildcard function specific to each database) were used both as keywords and mapped to relevant subject headings for each database (e.g. powered/wheelchair, wheelchair/utilization or mobility aids). Searches were either limited to ‘all childhood’ or ‘childhood’ and ‘adolescence’, (depending on database), or the key words and subject headings were combined with the term child*. See online Appendix A for search strategy. Bibliographies of electronically retrieved studies and review articles were manually searched to identify additional publications.

Titles and abstracts were independently reviewed by two reviewers (RL and DF) and, if the abstract appeared relevant, the full-text was obtained. The two reviewers independently determined if full-text articles met inclusion criteria. At all stages differences of opinion were resolved through discussion, and consensus was achieved without the need to involve a third reviewer.

Inclusion and exclusion criteria

The initial search included all primary source studies that included at least one child under the age of 19 years with a motor impairment or a movement disorder related to a neurological, musculoskeletal or neuromuscular condition. No limits were placed on design methodology or publication status in the search process. To meet inclusion criteria, articles needed to provide a detailed description of outcome(s) resulting from use of a power mobility device. Non-English language publications were excluded along with studies involving typically developing children only, or studies involving children and adults where outcomes could not be specifically attributed to children with a disability. Studies describing outcomes from a range of different assistive technologies, where power mobility outcomes were not specifically identified or described, were also excluded. Those articles that focused on development of technology or measurement tools were excluded along with non-peer-reviewed sources such as conference proceedings or

dissertations. During the search a number of qualitative research studies were identified but excluded from this systematic review as they merit a separate, more appropriate analysis.

Appraisal of evidence

Data were extracted independently by the reviewers using the McMaster critical review form for quantitative studies.[31] American Academy of Cerebral Palsy & Developmental Medicine (AACPDM) Levels of Evidence [32] for single-subject and group designs were assigned by consensus. Within this rating system, studies rated as Level I represent the highest level of certainty that the outcome can be attributed to the intervention in question whereas Level V evidence only suggests an association between outcome and intervention. AACPDM protocol can only be used to rate quality of studies achieving evidence levels I, II or III. For studies achieving evidence levels IV and V, quality was summarized using data previously extracted with the McMaster quantitative review form.[31] The PRISMA statement [33] was used to structure this systematic review.

Although the ICF [29][30] provides separate definitions for activity and participation, they are listed together in the classification system. There are different interpretations of what is covered under each component and there may be some overlap.[34][35] For the purposes of this review, activity outcomes were classified as those described in chapters 1-5 (learning and applying knowledge; general tasks and demands; communication; mobility; self-care) and participation outcomes as those described in chapters 6-9 (domestic life; interpersonal interactions and relationships; major life areas; community, social and civic life).[29][30]

Results

Figure 1 illustrates the PRISMA [33] flowchart outlining each step.

Insert Figure 1 about here

The electronic database search strategy identified 454 titles with an additional 42 titles identified through manual searching. After removal of duplicates, 259 titles remained. Full text articles were retrieved for 96 titles. Initial agreement between reviewers on abstracts to be reviewed as full text was 97% (n=93). From full-text review, 29 articles (30%) met the inclusion criteria, [9][10][17-22][24][25][28][36-53] with 6/29 identified through manual searching.[28][49-53] These 29 articles described the results of 28 individual research studies, with one study published as two articles: one focusing on parent outcomes [25] and another on child outcomes.[40] Initial agreement between reviewers on articles that should be included was 96% (n=85). See online Appendix B for detail of excluded studies.

Study characteristics

Table 1 provides a summary of the outcomes, study designs and evidence levels for included studies. Of 29 research articles involved in this review, one included adults [48] but had identifiable data specific to children's outcomes. Power mobility devices included power wheelchairs (20 studies), power mobility devices designed for very young children (five studies), the Smart Wheelchair (three studies) and one specialized seating and power mobility system.[53] Four studies included multiple assistive devices however data specific to power mobility could be identified.[24][28][37][49] A wide range of study designs were identified, including cross-sectional and survey designs, case studies, single-subject designs, some group designs and a single randomized controlled trial.

