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Environmental factors associated with participation and its related concepts among children and youth with cerebral palsy: a rapid review

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ABSTRACT

Purpose: To provide an overview of environmental factors associated with participation and participation-related constructs in children and youth with cerebral palsy (CP).

Methods: A rapid review following the principles from scoping methodology was performed with a literature search in September 2019. The CINAHL, Embase, Ovid MEDLINE and PsychINFO databases were searched to identify original articles which addressed participation in children and youth (aged 0–18) with CP.

Results: In total, 9511 unique articles were identified, of which 34 met all inclusion criteria. Many different measures for environmental factors were used. Most common environmental factors associated with participation (i.e., attendance and involvement) were family ecology, type of school, and parental stress. Regarding participation-related constructs (activity competence, sense of self and preferences), most common factors were parental stress and the physical environment.

Conclusions: While environmental factors are found to be associated with participation attendance and activity competence in children with CP, there is a lack of research of environmental factors in relation to both participation involvement and other participation-related constructs. To increase impact in clinical practice, future research should involve structured assessments of the environment and focus more on modifiable factors, to help service providers develop treatment paradigms needed for meaningful participation outcomes.

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Cerebral palsy; participation; attendance; involvement; environmental factors; ICF



► IMPLICATIONS FOR REHABILITATION


- Family ecology, type of school, and parental stress were the most common factors associated with participation.
- Future research should focus on modifiable factors associated with participation outcomes.
- Modifiable environmental factors associated with participation included parental stress, family activity and type of school.
- In clinical practice, environmental factors are to be assessed in a more systematic way in relation to current or future participation restrictions.

Introduction

Participation is defined as “involvement in life situations” in the International Classification of Functioning, Disability and Health (ICF) by the World Health Organization (WHO) [1] and is considered an important outcome in pediatric rehabilitation [2,3]. It is known that children and youth with cerebral palsy (CP) experience more participation restrictions than their peers without CP [4]. Within the group of children with CP, the frequency, intensity and types of participation vary [5–8]. This is of concern as participation is more than an outcome, it is essential for children’s learning and skill development [3,9–11]. In addition, participation is associated with quality of life in both children and youth with CP [2,12], as well as their typically developing peers [13,14].

As described in the International Classification of Functioning, Disability and Health (ICF), participation of an individual is interconnected with the health condition(s) and their associated impacts on body functions and structures and activities, as well as personal and environmental factors [1]. Previous studies on the topic have shown that both personal factors (i.e., age and gender), activity limitations (gross motor function), and environmental factors (including social attitudes and physical environment) are related to participation in children with CP [4,6,7,15]. From interviews held with adolescents living with CP, we know that they indicate that especially environmental factors play an important role in participation in daily life [8]. A number of quantitative studies investigated specifically the role of environmental factors in participation outcomes of children with CP [16–18]. For

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example, a cross-sectional European study has shown that participation on all domains varied substantially between different European regions [17]. The same has been described in different districts in Northern England [18]. Some studies have assessed the influence of specific environmental factors, such as family income, parental education and type of school, on participation of children with CP [19–26]. However, as most studies included a variety of different environmental factors in their analyses, it is difficult to compare their conclusions. To our knowledge, there has been no recent report that reviews all these different environmental factors in relation to participation outcomes in children with CP.

In the last decade, we have seen interesting developments regarding our definition and understanding of both the construct and measurements of participation. In 2017, Imms and colleagues have further clarified the activity and participation domains of the ICF [3], as they found considerable conceptual inconsistencies related to participation as an outcome in studies aiming to improve participation of children with disabilities [27]. Consequently, the family of participation-related constructs (fPRC) was developed to overcome this ambiguity and differentiate between participation and participation-related constructs [3]. Within the fPRC, participation consists of two main components: attendance and involvement. Attendance is defined as “being there,” while involvement includes elements of engagement, motivation, persistence, social connection and level of affect [3]. Furthermore, other factors that influence participation, but are not a direct element of participation, are described in the fPRC as well. These are called participation-related constructs and include activity competence, sense of self, preferences, context and the environment [3].

As reported by Adair and colleagues in 2018, various outcome measures used to quantify participation in childhood disability do not align with the fPRC with regard to participation attendance or involvement, but rather measure the participation-related constructs [28]. Also, some environmental factors may be associated with participation attendance and involvement, while other environmental factors are associated with participation-related constructs. For that reason, it is essential to make a distinction between participation attendance and involvement, and the participation-related constructs while comparing study outcomes. Accordingly, the aim of the current review is to assess which environmental factors are associated with home, school and community participation attendance and involvement and with other participation-related constructs in children and youth with CP. To make a useful comparison between studies aiming to identify environmental factors related to participation, we decided to assess the results in view of the fPRC and will divide our results according to the participation measure used and corresponding participation-related construct.

