mHealth applications for children and adolescents with neurological disabilities

Integrative Literature Review

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Abstract

The purpose of this study was to analyze and synthesize the previous research on the usability of mHealth applications for children and adolescents with neurological disabilities. A systematic review search was conducted on five databases, Cinahl (EBSCO), Google Scholar, IEEE Xplore, ProQuest Central and SportDiscus and additionally a manual international search was carried out. The searches were limited to years 2014-2020. A total of 20153 articles were found. Eleven articles met the inclusion and exclusion criteria. Synthesis of the data was made to identify the factors influencing accessibility, user engagement and adoption of the mHealth applications. The quality of the chosen articles was carried out with Critical Appraisal Skills Programme (CASP) and Mixed Methods Appraisal Tool (MMAT). The results are described and presented in tables. The quality of the seven applications were assessed with Mobile Application Rating Scale (MARS).

In recent years, more studies has been published on mHealth applications but few of the studies concentrates on children and adolescents with disabilities. Children, adolescents and people with disabilities have a legal right to participate to research voluntarily and increase awareness of their own thoughts and ideas about the topic. It is valuable to know about the accessibility of the mHealth apps for children and adolescents with neurological disabilities. The results show that mHealth applications have potential for empowering and supporting self-management skills and health behavior of children and adolescents with neurological disabilities. The classification of disability and health needs to be standardized and the different needs of the user`s should be recognised. Individual accessibility features increase mHealth application`s user engagement and adoption of the mHealth app. In the future, the efficacy of the mHealth applications should be focused more. Results can be used for targeting digital health promotion interventions and increasing health equity.

Keywords/tags

mHealth application, mobile application, disability, children, adolescent, self-management, empowerment, Mobile Application Rating Scale (MARS)

Miscellaneous (Confidential information)

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1 Introduction

There are estimated 93 million children worldwide between 0-14 years old living with moderate or severe disabilities. The estimated number of children and adolescents under 18 years old with disabilities is around 150 million. The estimation should be approached carefully because the classification and reporting systems varie extensively between countries. Disability in genaral includes physical, social and environmental barriers. The diversity of disabilities is extensive. People with disabilities benefit health promotion interventions even though these interventions are not usually targeted at them. There is an evidence-based information concerning how users` opinions should be considered when planning health care systems. Children and adolescents with neurological disabilities should be involved to the designing, developing and implementing different kind of activities in the field of health promotion. (World Report on Disability, 2011.) The value of everyday-life actions has been recognised in health promotion and interventions are focused more on the living environments. The use of mobile health applications (mHealth applications) aims to influence health factors in everyday lives and therefore their opportunities among children and adolescents with neurological disabilities should be assessed.

The physical activity, social participation and quality of life are lower among children and adolescents with neurological disabilities. The risk for secondary health conditions is bigger than among children and adolescents without disabilities. There are several barriers while attempting to health care services, therefore different interventions are needed. One of the main objectives in the WHO Global Disability Action Plan 2014-2021 is to improve access to health services and programmes. The action plan has several principles based on human rights for example equal opportunities, full participation of society and respect disabled children`s developing capacities. Children and adolescents with disabilities should have an equal opportunities and full participation to health services and programmes. (Parker et al., 2018; Terrill et al., 2019; WHO Global Disability Action Plan 2014-2021, 2015.)

Disabled people use less Information and Communication Technology (ICT) than non-disabled people (World Report on Disability, 2011). At the same time the use of ICT,

including mobile applications, is increasing all over the world. Many kind of mobile health applications (mHealth applications) are developed and used worldwide to increase people`s physical activity, social participation and improve their self-management skills. It is valuable to identify the factors which influence accessibility, user engagement and adoption of the mHealth applications for children and adolescents with neurological disabilities. Nowadays the importance of self-management skills is recognised. People who have better knowledge about their health, do better choices and have better quality of life. Opportunities for collaborative decision making and supportive environment can help people with disabilities to improve actively their own health and quality of life. (Sinha et al., 2018; World Report on Disability, 2011.)

Child`s function is related to the family and social and physical environment. Health conditions can be improved for example by technology and accessibility of health care, rehabilitation or buildings. International Classification of Functioning, Disability and Health (ICF) is an universal framework for defining health on different perspectives. ICF-CY is the same framework for children and adolescents, which recognises the importance of family, environment, participation and developmental delays. For children and adolescents with neurological disabilities, rehabilitation supports and enables participation in social environment. (International Classification of Functioning, Disability and Health. Children & Youth version, 2007; World Report on Disability, 2011.)

The purpose of this Integrative Literature Review is to analyze and synthesize the existing evidence-based knowledge about the usability of mHealth applications for children and adolescents with neurological disabilities. The primary objective is to examine the accessibility of the mHealth applications for children and adolescents with neurological disabilities. The second objective is to identify the factors which are influencing user engagement and adoption of mHealth applications for children and adolescents with neurological disabilities. Theoretical background is based on health empowerment and International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY).

2 Definition of disability

The definition of disability is complex and dynamic. Disability in genaral includes physical, social and environmental barriers. ICF is the International Classification of Functioning, Disability and Health, which is a framework designed by World Health Organization (WHO). It`s aim is to measure and describe health and disability in multidimensional way. According to ICF, both environmental and personal factors are in continuous interaction, influencing on person`s daily activities, function and participation. Possible limitations and barriers are recognised. ICF recognises the interactivity between health and personal and environmental factors. The foundation of rehabilitation is the ICF. Children and adolescents with neurological disabilities need individual and targeted support in their living environment so they are able to perform preferable and participate more in social or/ and physical activities. (International Classification of Functioning, Disability and Health. Children & Youth Version, 2007; World Report on Disability, 2011.) This research focuses on children and adolescents with spina bifida, developmental disability, Spinal Cord Injury, Spinal Cord Anomalies, Traumatic Brain Injury (TBI) and Cerebral Palsy (CP).