Insert Table 1 about here

Level of evidence and study quality

Level of evidence and study quality were variable with the majority of studies identified being lower level evidence (level IV and V). Initial agreement of evidence strength ratings

between the two raters was 93%. Initial agreement on quality of conduct ratings was 90% for AACPDM [32] quality ratings and 96% for McMaster quantitative review criteria.[31]

The only randomized controlled trial [43] rated as level II, while the only single-subject multiple-baseline design [38] rated as level III. As per AACPDM [32] protocol, quality ratings could only be assigned to these two studies, with one [43] rated as strong and the other [38] rated as moderate quality. See online Appendix C (Tables 3 and 4) for details of ratings.

Level IV and V studies presented some literature review and analyzed data as appropriate for their design. Most provided a theoretical or clinical rationale except for a few older case-studies [18][19][50] and one cross-sectional design.[37] Studies using standardized outcome measures [22][24][25][28][40][49] alluded to reliability and validity of findings, however those using driving skill tests [17-19][22][36][41][43][51] or survey tools [42] lacked this level of detail. Several studies carried out reliability checks on video or audio-taped coding.[9][20][44][46][47] Apart from a few exceptions,[17][22][36][41][45] studies published in the last 15 years provided information on ethics or consent. All provided detailed descriptions of sample and methods used, however, sample size justification was only included in one study.[48] Some studies lacked detail on contamination or co-intervention, potentially confounding results, [17][25][40] and only two studies [25][48] provided information on effect size. In several studies, outcome measures were used in a different manner to their original intent, [25][36][40][49] potentially putting into question the strength of conclusions.

Identification of ICF [29][30] components addressed with power mobility use:

Table 2 summarizes outcomes for all components; for further detail, see online Appendix C (Tables 5,6 and 7). Body structure and function-related outcomes such as heart-rate, sleep, eating and development were measured in 14 articles. Activity-related outcomes were measured in 28

articles. Most related to power mobility driving with a focus on initiation of mobility,[20][25][38][40] development of driving skills,[18][19][21][22][36][50] introduction with younger children,[10][39][43][44] those with more complex disabilities,[17][20][41][43][45][51-53] and impact on functional mobility skills.[9][22][24][28][37][43][46][49] Others focused on functional independence and occupational performance, interaction with toys, hand-use and device activation. Participation-related outcomes (11 articles) related to improvements in play and social skills.

Insert Table 2 about here

Discussion:

Twenty-eight studies (presented in 29 articles) related to power mobility use by children, aged 18 years or younger, with mobility limitations were critically reviewed. While two studies had stronger evidence ratings (levels II and III), the majority of studies were rated level IV and V, indicating that overall the body of evidence supporting outcomes for children using power mobility tends to be descriptive rather than experimental. This is not surprising given the difficulties inherent in carrying out more rigorous experimental designs and the lack of established methods for grading evidence and strength of recommendations appropriate for assistive technology interventions such as power mobility.[54] The findings of this review suggest that paediatric power mobility outcomes research is still in its infancy. This is the first systematic review that solely focuses on outcomes of power mobility use in children with mobility limitations. Most studies provide positive support for activity-related outcomes, primarily focused on power mobility skill development. For outcomes related to body structure and function, strong evidence from a smaller number of studies support positive impact on

overall development. Fewer studies of lower quality evidence support the positive impact of power mobility on participation outcomes.

It is surprising that a number of studies have initiated exploration beyond mobility outcomes to include the impact of power mobility on BSF. Heart-rate [48] and sleep/wake cycle [25] was measured in two group studies while descriptive evidence also supports improved sleeping, eating and weight gain following power mobility experience.[45] Case-study reports suggest that power mobility can promote emotional, perceptual and intellectual development,[18][21] increase curiosity, assertiveness, confidence, motivation and affect,[45][52] as well as enhance understanding of cause-effect, use of arms and hands and exploratory behaviours,[45] with similar results corroborated in qualitative research.[56] A group study [40] and a case-study [50] suggest that young children may demonstrate more typical and age-appropriate activity and attention levels when power mobility is introduced.[46]