Materials and methods

We followed the methodology of a scoping review, as described by Arksey and O'Malley [29] and further elaborated by Levac [30] and Colquhoun and colleagues [31], to allow for a rapid review to assess environmental factors associated with participation in children and youth with CP in a timely manner. Rapid reviews are gaining popularity in healthcare sciences and provide guidance and information for health policy and service programs [32–34]. However, to date no standardized framework for conducting a rapid review exists, resulting in varying methods [32,34]. In order to establish transparency and reproducibility, the WHO suggests that the selected approach should be described comprehensively

[34]. Our review was conducted using the framework of a scoping review [29–31] and followed the guideline provided by the WHO [34]. Within the framework of a scoping review, five different steps are described which we used in our review. An optional sixth step regarding consultation with consumers and stakeholders, was not used.

Step 1: identifying research question

We aim to answer the following research question: *Which environmental factors are associated with home, school and community participation attendance and involvement and with the participation-related constructs in children and youth with CP?*

Step 2: identifying relevant studies

A systematic literature search using CINAHL, Embase, Ovid MEDLINE, PsychINFO, Sociological abstracts and Web of Science was conducted in September 2019 with the help of an experienced academic librarian, aiming to identify original studies assessing the association between environmental factors and (what authors called) participation in children and youth with CP. The search terms (including synonyms and truncation) were *children, cerebral palsy, disability and participation*. The search was limited in the following features: species (human), language (English or Dutch), type of publication (no case studies, editorials, letters or comments), and date of publication (2001–current). The limitation on date of publication was based on the publication of the International Classification of Functioning Disability and Health (ICF) by the World Health Organization in 2001, which first described the term “participation” in their framework for health [1]. See [Supplementary Appendix 1](#) for a comprehensive search strategy.

Step 3: study selection

Peer-reviewed original articles were selected based on the following predetermined inclusion criteria:

- i. A part of the study population was described to consist of children and youth (0–18 years old, mean age <18 years) with CP. The age range was chosen in order to provide comparable results, as it is presumed that other environmental factors play a role in participation in children and youth with CP compared to adults, for example concerning housing and employment;
- ii. Studies consisting of both children with CP, children with other disabilities or typically developing children were only included if the results on children with CP were separately presented;
- iii. (a) Participation was determined with a measurement quantifying participation attendance or involvement, or one of the participation-related constructs, as described by Adair et al. (2018) [28];
(b) In case, it was not listed by Adair, the measurement was found to contain elements of the fPRC after firstly independent critical evaluation of its construct, and, secondly after comparing its content to outcome measures as classified by Adair by two authors (JvdK and JWG);
- iv. Report about an association between at least one environmental factor and participation or a participation-related construct; and
- v. Study design was cross-sectional or longitudinal in nature.

Articles were excluded based on the following predetermined exclusion criteria:

- i. Report about an intervention aiming to enhance participation; and
- ii. Qualitative studies.

After removal of duplicate articles, title and abstract of all articles were screened by the first author (JvdK) using the software package Covidence [35]. Full texts of eligible articles were read to assess their relevance. After selecting articles based on title and abstract and full text, 34 articles were left. Thereafter, references of included studies were checked for other relevant articles.

Step 4: charting the data

A data extraction file was created in which the following study characteristics, were extracted from the included articles: *first author, year of publication, location, study design, study population (number, mean age, gender distribution, GMFCS level), participation measure, and independent variables*. In case of study populations consisting of both children with CP and children with other disabilities or typically developing children, only results concerning the children with CP were extracted. Participation measures were linked to the corresponding construct of the fPRC as described by Adair et al. [28] or by independent critical evaluation of the content of the measures by two authors (JvdK and JWG) in case the measure was not listed by Adair and colleagues.

Step 5: collating, summarizing and reporting the results

Another data extraction file was designed in order to summarize the results. All environmental factors assessed in the included studies were collected, as well as all environmental factors significantly ($p < 0.05$) associated with participation or the participation-related constructs. To organize and present the various environmental factors in an accessible way, we have clustered them in home, school and community factors, and used subcategories such as family factors, socioeconomic status, supports & services, attitudes and physical environment. This presentation of environmental factors is similar to other reviews [4,6,7,36]. We have considered using the ICF chapters on environmental factors but discovered that there was too much diversity in environmental factors within each chapter. The reported outcomes were divided based on the different constructs of participation (i.e., attendance and involvement) and the participation-related constructs (i.e., activity competence, sense of self and preferences).