2.1 The International Classification of Functioning, Disability and Health (ICF)

The ICF considers health as a combination of biological, social and individual factors. It is universal and can be used worldwide for defining individual`s functioning, disability and health. Health conditions and environmental and personal factors are always interactive towards one another. The interaction between health conditions and environmental and personal factors compose disability and functioning level of the individual. Environmental factors can be for example attitudes, climate or infrastructure. Personal factors can be for example age, social background, behavior or experience. Every individual, for example a child with Cerebral Palsy, experience her/his disability in individual way. The experience is based on her/his health condition and environmental and personal factors together because they influence individual`s function, activity and participation (see Figure 1). (Towards a Common Language for Functioning, Disability and Health. ICF, 2002.)

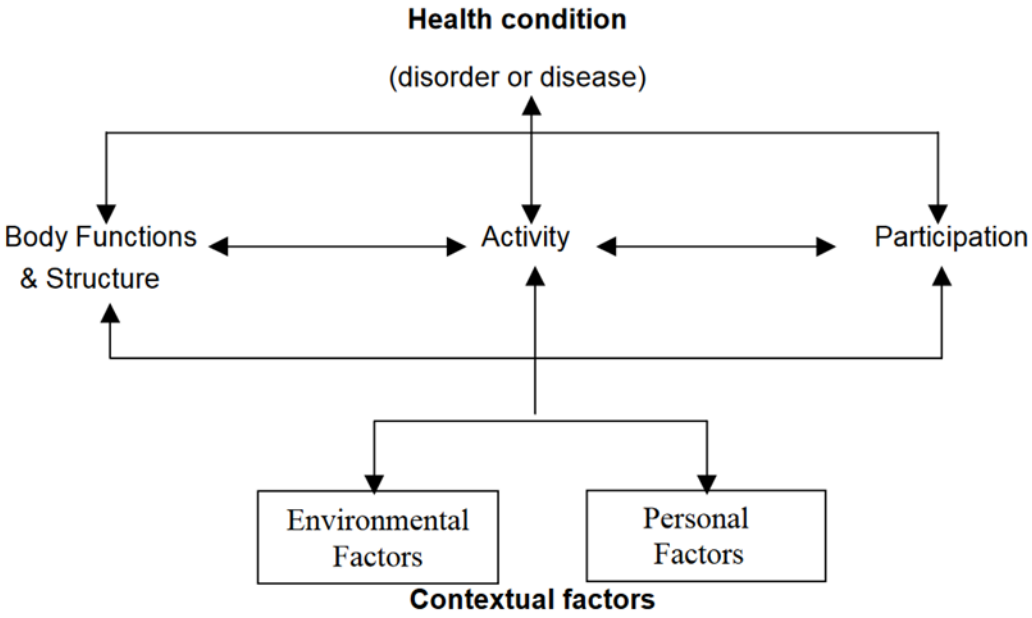

Figure 1. ICF Framework from WHO (Towards a Common Language for Functioning, Disability and Health. ICF, 2002, 9)

Disability is multidimensional. Different health conditions can be inborn, caused by trauma or illness. Disability can be visible or invisible. There are also diversity in the personal factors as well. Consideration should be present while talking about disability. Every child and adolescent with disabilities experience their own health and situation differently. The diversity of disability should be recognised and generalization and predujice avoided. Different preventive research and interventions should be tailored and targeted at spesific groups and involve them on development. (Child disability overview, 2015; World Report on Disability, 2011.)

The International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) is an universal classification for children and youth under 18 years old. The ICF-CY recognises the importance of family, developmental features of an individual in different age phases, participation and environmental factors. In ICF-CY the child is thought as a part of a family unit and therefore the child`s function and family relations are influencing one another. Every individual`s development in terms of physical and social factors are identified. The current level of body function, body structure, activity and participation are being compared to the expected skills of the

different age phases. That gives a valuable information of the potential risk of a disability. (International Classification of Functioning, Disability and Health. Children & Youth version, 2007.)

2.2 Health empowerment as a part of health equity

The Declaration of Alma Ata in 1978 by World Health Organization (WHO) says, Health is everyone`s fundamental right and health and social development affect each other. Individual should have a right to participate in their own health care. WHO defined in 1984 health promotion as a process where people are enabled to have responsibility for their own health. Health promotion analyses the social and environmental needs and defines the concept of well-being. People have an essential need for participation. It has been proved that active involvement affects positive way to learning and empowerment. (Green et al., 2019.)

World Health Organization (WHO) redefined the message of Ottawa Charter (1986) in 2016 “health is created in the settings of everyday-life in the neighbourhoods and communities, where people live, love, work, shop and play”. The importance and power of everyday settings in health has been recognized and underlined. (Green et al., 2019, 497.) The use of mHealth applications aims to influence health factors in everyday lives. United Nation`s Article 23 says “…shall be designed to ensure that the disabled child has effective access to and receives education, training, health care services, rehabilitation services, preparation for employment and recreation opportunities in a manner conductive to the child`s achieving the fullest possible social integration and individual development, including his or her cultural and spiritual development” (Convention on the Rights of the Child 1989, Article 23).

Health promotion aims to equity and empowerment worldwide. The development of knowledge, values and skills affects individual decision-making. Individual empowerment increases when individuals have better understanding and opportunity to make decisions according to their own health. The interpretation of health is complex but one of the main components of health empowerment. The empowerment affects health equity. Well-being and disease influence each other. It is considered that individual can experience high-level of well-being despite of his

disease. Prevention and management of disease and disability are important aspects of health promotion and health equity. Health equity could be reached with digital health, including mHealth applications. It could be increased with targeted and adequate health interventions. At the same time inequity can increase if health interventions aren`t targeted well. (Green et al., 2019; Sinha et al., 2018.)