The common concern that power mobility use may have a negative impact on motor development was not substantiated by higher-level group designs.[17][43] In fact, the independence fostered by power mobility may stimulate increased interest in motor activities [55] and decrease need for caregiver assistance.[43] The positive impact of power mobility use on overall development in very young children has been supported by a randomized controlled trial [43] as well as case-studies.[22][44] In contrast, for older children, there was no change in intelligence quotient (IQ) after six months of power wheelchair use.[17] The positive results from power mobility introduction with very young children may provide support for the concept of grounded cognition and the wide-spread impact of perceptual-motor experiences such as independent mobility for infants and toddlers.[11] This also raises the question of whether there

is a ‘window of opportunity’ for influencing overall development in children with mobility limitations.

Early case-studies [18][19][22][50] conclude that children as young as 18-24 months can learn to drive power wheelchairs in very short periods of time. However a recent study, using a more rigorous outcome measure,[57] reported independence taking longer to achieve.[36] Children with complex developmental delays and cognitive limitations [17][20][41][43][53] as well as those using alternate access methods [21][41][53] have also successfully developed independent power mobility skills with longer training times, or use of additional technologies.[45][51][52] Recently, more rigorously conducted case-studies conclude that children below one-year-of-age can use a joystick to activate a power mobility device.[10][39][44] The most effective methods and strategies to enhance learning of power mobility skills in children have yet to be adequately investigated.

While proficient manual wheelchair users may be able to achieve similar levels of mobility to power wheelchair users,[37] few children with cerebral palsy achieve this level of proficiency.[6][7] In this population, use of a power wheelchair may be associated with increased mobility and communication.[24] Power mobility appears to have a generally positive impact on functional independence and occupational performance,[17][22][28][42][43][49] whereas impact on interaction with others and the environment is more varied. Children may demonstrate increased self-initiated mobility [20][25][38] without necessarily increasing interaction with toys or objects.[38][40] This highlights the need for development of paediatric power mobility equipment that enhances environmental interaction. Some children may become more communicative following introduction of power mobility [20][21] while others, who are verbal and demanding of attention, may talk less as they became more independent.[38] Power

mobility interventions may impact significantly on children's play and social skills [9][20][25][40][46][50] and increase participation with other children [45][49][52] and family members.[42] There may also be an association with enhanced interpersonal relationships and levels of responsibility for children with cerebral palsy who use a power wheelchair.[24] While there is room for developing a stronger evidence base across all components of the ICF [29][30] the impact of power mobility use on participation outcomes is in particular need of further research.

Common concerns expressed by parents related to the weight, storage, transportation and technological difficulties of using power mobility equipment and stress the importance of a good match between the device, the user and the environment.[25][42][47][49] Successful achievement of driving skills may significantly relate to the amount of time spent in the power wheelchair.[17] In addition, the child's use of power mobility may change parental attitudes from negative to predominantly positive views.[17] Children's use of power mobility may also impact positively on parents' own quality of life and decrease level of stress,[25] possibly in response to increased perception of societal acceptance.[25][50] This review highlights the importance of physical, social and attitudinal environmental factors in children's use of power mobility.

One limitation of this review was that the inclusion criteria were restricted to research studies published in English in a peer-reviewed journal; studies published in other languages or grey literature may have been missed. A number of international seating, mobility and assistive technology proceedings were searched to identify authors and potential publications in an attempt to minimize publication bias but descriptors related to power mobility have changed over time and studies catalogued using alternate or older terminology may have been missed. Some

early studies were published in less detail, in keeping with the standard of the time, and this may have influenced results and reduced ability to draw conclusions. Different wheelchair driving measures have been used, with few studies reporting psychometric properties, making comparisons and synthesis challenging. The AACPDm protocol [32] for systematic reviews provides a quality evaluation for studies rated evidence levels I-III only, necessitating use of a descriptive quality evaluation for the majority of included studies. However, the large number of databases searched, significant amount of hand searching undertaken, and the high-level of agreement between raters add strength to this review.