Results

The literature search yielded 9511 unique articles. In total, 34 articles met all inclusion criteria [5,9,17–26,37–57], of which 20 described participation attendance and/or involvement [19–26,37–48], and 14 described one or more participation-related constructs [5,9,15,17,18,49–57]. Cross-reference checking did not result in any additional articles (see Figure 1 for a flowchart of the article selection). All included studies together describe the participation of 9176 children and youth with CP (with overlap in some study populations), mean ages ranging from 2.6 years (SD 0.1) [20] to 17.9 (1.4) years [51]. Except eight longitudinal studies [5,20,21,40,49,50,56,57], all studies followed a cross-sectional design. Fourteen different measures were used to quantify participation, the most frequently used participation measure was the Children's Assessment of Participation and Enjoyment (used in 10

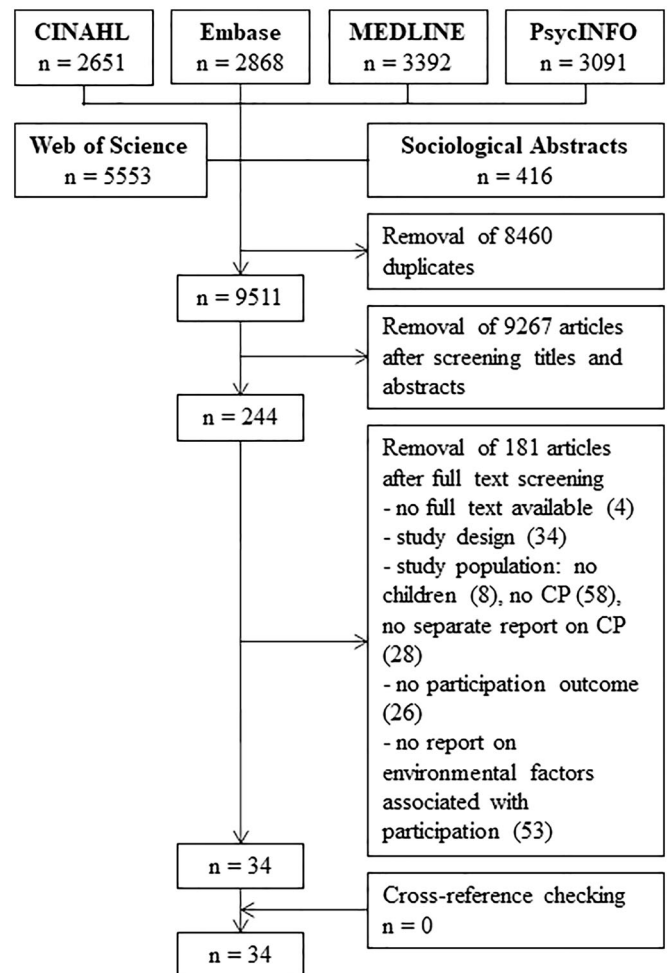


Figure 1. Flowchart of article selection.

studies) [58], followed by the Assessment of Life Habits questionnaire (6 studies) [59], the School Function Assessment (4 studies) [60] and the Vineland Adaptive Behavior Scale (4 studies) [61]. An overview of study characteristics is provided in Table 1 (regarding participation attendance and involvement) and 2 (participation-related constructs).

Participation attendance and involvement

Regarding participation, 20 studies reported on participation attendance [19–26,37–48], of which 4 studies also reported on participation involvement [21,40,41,47]. Table 3 and Supplementary Appendix 2 show all environmental factors assessed and associated with participation attendance or involvement in these studies.

Factors associated with participation attendance

Home and family factors were the items assessed most frequently by the 20 studies addressing *participation attendance*. Concerning family factors, especially family ecology and parental education were often considered, of which the former was more frequently found to be positively associated with participation attendance than the latter. The term family ecology refers to a comprehensive construct concerning family interactions, relationships and functioning, as well as the family's expectations of and supports to their child [21,62]. Other family factors, such as family organization, parental characteristics and parental employment were

Table 1. Study characteristics of included articles concerning participation attendance and involvement (n = 20).