Self-efficacy is an important part of health. People who have better belief and understanding to the control of their lives, are more able to make healthy decisions about their lives. They handle better the information they receive and can manage their own health better. There has been discussion about the difference of social marketing and health promotion. Co-operation of health promotion and social marketing can improve specialized health strategies and practice. Health promotion focuses on empowering individuals and communities, social marketing focuses more on social determinants of health behavior. (Green et al., 2019.) Self-efficacy influences self-management. Self-efficacy`s relation to health behavior and behavior change has been recognised. The combination of personal, behavioral and environmental factors influence health and disability. (Parker et al., 2018.)

Important facilitators in behavior change are goal setting, self-management and self-efficacy. There is only a little information about mHealth application`s opportunities and challenges for children and adolescents with disabilities and their self-management skills and social participation. Sport and games can improve disabled people`s self-esteem and body function. This has also a positive effect on their quality of life and participation to community. (World Report on Disability, 2011.) Everyone should have a chance to be an active part of their social community.

2.3 Self-management and disability

Self-management skills are important part of life especially for adolescents who are becoming more autonomous. Self-management means that individual is able to manage own health, physical and psychosocial consequences and possible changes in lifestyle because of a chronic condition. It means individuals participate actively in their own health management. Self-efficacy influences self-management. Good self-management skills enable people to solve problems and make decisions about their

own health. The aim is to manage and prevent secondary conditions. Children and adolescents with neurological disabilities, for example people with spinal cord injury, are at greater risk to have more secondary health conditions like depression, hypertension or spasticity. It is essential that people with chronic disease or disability learn to live their life as healthy as possible and as independent as possible. (Mortenson et al., 2019; Parker et al., 2018; Singh et al., 2019.)

It is essential to support self-management skills in the living environment. The amount and quality of support depends on child`s or adolescent`s individual needs and functional level. There are some evidence-based knowledge that self-management interventions can be effective and reduce health care cost. The need for transportation reduces if the support is given in the living environment. Regular support in the living environment can help to maintain the motivation in behavior change. Good self-management skills can influence positively health behavior and health. (Lorentzen et al., 2015; Parmanto et al., 2013.)

2.4 Social participation and people with disabilities

Social participation means individuals opportunities to participate in activities. Participation in the living environments has a positive effect on individual`s health and quality of life. Environment should enable and meet individual`s skills and knowledge. The environment, family and care givers influence child`s ability to participate in meaningful activities. People with neurological disabilities, especially children and adolescents, are at greater risk to have challenges with social participation because of the environmental barriers and individual skills like communication or physical condition and functioning level. It is important to support children and adolescents with neurological disabilities with self-management skills and therefore support their individual life and social participation with their peers. Young children need their family`s and care giver`s support more than adolescents, who are becoming more independent. (Bedell et al., 2017; International Classification of Functioning, Disability and Health. Children & Youth version, 2007; Palisano et al., 2011.)

Evidence shows that for example Cerebral Palsy (CP) and Traumatic Brain Injury (TBI) may affect to social relationships among children and adolescents and decrease their quality of life. Peers` influence on social life becomes more important part of life in teenage years. Sufficient social support and opportunities are important and needed for children and adolescents with neurological disabilities to facilitate social participation. There are a lack of interventions concerning social participation of children and adolescents with neurological disabilities. It is important to recognise barriers and facilitators in terms of social participation. (Bedell et al., 2017; Palisano et al., 2011.) ICT, including mobile applications can enable children with disabilities to participate to their environment (Coutinho et al., 2017). Personal factors such as self-management skills and motivation influence participation (World Report on Disability, 2011).

2.5 Environmental factors in disability

Environmental factors are physical, social and attitudinal. Environmental factors on disability can be facilitators or barriers. There can be physical, emotional or social barriers in the lives of children and adolescents with neurological disabilities. Accessibility to the buildings, activities or technology need to be improved along with the attitudes towards persons with disabilities. The use and availability of assistive technology should be increased worldwide to enable participation for everyone. It is essential to understand the value of enabling and supporting environment to person`s function and participation. Health conditions can be improved for example by technology and accessibility of health care, rehabilitation or buildings. Evidence shows that sufficient support in individual`s living environment can be beneficial to individual`s self-management skills and health. ICF is a framework for rehabilitation. For children and adolescents with neurological disabilities, rehabilitation supports and enables participation in social environment. (International Classification of Functioning, Disability and Health. Children & Youth version, 2007; Parmanto et al., 2013; World Report on Disability, 2011.)

The role of the environment is different with children and youth because they are more dependent on adults and peers around them. The children or adolescents are more depend on family`s, peers` and care givers` attitudes and other environmental

factors. The level of participation depends on how interactive and enabling the environment is. Environmental factors, physical, social and attitudinal factors, all have influence on how the child or adolescent with neurological disabilities can function and participate. Environmental factors can be enabling or restricting. The needs of the individual differ in different developmental phases, so the environment should be adapted to the change. (International Classification of Functioning, Disability and Health. Children & Youth version, 2007; Pakarinen et al., 2018; Palisano et al., 2011.)

3 mHealth applications

The use of Information and Communication Technology (ICT) in health care will increase in the future. Digital health can increase access to health care and offer access to evidence-based health information. (Jones et al., 2020.) Mobile health (mHealth) as a dimension of digital health is specified as a health care service via mobile devices. mHealth is an economical way to widen the health care services worldwide to people`s living environment. mHealth application can be used alone or wearable technology can be used with it. There is a need and opportunity to use mobile health care for people with neurological disabilities. mHealth application offers an opportunity to reach more people. The acceptance and adoption of the mobile devices and mHealth applications could be barriers without an adequate knowledge and support. Good knowledge by clinician and practice together could be facilitators to the use of mHealth or mobile applications. mHealth application`s purpose is to develop self-management skills or/and physical activity, when the user is engaged to the app. (Lee et al., 2017; Morris et al., 2019; Sinha et al., 2018; Zhou et al., 2020.)