In conclusion, although the body of evidence supporting studies' outcomes is primarily descriptive rather than experimental, power mobility can be considered a viable treatment option for children, with positive impact demonstrated on a range of outcomes.

Clinical Messages:

- One randomized controlled trial has been conducted with results demonstrating positive impact on overall development and independent mobility.
- Evidence primarily from observational studies suggests that power mobility has a widespread and positive impact on body function, activity and participation.
- Environmental factors appear to influence power mobility use and skill development.

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Contributors

RL initiated the idea, but both authors (DF and RL) designed the study, undertook the search, evaluated the evidence and wrote the manuscript. RL is the guarantor.

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Table 1: Characteristics of included studies

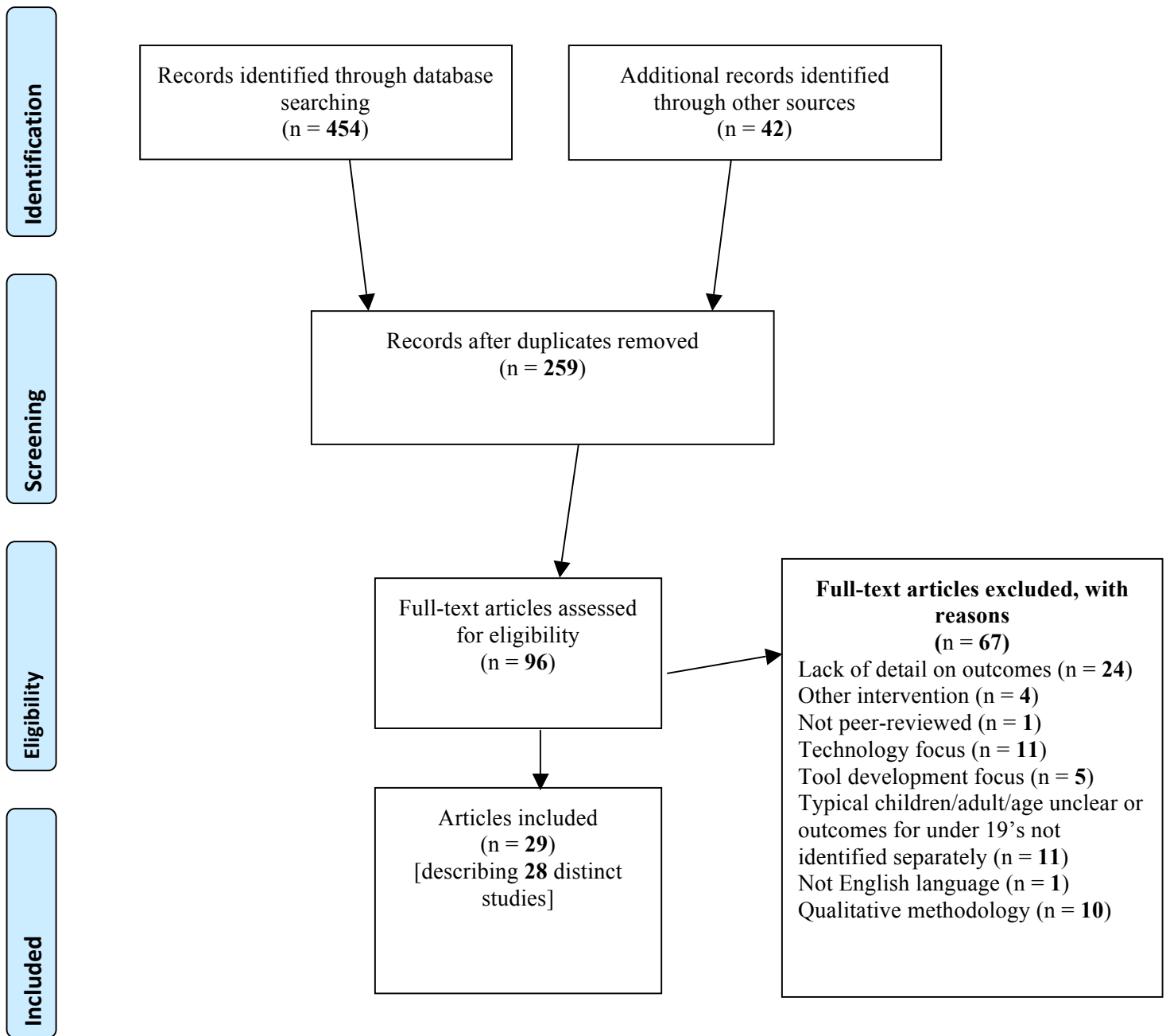
Study	Study Design	Participants and sample	PMD type and duration
Barfield et al. 2005 [48]	Non-randomized pre-test post-test	48 participants including 7 children 14.1± 2.9 yrs with MD	PWC; Not stated
Benedict et al. 1999 [49]	Cross-sectional	13 families; 2-4 yrs; 11 CP, 2 metabolic; 1 PWC user	PWC; Not stated
Bottos et al. 2001 [17]	Case series	25 children; 3-8 yrs; CP	PWC; 6-8 mos
Butler et al. 1983 [18]	Case studies	9 children; 20-39 mos; CP, OI, SMA, SB and other	PWC; 1-4 mos
Butler et al. 1984 [19]	Case studies	13 children; 20-37 mos; SB, CP, OI and other	PWC; 3 wks-4 mos
Butler 1986 [38]	SSRD MBD	6 children; 23-38 mos; CP, SB, OI	PWC; 1-3 wks
Cooper et al. 2008 [37]	Cross-sectional	18; 8-17 yrs; CP, MD, SB, SCI; 9 PWC users	PWC; 7 days
Deitz et al. 2002 [20]	SSRD ABAB	2 children; 5 yrs; CP	Boss toy car; 3-4 hrs