| First author | Year | Country | Study design (follow-up duration) | Study population | | | Outcome measure | | | |
|------------------------------|------|---|--------------------------------------|------------------|---------------------------|---------|-------------------|--|------------|-------------|
| | | | | n | Mean age in years (SD) | % girls | GMFCS level | Participation measurement (subscale) | Attendance | Involvement |
| Amini ¹⁹ | 2018 | Iran | Cross-sectional | 274 | 9.6 (1.9) | 38% | I-V | CPAS (social participation subscale) | x | |
| Bult ²⁰ | 2013 | The Netherlands | Prospective cohort (3–5 years) | 46 | 2.6 (0.1) | 44% | I-V | CAPE | x | |
| Chiarello ²¹ | 2016 | USA | Prospective cohort (1 year) | 429 | 3.2 (0.1) | 44% | I-V | CEDL (family and recreational activities domain) | x | x |
| Chiarello ³⁷ | 2012 | USA | Cross-sectional | 85 | 4.5 (0.8) | 41% | I-V | APCP | x | |
| Furtado ²² | 2015 | Brazil | Cross-sectional | 102 | 9.9 (2.8) – 10.1 (2.7) | 47% | I-III | SFA | x | |
| Imms ²³ | 2009 | Australia | Cross-sectional | 108 | 11.7 (0.5) | 42% | I-V | CAPE | x | |
| Kang ²⁴ | 2010 | USA | Cross-sectional | 209 | 16.2 (2.3) | 48% | I-V | CAPE | x | |
| King ³⁸ | 2013 | Australia, Canada, USA | Cross-sectional | 1076 | n.g. (age range 6–20) | 43% | I-V | CAPE | x | |
| Longo ²⁵ | 2012 | Spain | Cross-sectional | 199 | 12.1 (3.0) | 43% | I-V | CAPE | x | |
| Mahel ³⁹ | 2007 | Australia | Cross-sectional | 112 | 13.9 (1.0) | 32% | I-V | PAQA | x | |
| Majnemer ⁴⁰ | 2015 | Canada | Prospective cohort (5 years) | 38 | 10.1 (1.6) | 37% | n.g. [†] | CAPE | x | x |
| Majnemer ⁴¹ | 2008 | Canada | Cross-sectional | 67 | 9.7 (2.1) | 37% | I-V | CAPE | x | x |
| Michelsen ⁴² | 2008 | Denmark, England, France, Germany, Ireland, Italy, Sweden | Cross-sectional | 818 | 10.4 (n.g.) | 41% | I-V | FPQ | x | |
| Morris ⁴³ | 2006 | UK | Cross-sectional | 129 | 9.9 (1.9) | 44% | I-V | ASK | x | |
| Palisano ²⁶ | 2011 | USA | Cross-sectional | 205 | 16.2 (2.2) | 48% | I-V | CAPE | x | |
| Schenker ⁴⁴ | 2006 | Israel | Cross-sectional | 148 | 9.7 (1.9) | 41% | II-IV | SFA | x | |
| Schenker ^{45, #} | 2005 | Israel | Cross-sectional | 148 | 9.8 (1.9) – 9.9 (2.0) | 41% | II-IV | SFA | x | |
| Schenker ⁴⁶ | 2005 | Israel | Cross-sectional | 148 | 9.8 (1.9) | 41% | II-IV | SFA | x | |
| Shikako-Thomas ⁴⁷ | 2013 | Canada | Cross-sectional | 175 | 15.3 (2.2) | 41% | I-V | CAPE | x | x |
| Shikako-Thomas ⁴⁸ | 2013 | Canada | Cross-sectional | 187 | 15.4 (2.2) | 41% | I-V | CAPE | x | |

Abbreviations: APCP: assessment of preschool children's participation; ASK: activity scale for kids; CAPE: children's assessment of participation and enjoyment; CEDL: child engagement in daily life measure; CPAS: children participation assessment scale; FPQ: frequency of participation questionnaire; GMFCS: gross motor function classification system; n: number; n.g.: not given; PAQA: physical activity questionnaire for adolescents; SD: standard deviation; SFA: school function assessment; UK: United Kingdom; USA: United States of America.

[#]The study populations of these articles included amongst others children with cerebral palsy, as well as typically developing children or children with other disabilities. Only the characteristics of the children with cerebral palsy are reported here, unless stated otherwise.

[†]Mobility of the study population is described as "most were ambulatory (32/38 GMFCS I – II)".

Table 2. Study characteristics of included studies concerning participation-related constructs (n = 14).