The interactivity of user`s perspective is an important part of technology use. When users have a positive feeling towards the application, they become engaged and active. The feelings and the genuine experience of interactivity are more important than technical or mechanical features of the application or game. (Noar et al., 2012.) People who want to change their behavior, need to be engaged to the change. The digital health has also restrictions. The quality of the mHealth applications differs. The data protection and accessibility factors should be recognised.

The use of mobile phones in health promotion interventions needs more research and evidence-base even though there have been some promising results (Noar et al., 2012; Pakarinen et al., 2018). Participation and engagement to physical activity can improve children`s musculoskeletal health and mental well-being. There are a lot of information about the children`s physical activity, but there are unclear ways to transfer the evidence-based knowledge into the practice. (Dugdill et al., 2009; Palisano et al., 2011.) Assistive technology also involves ICT, including mobile applications. They are very important for participation and function. ICT could be empowering and enabling for a child and an adolescent with neurological disabilities. mHealth applications are empowering for the individuals with disabilities in managing their own health. (Singh et al., 2016; WHO Global Disability Action Plan 2014-2021, 2015.)

People with chronic conditions, like neurological disabilities usually carry a mobile device with them. Mobile devices can be used almost anywhere so the different mHealth applications may offer important way of supporting self-management. (Parmanto et al., 2013.) mHealth applications offer people an opportunity to facilitate and communicate health information via mobile technology. It offers an opportunity to take more responsibility for their own health. Better life quality and self-management skills can be reached with active client engagement and good self-management skills. Adoption of the mHealth applications may be achieved if the applications are targeted successfully. It is problematic to find relevant and useful mHealth applications for children and adolescents with neurological disabilities. The needs and current state of mHealth application`s development don`t meet. More research is needed to get evidence-based knowledge about the usability and effectivity of mHealth applications with people with disabilities. The health disparities should be decreased and access to health care and improvement of health outcomes increased. (Jones et al., 2017.)

3.1 User engagement

Different digital methods offer opportunities to improve cost-effective and client-centered orientation. They may improve access to the health care and increase equality. There are different strategies to activate users. The different strategies

influence user engagement. User engagement to the mHealth application enables participation and health empowering. Providing educational information is the lowest level of engagement and supporting behavior change through rewards is the highest level. It is important to identify the quality of an application and the aspects of safety. A mHealth application could increase person`s ability to participate, be engaged to the change and be more active if the application is targeted right. (Parker et al., 2018; Singh et al., 2016; Sinha et al., 2018.) Figure 2 presents different strategies for user activity and engagement with health care.

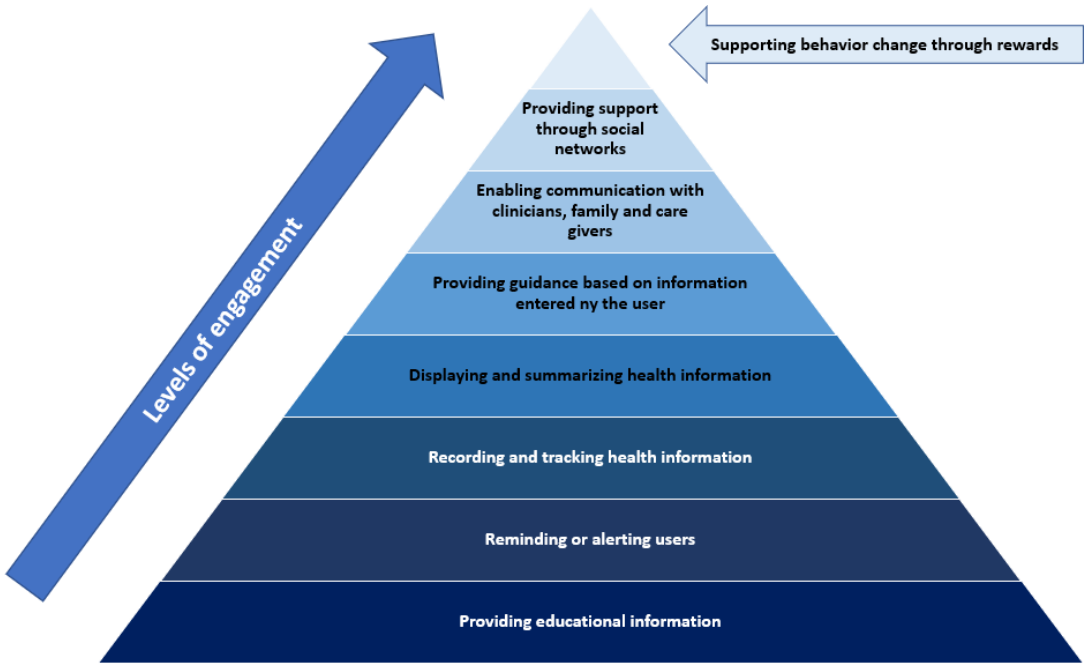

Figure 2. Strategies for user activity and different engagement levels (Singh et al., 2016, 3).

Behavior change and engagement are interactive. Self-efficacy is an essential factor in the user engagement. It is also an important personal factor in behavior change. If a child or an adolescent with neurological disabilities believe in herself/himself, it is easier to learn new things and learn to use a new mHealth application. Self-efficacy and user`s attitudes reflect on the user engagement and adoption of the application. Client engagement is one of the most important factors in chronic disease self-management. (Hoj et al., 2017; Pakarinen et al., 2018; Reychav et al., 2019.)