Douglas & Ryan 1987 [21]	Case study	1 child; 4 yrs; high level SCI	PWC; 5 mos
Dunaway et al. 2012 [36]	Case studies	24-34 mos at PWC delivery; 5 SMA, 1 congenital MD	PWC; Average 7.9 mos Range: 73 to 458 days
Everard 1984 [50]	Case study	1 child; 22 mos; SMA	PWC; 6 wks
Galloway et al. 2008 [39]	Case study	14 mos; Down's syndrome	Mobile robot; 6 wks
Guerette et al. 2013 [40]	Cohort without control	23 children; 18-72 mos; 13 CP, 10 other	PWC; 4 mos
Horne & Ham 2003 [42]	Cross-sectional	61 parents; 2-7 yrs; CP, SMA	PWC; Not stated
Huhn et al. 2007 [41]	Case study	1 child; 9 yrs; CP	PWC; 3 yrs
Jones et al. 2003 [22]	Case study	1 child; 20 mos; SMA	PWC; 6 mos
Jones et al. 2012 [43]	RCT	28 children; 14 matched pairs, 14-30 mos; CP and other	PWC; 12 mos
Le Page et al. 1998 [24]	Cross-sectional	96 children; 5-17.8 yrs; CP; 12 PWC users	PWC; Not stated
Lynch et al. 2009 [44]	Case study	1 child; 7 mos; SB	UD1 4 mos; PWC 1 mo
McGarry et al. 2012 [51]	Mixed methods	4 children; 5-13 yrs; CP	Smart PWC; 16 sessions
Nisbet et al. 1996 [52]	Case studies	3 children; 8, 8.5 and 10 yrs; CP	Smart PWC; 15 mos
Nisbet 2002 [45]	Case studies	3 children; 10, 10 and 5 yrs; CP	Smart PWC; 6 mos
Ostensjø et al. 2005 [28]	Cross-sectional	Parents of 95 children; 2-7.5 yrs; CP; 22 PWC users	PWC; Not stated
Pope et al. 1994 [53]	Case studies	10 children; 2.5-9 yrs; CP	SAM; 3 yrs
Ragonesi et al. 2010 [9]	Case study	1 child; 3 yrs; CP	UD2; 4 wks
Ragonesi et al. 2011 [46]	Case study	1 child; 3 yrs; CP	UD2; 10 + 7 days
Ragonesi & Galloway 2012 [10]	Case study	1 child; 11 mos; CP	PWC; 14 days
Tefft et al. 2011 [25]	Cohort without control	Parents of 23 children; 18-72 mos; 13 CP, 10 other	PWC; 4-6 mos
Wiaart et al. 2003 [47]	Cross-sectional	66 used PWC before 18yrs (52 participated by proxy); 4.5-27.5 yrs; CP, SB, SCI, OI	PWC; Not stated