| First author | Year | Country | Study design (follow-up duration) | Study population | | | Outcome measure | | | | |
|------------------------------|------|---|--------------------------------------|------------------|---|---------|-----------------|---|---------------------|---------------|-------------|
| | | | | n | mean age (SD) in years | % girls | GMFCS level | Participation measurement (subscale) | Activity competence | Sense of self | Preferences |
| Bartlett ⁴⁹ | 2014 | Canada, USA | Prospective cohort (1 year) | 429 | 3.2 (0.9) | 44% | I-V | CEDL (self-care domain) | x | | |
| Colver ¹⁵ | 2012 | Denmark, England, France, Germany, Ireland, Italy, Sweden | cross-sectional | 818 | n.g. (age range 7–13) | 41% | I-V | LIFE-H (mealtimes, health hygiene, personal care, home life, mobility, responsibilities, relationships, school, and recreation domains) | x | | |
| Dang ⁵⁰ | 2015 | Denmark, England, France, Germany, Ireland, Italy, Sweden | Prospective cohort (5 years) | 594 | 10.4 (n.g.) at baseline; 15.1 (n.g.) at follow-up | 42% | I-V | LIFE-H | x | | |
| Donker-voort ⁵¹ | 2007 | The Netherlands | Cross-sectional | 103 | 17.9 (1.4) | 40% | I-V | FIM/FAM LIFE-H VABS | x x x | | |
| Faucon-nier ¹⁷ | 2009 | Denmark, England, France, Germany, Ireland, Italy, Sweden | Cross-sectional | 818 | n.g. (age range 8–12) | n.g. | I-V | LIFE-H | x | | |
| Hammal ¹⁸ | 2004 | England | Cross-sectional | 443 | 4.8 (1.1) | 40% | n.g. | LAQ | x | | |
| Imms ⁵² | 2017 | Australia, Canada | Cross-sectional | 236 | n.g. (age rang 10–13) | 37% | I-IV/V | CAPE-PAC | | x | |
| Majne-mer ⁹ | 2010 | Canada | Cross-sectional | 55 | 9.9 (2.0) | 35% | I-V | PAC | | x | |
| Parke ⁵³ | 2010 | Ireland | Cross-sectional | 102 | n.g. (age range 7–13) | 38% | I-V | LIFE-H | x | | |
| Ramstad ⁵⁴ | 2012 | Norway | Cross-sectional | 105 | 14.0 (3.0) | 49% | I-IV/V | LIFE-H | x | x | |
| Shikako-Thomas ⁵⁵ | 2015 | Canada | Cross-sectional | 128 | 15.3 (2.0) | 41% | I-V | PAC | x | | x |
| Tan ⁵ | 2016 | The Netherlands | Prospective cohort (3–4 years) | 424 | 9.5 (6.2) | 38% | I-V | VABS (socialization domain) | x | | |
| Van Schie ⁵⁶ | 2013 | The Netherlands | Prospective cohort (2 years) | 108 | 6.3 (1.0) | 36% | I-V | VABS (socialization and communication domains) | x | | |
| Voorman ⁵⁷ | 2010 | The Netherlands | Prospective cohort (3 years) | 110 | 11.3 (1.7) | 36% | I-V | VABS (socialization and communication domains) | x | | |

Abbreviations: CAPE-PAC: children's assessment of participation and enjoyment - preferences for activities of children; CEDL: child engagement in daily life measure; FIM/FAM: functional independence measure/functional assessment measure; GMFCS: gross motor function classification system; LAQ: lifestyle assessment questionnaire; LIFE-H: assessment of life habits questionnaire; n: number; n.g.: not given; PEDI: pediatric evaluation of disability inventory; SD: standard deviation; USA: United States of America; VABS: vineland adaptive behavior scales.

Table 3. Environmental factors correlated with participation attendance (n = 20) and involvement (n = 4).

| | Attendance | | | | | | | | | | Involvement | | | | | | | | | | | | | | | | |
|-----------------------------|---------------------------|--------------------------|-------------------------------|-------------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|---------------------------|----------------------------|------------------------------|------------------------------|-------------------------------|----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------------|------------------------------------|-------------------------------|------------------------------|------------------------------|------------------------------------|--|--|--|
| | Amini, 2018 ¹⁹ | Bult, 2013 ²⁰ | Chiarello, 2016 ²¹ | Chiarello, 2012 ²⁷ | Furtado, 2015 ²² | Imms, 2009 ²³ | Kang, 2010 ²⁴ | King, 2013 ³⁸ | Longo, 2012 ²⁵ | Maheer, 2007 ³⁹ | Majnemer, 2015 ⁵⁰ | Majnemer, 2008 ⁵¹ | Michelsen, 2008 ⁵² | Morris, 2006 ⁵³ | Palisano, 2011 ²⁶ | Schenker, 2006 ⁴⁴ | Schenker, 2005 ⁴⁵ | Schenker, 2005 ⁴⁶ | Shikako-Thomas, 2013 ⁴⁷ | Shikako-Thomas, 2013 ⁴⁸ | Chiarello, 2016 ²¹ | Majnemer, 2015 ⁴⁰ | Majnemer, 2008 ⁵¹ | Shikako-Thomas, 2013 ⁴⁷ | | | |
| HOME | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Family factors</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Family ecology | | + | + | - | | +/- | +/- | | | | | | | | | | | | | | | | | | | | |
| Family organization | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parental characteristics | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parental education | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parental employment | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parental stress & coping | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Financial resources</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Family income | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Socioeconomic status | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Type/size of residence | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Physical environment</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Supports | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Attitudes | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SCHOOL | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Type of school | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physical environment | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Supports/services | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Attitudes | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMMUNITY | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Physical environment | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Attitudes | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Supports/services | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Medical services | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Grey cell indicates that the environmental factor was assessed in the study.
 +Indicates an association between the environmental factors and outcome.
 ±Some, but not all, elements of the environmental factor were associated with the outcome.
 -Indicates that no significant association was found.

assessed in 6 studies [12,23–25,37,42]. One study reported on parental stress and coping and found both positive and negative associations with participation attendance in children with CP [20]. Regarding financial resources, family income was the most frequently considered item which correlated positively to participation attendance in two studies [38,48]. Supports in the home environment were assessed in one study, but no correlations with participation outcomes were found [20]. None of the 20 studies assessed attitudes of others in the home and school environment in relation to participation attendance.