3.2 Accessibility and adoption of mHealth applications

Targeted and tailored health education materials and service are essential when people are involved. The ICT, including digital health has developed in the past decade and it could offer great opportunities to individuality. Identification and reflective communication are important components on health promotion and health education. It is essential to identify different groups and subgroups in the field of health. People have different needs and targeting and tailoring the service could be effective way to empower people. The ICT and tailoring could offer more effective health programmes. (Green et al., 2019.)

Accessibility means the application is easy to use and navigate, understandable and includes information what user needs. Accessibility should be considered regarding the needs of the users. Different challenges in functional level requires different features in needs and applications. People have different kind of disabilities: cognitive, physical, mental, visual or hearing related disabilities or it could be variety of different kinds. That is why the needs of the users varies and targeting becomes more important. Good accessibility level can increase user engagement to the application. If mHealth application has a good accessibility features, a child or adolescent with neurological disabilities belief and feel they can influence on their own health and are more motivated to the change. The accessibility and user engagement are in relation with self-efficacy. (Parker et al., 2018; Reychav et al., 2019; Zhou et al., 2020.)

The mHealth applications could enable the support and empowerment of people in terms of health in their living environment. Assistive technology, including mHealth applications, should be accessible and suitable for every user. The use of assistive technology is diverse worldwide but it provides possibilities. The pace of technological change is fast and it challenges the field of disability. The accessibility to ICT differs but it can be improved by tailoring and targeting the products such as mHealth applications. (Sinha et al., 2018; World Report on Disability, 2011.) Gamification in mHealth application can increase motivation of the user and increase the adoption of mHealth application (Lee et al., 2017).

There is only a little evidence-based knowledge about the use of mHealth applications for children and adolescents with neurological disabilities. It is essential to integrate the available literature and challenge the field of research and disability. Children, adolescents and people with neurological disabilities have a legal right to participate to research voluntarily and increase awareness of their own ideas, thoughts and point of views about the topic. Children and adolescents with neurological disabilities should have an opportunity to be heard on issues involving them. The guardian should always give permission to the participation, but the final decision is child`s or adolescent`s. (Child disability overview, 2015; Kuula, 2011.)

3.3 Mobile Application Rating Scale (MARS)

Health management and health promotion can be improved with mobile application (Duplaga et al., 2018). Health care costs could be decreased if the adoption of an application is prosperous. More mobile technology and mobile applications are used for health care, including rehabilitation. Some applications are free, some are chargeable. That aspect should also be considerate, when recommending an application. There is some evidence that mHealth applications are able to empower clients and increase self-management skills and physical activity. There is huge amount of mHealth applications available but only few of them offer evidence-based information. Evidence-based practice is one of the targets of health promotion. (Sinha et al., 2018; Stec et al., 2019.)

Mobile Application Rating Scale (MARS) is a reliable and systematic instrument for quality assessment of an application. It is recommendable, that clinicians are aware of the quality of the app they recommend. The Mobile Application Rating Scale (MARS) assess the quality on four sections: engagement (section A), functionality (section B), aesthetics (section C) and information (section D). Section E is a subjective app quality assessment. Each section consists of different amount of questions (see Table 1). Every answer is given a numeric answer in scale 1-5. One (1) is the lowest and means inadequate. Five (5) is the highest meaning excellent. Each section is given a score at the end of the quality assessment. Each section`s numeric answer is counted and averaged. The quality assessment of an application is important so consumer can have evidence-based and trustworthy information. The

score three (3) out of five (5) is a minimum acceptable score. The score four (4) out five (5) or above means preferable application. (Stec et al., 2019.)

Table 1. Number of questions in MARS

Section	Amount of questions
Section A: Engagement	Five (5)
Section B: Functionality	Four (4)
Section C: Aesthetics	Three (3)
Section D: Information	Seven (7)
Section E: Subjective quality	Four (4)

4 Purpose and objectives

The purpose of this integrative literature review is to analyze and synthesize the existing evidence-based knowledge about the usability of mHealth applications for children and adolescents with neurological disabilities. The primary objective is to examine the accessibility of the mHealth applications for children and adolescents with neurological disabilities. The second objective is to identify factors influencing user engagement and adoption of the mHealth applications for children and adolescents with neurological disabilities.

Results can be used for targeting digital health interventions and increasing health equity. Results can also be used for accessible mHealth applications` development. It is valuable to know which factors are facilitators and barriers for using mHealth applications.

Research questions of this study:

- What type of mHealth applications meet the needs of the children and adolescents with neurological disabilities?
- What factors influence user engagement and adoption of the mHealth applications for children and adolescents with neurological disabilities?

5 Methods and material

An integrative literature review gives a great opportunity to really understand what kind of information is available and how well this specific topic is presented in the literature. This is an opportunity to challenge the existing knowledge and identify possible missing aspects of this phenomenon. The aim is to find strengths, problems and identify the possible knowledge which should be recognised and created. The combination of the existing literature can be explained understandable way in the literature review. (Boland et al., 2014; Torraco, 2005.)

5.1 Search of data

The literature review search was conducted on following databases: Cinahl (EBSCO), Google Scholar, IEEE Xplore, ProQuest and Sportdiscus and additionally a manual international article search was carried out. The preliminary search was made between May 2019 and October 2019 but amount and the quality of the studies was not good enough. The main search was conducted between February 2020 and July 2020. The search was carried out in a long period because of the lack of high-quality research. Used keywords were mhealth, m-health, mobile applications, mobile app, ehealth, children, adolescents, disability, neurological disability, neurological disorders, physical disability, neurorehabilitation, self-management, engagement. The more detailed information of the use of keywords is in the Figure 3 on page 19. Different keywords were used based on the previous preliminary search and the consultation of the librarian of JAMK University of Applied Sciences. The librarian of JAMK University of Applied Sciences was consulted in January 2020 to get more effective data search. Different keywords on different databases were used because the same topic was described with different words in different studies.