ABAB: two experimental conditions with A: no intervention; B: intervention; CP = Cerebral Palsy; hrs = hours; mo(s) = month(s); MBD = multiple baseline design; MD = Muscular Dystrophy; OI = Osteogenesis Imperfecta; PM = power mobility; PMD = power mobility device; PWC = power wheelchair; SSRD = single subject research design; SB = Spina Bifida; SCI = Spinal Cord Injury; SMA = Spinal Muscular Atrophy; SAM = Seating And Mobility system; UD1 and UD2 = specialized power mobility device; wk(s) = week(s); yrs = years.

Table 2: Outcomes classified to ICF components within evidence levels

Study	Body structure & function	Activity	Participation
Level II			
Jones et al. 2012 [43]	Developmental change	PWC mobility	
Level III			
Butler 1986 [38]		Self-initiated mobility Interaction with objects Verbal communication	
Level IV			
Barfield et al. 2005 [48]	Heart rate		
Bottos et al. 2001 [17]	IQ Motor level	PWC mobility Independence	
Deitz et al. 2002 [20]	Affect	Self-initiated mobility	Social interaction
Guerette et al. 2013 [40]	Engagement	Self-initiated mobility Interaction with objects Verbal communication	Play skills Social skills and interaction
Tefft et al. 2011 [25]	Sleep/wake pattern	PWC mobility	Social interaction
Level V			
Benedict et al. 1999 [49]		PWC mobility	
Butler et al. 1983 [18]		PWC mobility	
Butler et al. 1984 [19]		PWC mobility	
Cooper et al. 2008 [37]		Driving time & distance	
Douglas & Ryan 1987 [21]	Developmental change	PWC mobility	
Dunaway et al. 2012 [36]		PWC mobility	
Everard 1984 [50]	Developmental change	PWC mobility	Peer participation
Galloway et al. 2008 [39]		Self-initiated mobility	
Horne & Ham, 2003 [42]	Developmental change	Independence	Peer & social interaction
Huhn et al. 2007 [41]		PWC mobility	
Jones et al. 2003 [22]	Developmental change	PWC mobility	
LePage et al. 2009 [24]		Mobility Communication	Social roles, Education Responsibility Interpersonal relationships
Lynch et al. 2009 [44]	Developmental change	Self-initiated mobility	
McGarry et al. 2012 [51]		Smart PWC mobility	
Nisbet et al. 1996 [52]	Developmental change	Smart PWC mobility	Peer participation
Nisbet 2002 [45]	Developmental change	Smart PWC mobility Cause-effect Hand use	Peer participation
Ostensjø et al. 2005 [28]		Independence	
Pope et al. 1994 [53]		PWC mobility	
Ragonesi et al. 2010 [9]		Self-initiated mobility	Peer participation Play skills
Ragonesi et al. 2011 [46]		Self-initiated mobility	Peer participation Play skills
Ragonesi & Galloway 2012 [10]		PWC mobility	
Wiat et al. 2003 [47]	Psychological impact	Independence Self-initiated mobility	Peer participation

IQ = Intelligence quotient; PWC = power wheelchair; & = and.