Regarding other school factors, type of school was found to be associated in the majority of studies that investigated this demographic variable. Overall, children with CP who attended special schools scored lower on participation measures than those attending regular schools. Few studies have assessed the physical environment, supports and services with regards to participation attendance. Nonetheless, the two studies that did assess these items found positive associations with participation attendance [24,44].

The community factors show variable results. Overall, the abundance of empty cells in Table 3 indicate that most studies have not focused on community factors in relation to participation attendance. Still a few studies have described mostly positive associations between the physical environment ($n=1$) [22] or (medical) services ($n=4$) [21–24] and participation attendance.

Factors associated with participation involvement

Family factors were the items assessed most frequently in the four studies addressing *participation involvement*. In three studies assessing family factors, a positive association between family ecology [21] and participation involvement was found, whereas parental stress was negatively correlated [41]. Regarding participation involvement, no associations were found with the impact of the health condition on the family [41] and parental education [40]. Other family factors, including family organization, parental characteristics and parental employment, were not assessed. Family income was described not to be correlated to participation involvement in two studies [40,41]. All other home factors concerning financial resources, supports and attitudes have not been studied.

With regard to school factors, the association between type of school and participation involvement was assessed in two studies. Neither study described a significant association [41,47]. Other school factors, that is, physical environment, supports/services, and attitudes of teachers and classmates have not been investigated in relation to participation involvement.

Two studies analyzed community factors in the context of participation involvement [21,41], which showed varying results. For example, regarding medical services, children who received rehabilitation services showed higher participation involvement (enjoyment) in active-physical activities [41]. On the other hand, no association was found between the intensity of therapy and participation involvement [21]. None of the studies analyzed associations with the physical environment or attitudes in the community.

Participation-related constructs

Regarding the participation-related constructs, 11 studies reported on activity competence [5,15,17,18,49,51,53,54,56,57], of which one study also reported on sense of self [54]. Three other studies described results concerning participation preferences [9,52,55]. Table 4 and Supplementary Appendix 3 show all environmental

factors assessed and associated with the participation-related constructs in these 14 studies.

Factors associated with activity competence

Concerning home factors, most studies addressing activity competence focused on family factors and financial resources. However, few studies found correlations between activity competence and family factors, including family ecology ($n=1$ out of 1 study that assessed this item) [49], family organization ($n=2$ out of 5) [54,57], parental education ($n=1$ out of 6) [57] and parental stress ($n=3$ out of 5) [50,53,57]. Regarding financial resources, no associations were found with activity competence in three studies [18,51,54]. All studies assessing supports and attitudes [15] and the physical environment around home [15,17,18] showed positive correlations with activity competence.

With regard to school factors, type of school was described to be associated with activity competence in one study [5]. Children at specialized schools were found to experience less activity competence compared to their peers at regular schools [5]. The one study addressing the physical environment at school and attitudes of classmates and teachers found a significant positive correlation between attitudes of classmates and teachers, but not physical environment, and activity competence [15]. Supports at school have not been investigated in relation to activity competence.

Five studies addressed the physical environment of the community in light of activity competence [15,17,18,54,57], of which one study described a significant positive association [15]. Two studies assessing supports and (medical services) showed varying results [15,49]. For example, social support in the community was found to be positively associated with activity competence in one study [15], while the number of community programs was not in another study [49]. None of the studies analyzed associations between attitudes in the community and activity competence.

Factors associated with sense of self

In the one study considering sense of self, only parental mental health was associated with the outcome. An increasing level of parental mental health issues was associated with reduced satisfaction with the accomplishment of daily activities. Other home factors, including living with one or both parents, parental education and financial resources were not associated with satisfaction with the accomplishment of daily activities or social roles. Type of school was described not to be associated with sense of self. No community factors were taken into account [54].

Factors associated with participation preferences

In the three studies addressing participation preferences, no associations were found between home or school factors and the outcome. Regarding home factors, family ecology [55], parental education [52], parental stress [9] and family income [52,55] were reported not to be associated with participation preferences. Type of school was assessed once, but not found to be associated [55]. Community factors and physical environment, supports and attitudes at home and at school have not been investigated in these studies in relation to participation preferences.