The search was narrowed to include peer-reviewed, full-text available for free and written in English articles. The selected studies had to be published between 2014-2020. The selected studies had to be focused on children or adolescents with neurological disabilities or people with neurological disabilities. There were only few studies, which were focused on mHealth applications and children or adolescents

with neurological disabilities. That is why it was justifiable to use also studies focused on people with neurological disabilities.

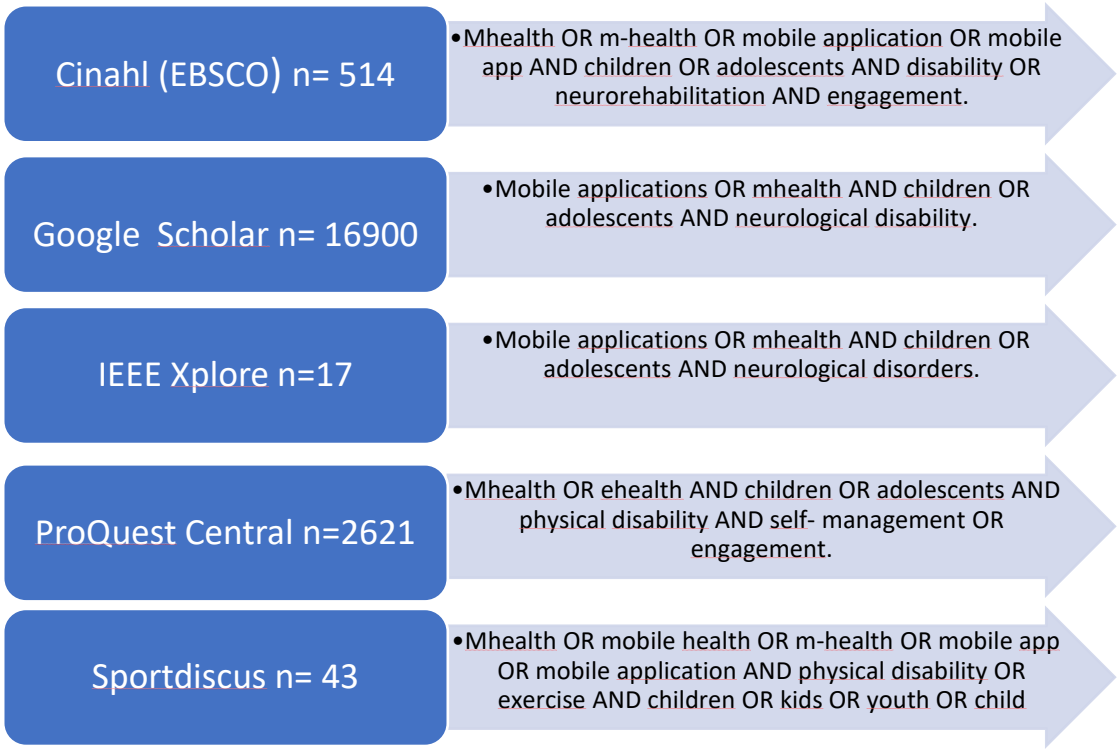

Figure 3. Keywords and databases

The searches across all selected databases led to total of 20153 studies. A total of 212 studies were chosen by the title. Abstracts and keywords of the studies were read and 90 articles removed. The studies were excluded if they were not peer-reviewed, were published before 2014, were focused on people with ADHD, elderly, hearing problems, arthritis or musculoskeletal problems. The needs and physical challenges of elderly, people with ADHD or people with musculoskeletal problems are different compared to children and adolescents with neurological disabilities, therefore those studies were excluded from the search.

There were several studies focused on technical point of views, computer games or Virtual Reality (VR) but not mHealth applications. Those studies were excluded from the analysis because this study is focused on mHealth applications. Smart mobile

devices are more used and owned worldwide than computers or VR. Smart mobile devices are easier and cheaper to use on the living environment compared to computers or VR. The studies focused on technical point of views do not consider the accessibility or the user experience that is why they were excluded. Technology develops fast and the mHealth applications are nowadays more common than many years ago. That is why it was justified to focus on studies published after 2014.

A total of 36 (n = 36) full-text studies were chosen by one person. The studies were excluded if they were not focused on mHealth applications and their usability and accessibility features, did not include children, adolescents or people with neurological disabilities and did not include any results. A total of eleven (n = 11) studies met inclusion criteria. Figure 4 presents the whole data search. All study titles, keywords and abstracts were screened based on inclusion and exclusion criteria (see Figure 5). The quality of the chosen studies were assessed with Critical Appraisal Skills Programme (CASP) or Mixed Method Appraisal Tool (MMAT). Synthesis was made with the results of the chosen studies.