Figure 1. PRISMA flow diagram of the search results

APPENDIX A: Search strategy

Date	Database	Search terms	Limits	# Articles retrieved	# Articles saved
23 rd February 2014	EBSCO MEDLINE and CINAHL	Power* mobility	All child	49	41
“	“	Power* mobility	All child, 0-18	58	33
“	“	Power* wheelchair	All child	34	31
“	“	Power* wheelchair	All child, 0-18	41	24
“	“	Wheelchair/powerd	All child	44	40
“	“	Wheelchair/powerd	All child, 0-18	38	30
“	EBSCO PsychInfo	Power* mobility	Childhood and adolescence	19	17
“	“	Power* wheelchair	Childhood and adolescence	19	15
“	EBSCO ERIC	Power* mobility		27	9
“	“	Power* wheelchair		19	7
“	Ovid EMBASE	Power* mobility AND child*		49	44
“	“	Power* wheelchair AND child*		46	36
“	“	Powered wheelchair/ (MESH) AND child*		15	8
“	Ovid MEDLINE	Power* mobility AND child*		31	30
	“	Power* wheelchair AND child*		25	20
“	“	Wheelchairs/ut (MESH) AND child*		11	5
“	All EBM reviews	Power* mobility		15	0
“	“	Power* wheelchair		11	3

APPENDIX B: Full-text articles excluded from review with reasons

Twenty-four studies were eliminated for lack of detail on power mobility outcomes. These included general reviews, [1-8] descriptive, commentary or background articles [10-19] and research articles lacking detail on power mobility outcomes.[20-24] Sixteen articles were excluded as they were either focused on technology development [25-35] or measurement tool development.[36-40] Two articles were excluded as non-peer reviewed [41] or non-English language.[42] A further 14 articles were excluded for involving typically developing children or adults where outcomes for children with disabilities could not be specifically identified, [43-53] or for describing an intervention other than power mobility.[54-57] Finally, ten studies were excluded from this systematic review as they used qualitative methodologies only.[58-67]

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APPENDIX C

Table 3: AACPDM [32] Conduct questions for group designs

Quality rating: Strong (well conducted 6-7); Moderate (fairly conducted 4-5); Weak (poorly conducted 0-3)

Question	1.	2.	3.	4.	5.	6.	7.	Total	Quality
Jones et al. 2012 [43]	Yes	Yes	Yes	Yes	No	Yes	Yes	6	Strong

1. Were inclusion and exclusion criteria of the study population well described and followed?
2. Was the intervention well described and was there adherence to the intervention assignment? (for 2-group designs, was the control exposure also well described?) Both parts of the question need to be met to score 'yes'.
3. Were the measures used clearly described, valid and reliable for measuring the outcomes of interest?
4. Was the outcome assessor unaware of the intervention status of the participants? (i.e. were the assessors masked)?
5. Did the authors conduct and report appropriate statistical evaluation including power calculations? Both parts of the question need to be met to score 'yes'.
6. Were dropout/loss to follow-up reported and less than 20%? For 2-group designs, was dropout balanced?
7. Considering the potential within the study design, were appropriate methods for controlling confounding variables and limiting potential biases used?

Table 4: AACPDM [32] Conduct questions for single-subject designs

Quality Rating:

Strong (well conducted 11-14); Moderate (fairly conducted 7-10); Weak (poorly conducted < 7)

Question	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	Total	Quality
Butler, 1986 [38]	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	Yes	No	No	7	Moderate

1. Was/were the participant(s) sufficiently well described to allow comparison with other studies or with the reader's own patient population?
2. Were the independent variables operationally defined to allow replication?
3. Were the intervention conditions operationally defined to allow replication?
4. Were the dependent variables operationally defined as dependent measures?
5. Was inter-rater or intra-rater reliability of the dependent measures assessed before and during each phase of the study?
6. Was the outcome assessor unaware of the phase of the study (intervention vs. control) in which the participant was involved?
7. Was stability of the data demonstrated in baseline, namely lack of variability or a trend opposite to the direction one would expect after application of the intervention?
8. Was the type of SSRD clearly and correctly stated, for example, A-B, multiple baseline across subjects?
9. Were there an adequate number of data points in each phase (minimum of five) for each participant?
10. Were the effects of the intervention replicated across three or more subjects?
11. Did the authors conduct and report appropriate visual analysis, for example, level, trend and variability?
12. Did the graphs used for visual analysis follow standard conventions, for example x-y-axes labeled clearly and logically?
13. Did the authors report tests of statistical analysis, for example celebration line approach, two-standard deviation band method, C statistic, or other?
14. Were all criteria met for the statistical analyses used?