Discussion

In this review, we included 34 articles to synthesize the published literature on environmental factors and their associations with home, school and community participation attendance and involvement, and with other participation-related constructs in

Table 4. Environmental factors associated with activity competence ($n = 11$), sense of self ($n = 1$) and preferences ($n = 3$).

| | Activity competence | | | | | | | | | | | Sense of self | | | Preferences | |
|--------------------------|---------------------------------|-------------------------------|-----------------------------|------------------------------------|-----------------------------------|-------------------------------|-------------------------------|--------------------------------|---------------------------|----------------------------------|--------------------------------|-----------------------------|--------------------------------|---------------------------------------|-------------|--|
| | Bartlett, 2014 ⁴⁹ | Colver, 2012 ¹⁵ | Dang, 2015 ⁵⁰ | Donkervoort, 2007 ⁵¹ | Fauconnier, 2009 ¹⁷ | Hammal, 2004 ¹⁸ | Parkes, 2010 ⁵³ | Ramstad, 2012 ⁵⁴ | Tan, 2016 ⁵ | Van Schie, 2013 ⁵⁶ | Voorman, 2010 ⁵⁷ | Imms, 2016 ⁵² | Majnemer, 2010 ⁹ | Shikako-Thomas, 2015 ⁵⁵ | | |
| HOME | | | | | | | | | | | | | | | | |
| Family factors | | | | | | | | | | | | | | | | |
| Family ecology | + | | | | | | | | | | | | | | | |
| Family organization | | | | | | | | | | | | | | | | |
| Parental characteristics | | | | | | | | | | | | | | | | |
| Parental education | | | | | | | | | | | | | | | | |
| Parental employment | | | | | | | | | | | | | | | | |
| Parental stress & coping | | | | | | | | | | | | | | | | |
| Financial resources | | | | | | | | | | | | | | | | |
| Family income | | | | | | | | | | | | | | | | |
| Socioeconomic status | | | | | | | | | | | | | | | | |
| Type/size of residence | | | | | | | | | | | | | | | | |
| Physical environment | | | | | | | | | | | | | | | | |
| Supports | | | | | | | | | | | | | | | | |
| Attitudes | | | | | | | | | | | | | | | | |
| SCHOOL | | | | | | | | | | | | | | | | |
| Type of school | | | | | | | | | | | | | | | | |
| Physical environment | | | | | | | | | | | | | | | | |
| Supports | | | | | | | | | | | | | | | | |
| Attitudes | | | | | | | | | | | | | | | | |
| COMMUNITY | | | | | | | | | | | | | | | | |
| Physical environment | | | | | | | | | | | | | | | | |
| Attitudes | | | | | | | | | | | | | | | | |
| Supports/services | | | | | | | | | | | | | | | | |
| Medical services | | | | | | | | | | | | | | | | |

Grey cell indicates that the environmental factor was assessed in the study.

+Indicates an association between the environmental factors and outcome.

±Some, but not all, elements of the environmental factor were associated with the outcome.

–Indicates that no significant association was found.

children and youth with CP. With the extracted data, we were able to summarize our current knowledge, and to identify knowledge gaps about environmental factors and participation outcomes in children and youth with CP.

Concerning associations with *participation attendance*, most common factors in this review were family ecology and type of school. The few studies reporting on *participation involvement*, also found associations with family ecology, as well as with parental stress and services. Regarding the participation-related constructs, *activity competence* was found to be related to parental stress and the physical environment at home amongst other factors. The one study assessing *sense of self* described a relation with parental stress. Three studies addressing *participation preferences* reported no significant associations. Overall, the majority of studies focused on family factors as potential influencers of participation in children with CP. School and community factors were less frequently taken into account.

These findings are partially in line with findings from previous literature reviews on participation in children with CP. They also found associations between social supports and attitudes [4,6,7], type of school [4], physical environment [4,6], family factors [7], and participation in children with CP. However, in contrast to our study, these reviews did not differentiate between participation attendance, participation involvement and the participation-related constructs, nor they did focus specifically on the influence of environmental factors. A scoping review concerning the impact of environmental factors on participation in children with disabilities, not only children with CP, by Anaby et al. states that all environmental domains in the ICF affect children's community participation. The most common reported facilitators in this review were social support from family and friends, and geographic location. Whereas the most common barriers were negative attitudes, physical accessibility of the environment, transportation, services and policies and lack of support from staff and service providers [63]. The difference in results from our study might be explained by the heterogeneity in study populations, as well as by the fact that Anaby and colleagues solely focused on community participation. Studies on home and school participation were not included by Anaby et al. [63], while different environmental factors might be of importance in these contexts.