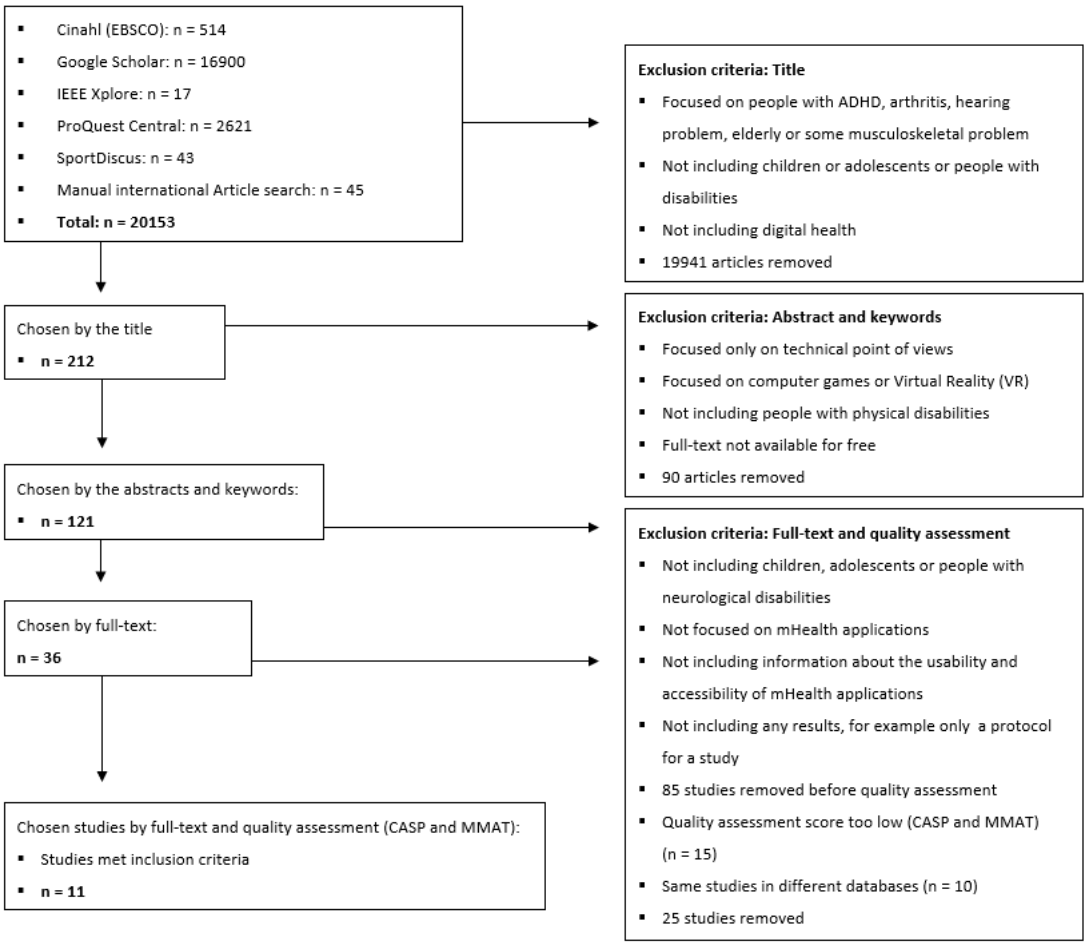

Figure 4. Data search

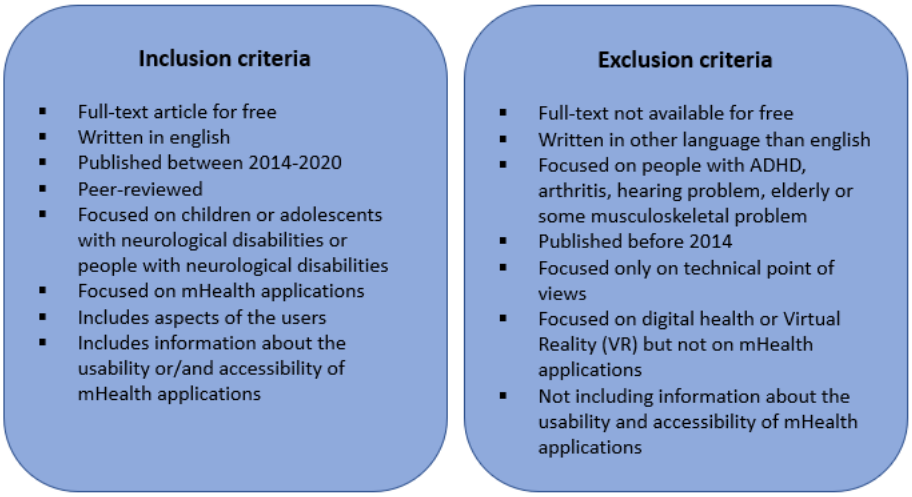

Figure 5. Inclusion and exclusion criteria

5.2 Ethical guidelines

Ethical guidelines in research has been followed. The methodology is thoroughly explained. Tables and figures are used to make the whole methodology clear. The studies are cited to give the credit for the original authors. The writing process and data analysis are transparent, thorough and accurate. (Kuula, 2011.) Ethical values are the core in health promotion practice. Respect for everyone regardless of their disability, gender or age and empower individuals to independent life are essential aspects of health promotion. It is also important to implement evidence-based practice and try to find effective and harmless health promotion actions. Decreasing of health inequities and concentrating to the needs of the social marginal groups, such as people with disabilities or children, are very important aspects of ethical health promotion practice. (Dempsey et al., 2011.) The value of this integrative literature review is the synthesis of the available evidence-based information of children and adolescents with neurological disabilities and focus on health promotion actions among this social marginal group.

5.3 Data analysis

Included articles (n = 11) were five qualitative studies (n = 5), one randomized controlled trials (n = 1), two usability studies (n = 2), one feasibility study(n = 1), one systematic review (n = 1) and one mixed methods study (n = 1). Critical Appraisal

Skills Programme (CASP) was used with qualitative studies, randomized controlled trial and systematic review. Mixed Method Appraisal Tool (MMAT) was used with feasibility study and usability studies. Critical Appraisal Skills Programme (CASP) is a tool for critical quality research assessment. It is an effective way to assess systematically study`s reliability, results and its relevance to everyday life. Each answer was scored between zero and two (0-2) points. The answer

- Yes = 2 points
- Can`t tell = 1 point
- No = 0 points.

The study can be considered as a high quality if the total score is more than 10 points. The maximum score is 20 or 22 points. (Anttila et al., 2014; CASP, 2018.)