Although environmental factors corresponding to all ICF domains were included in the analyses reported in the current literature review, the majority of these variables was only included in one or two studies, or was measured in different ways as most studies are using diverse measurements or questionnaires to assess environmental factors. As a result of which no firm conclusions could be drawn. In order to make the results of studies describing environmental factors more easily comparable, it would be of great value if environmental factors, including home, school and community factors, are to be assessed in a more systematic way instead of looking at various individual factors that could serve as an indicator of a certain environmental factor. In order to accomplish this, the environment and its related constructs should be parsed, as has been done with participation in developing the family of participation-related constructs [3]. In our opinion, the ICF chapters on environmental factors are not useful for this particular purpose, as there is too much diversity in environmental factors within each chapter. Furthermore, the usage of actual validated measures of environmental factors or participation measures that also involve the environment might provide a first solution for partially overcoming the inconsistency and diversity in environmental variables, for example measures such as the Craig Hospital Inventory of Environmental Factors

[64], the European Child Environment Questionnaire [65], the Family Environment Scale [66], the Participation and Environment Measures for Children and Youth [67], or Young Children Participation and Environment Measure [68].

Implications for clinical practice

Even more interesting than determining which factors are associated with participation, might be which factors are modifiable, as this could provide insights and starting points for possible intervention to increase the level of participation for children and youth with CP. Clearly, factors such as parental education and number of siblings are not modifiable when supporting a child with CP. However parental stress, family activity orientation and type of school were also found to be associated with participation in some studies included in the review. At the clinical level, these factors can potentially be modified by therapy, training or technological assistance and should be considered when assessing participation restrictions of children and youth with CP in clinical settings. For example, parental stress could be reduced by providing family-centered services, family activity orientation could be supported by meaningful activities for the whole family (e.g., using the F-Words approach with goal sheet [69]), and type of school could be influenced by policy makers, teachers and rehabilitation professionals aiming for inclusive education.

Directions for future research

As stated above, a majority of the included studies addressed participation *attendance* and *activity competence*. Merely four out of 34 studies assessed participation *involvement*, three assessed participation preferences, and only one *sense of self*. Furthermore, the results reveal that most studies on participation are addressing the family and school contexts, and to a lesser extent the community. In all contexts the physical environment is targeted, but information on social attitudes is sparse. Future research on participation in children and youth with CP might focus more on participation *involvement* and the participation-related constructs other than activity competence, such as *preferences*, *sense of self*, and *context*. Moreover, more attention should be paid to impact of community factors and social attitudes on participation. Although the results in this review in general are based on cross-sectional associations and therefore no conclusions on causality can be drawn, the results provide a basis for future studies focusing on understanding causal relationships, paying attention to modifiable factors to create a stronger impact on policy and clinical practice.

Limitations

Naturally, some limitations of our study should be mentioned. First, the literature search and article selection was performed by one author, which may have resulted in the missing of relevant articles. Also, the participation-related constructs were not included in the literature search, as we used the terms "participation" and "engagement" to find studies on (what authors called) participation. This may have resulted in the missing of relevant articles which used a participation-related construct as their main outcome. Nonetheless, cross-reference checking was performed and did not result in the inclusion of additional articles. The cross-reference checking, however, was performed after exclusion of studies that included both children with CP as well as other children and did not report the results on these subgroups

separately. These studies may have referenced relevant articles involving children with CP, which because of our approach are not included in our review. Furthermore, due to the heterogeneity of the study populations (i.e., severity of CP), environmental factors measured, and participation measures used in research with children and youth with CP, results of different studies are difficult to compare. We attempted to overcome this problem by only including studies that reported on children and youth with CP separately in case the study population consisted of children with other disabilities as well. However, this may have resulted in the missing of relevant information from studies where results for children with CP were not reported separately. Moreover, we did not report on the strength of correlation, solely on statistical significance and direction of the correlations. Because of the overall large sample sizes of the included studies, relatively small correlation coefficients may have been statistically significant. Also, we organized our results in line with fPRC, dividing participation and the participation-related constructs, in order to make our results more comparable and generalizable. Still, some studies considering a certain participation-related construct further divided their results based on different activities. We decided not to elaborate on these details to maintain a comprehensible overview.

Conclusion

In summary, family factors, community factors and social attitudes were found to be associated with participation attendance and activity competence in children and youth with CP. Therefore, more attention should be given to the role of environmental factors in promoting participation outcomes. We also identified the lack of research about environmental factors in relation to both participation involvement and other participation-related constructs than activity competence. We suggest that future research should involve structured assessments and should focus more on modifiable environmental factors to help service providers develop treatment paradigms needed for meaningful participation outcomes.

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