Seven (n = 7) included studies for this literature review was assessed with CASP and four (n = 4) included studies were assessed with Mixed Methods Appraisal Tool (MMAT). Mixed Methods Appraisal Tool (MMAT) can be used to assess the quality of five different study designs: qualitative, quantitative randomized controlled trials, quantitative non- randomized, quantitative descriptive and mixed methods. Mixed methods research combines qualitative and quantitative methods and it should be well justified why this combination has been used. MMAT helps to assess whether the integration of qualitative and quantitative research is effective and adequate. The possible differences and incoherence between study methods should be well explained. It is recommendable to appraise the qualitative and quantitative components separately to increase the trustworthiness of the study. (Hong et al., 2018.) The maximum score on the Mixed Method Appraisal Tool (MMAT) is 10 points. The answer

- Yes = 2 points
- Can`t tell = 1 point
- No = 0 points

The chosen studies, methods, quality assessment tools and scores are presented in Table 2. Every included study`s quality can be considered as good or high quality.

Table 2. Quality analysis methods and scores

Author(s), publishing year	Study method	Analysis method	Score points/max
Bedell, Wade, Tursktra, Haarbauer- Krupa & King, 2017.	Qualitative study	CASP (Qualitative study)	18/20
Bendixen, Fairman, Karavolis, Sullivan & Parmanto, 2017.	Qualitative study	CASP (Qualitative study)	19/20
Choi & Van Riper, 2020.	Feasibility study	Mixed Methods Appraisal Tool (MMAT)	8/10
Coutinho, Bosisio, Brown, Rishikof, Skaf, Zhang, Perlman, Kelly, Freedin & Dahan- Olief, 2017.	Randomized Controlled Trial	CASP (Randomized Controlled Trial)	18/22
Jiam, Hoon Jr, Hostetter & Khare, 2017.	Qualitative study	CASP (Qualitative study)	17/20
Lai, Wilroy, Young, Howell, Rimmer, Mehta & Thirumalai, 2019.	Usability study	Mixed Methods Appraisal Tool (MMAT)	9/10
McPherson, Oake & Stinson, 2020.	Qualitative study	CASP (Qualitative study)	18/20
Nussbaum, Kelly, Quinby, Mac, Parmanto & Dicianno, 2019.	Systematic review	CASP (Systematic review)	18/20
Singh, MacGillivray, Mills, Adams, Sawatzky & Mortenson, 2019.	Mixed method study	Mixed Methods Appraisal Tool (MMAT)	8/10
Stiles- Shields, Garcia, Villota, Wartman, Winning & Holmbeck, 2019.	Usability study	Mixed Methods Appraisal Tool (MMAT)	7/10
Zhou, Saptono, Setiavan & Parmanto, 2020.	Qualitative study	CASP (Qualitative study)	18/20

6 Results

Chosen studies (n = 11) included mHealth applications` usability and accessibility features for children, adolescents and people with neurological disabilities in different point of views. Studies were published in Canada (n = 3), South Korea (n = 1) and United States of America (n = 7). None of the studies were published in Europe (see Table 3).

Table 3. Studies and countries

Study	Country
▪ Coutinho, Bosisio, Brown, Rishikof, Skaf, Zhang, Perlman, Kelly, Freedin & Dahan-Olief, 2017. ▪ McPherson, Oake & Stinson, 2020. ▪ Singh, MacGillivray, Mills, Adams, Sawatzky & Mortenson, 2019.	Canada
▪ Choi & Van Riper, 2020.	South Korea
▪ Bedell, Wade, Tursktra, Haarbauer-Krupa & King, 2017. ▪ Bendixen, Fairman, Karavolis, Sullivan & Parmanto, 2017. ▪ Jiam, Hoon Jr, Hostetter & Khare, 2017. ▪ Lai, Wilroy, Young, Howell, Rimmer, Mehta & Thirumalai, 2019. ▪ Nussbaum, Kelly, Quinby, Mac, Parmanto & Dicianno, 2019. ▪ Stiles-Shields, Garcia, Villota, Wartman, Winning & Holmbeck, 2019. ▪ Zhou, Saptono, Setiavan & Parmanto, 2020.	United States of America (USA)

Three main themes were seen in the results: social participation, user engagement and adoption of the application. One of the studies was a systematic review, which included mobile health applications use in neurorehabilitation but it was not restricted to children or adolescents (Nussbaum et al., 2019). Other chosen studies included needs of the users, usability and accessibility features of the mHealth applications for people with disabilities or chronic conditions (Bedell et al., 2017;

Bendixen et al., 2017; Choi et al., 2020; Jiam et al., 2017; Lai et al., 2019; McPherson et al., 2020; Singh et al., 2019; Stiles-Shields et al., 2019; Zhou et al., 2020). One study included the effectiveness of the iPad application intervention compared to the traditional methods among children with poor visual-motor integration (Coutinho et al., 2017). Three of the chosen studies considered children with disabilities and families, four adolescents and/ or young adults with disabilities and four people with disabilities (see Table 4).

There is a little evidence about the usability of mHealth applications for children and adolescents with neurological disabilities. Small sample sizes in the studies challenges the generalization of the results. Several barriers and facilitators for the mHealth use with children and adolescents with neurological disabilities are shown.

Table 4. User groups

	CHILDREN WITH DISABILITIES/ FAMILIES	ADOLESCENT/YOUNG ADULTS WITH DISABILITIES	PEOPLE WITH DISABILITIES
Bedell, Wade, Tursktra, Haarbauer-Krupa & King, 2017.		X	
Bendixen, Fairman, Karavolis, Sullivan & Parmanto, 2017.		X	
Choi & Van Riper, 2020.	X		
Coutinho, Bosisio, Brown, Rishikof, Skaf, Zhang, Perlman, Kelly, Freedin & Dahan-Olief, 2017.	X		
Jiam, Hoon Jr, Hostetter & Khare, 2017.	X		
Lai, Wilroy, Young, Howell, Rimmer, Mehta & Thirumalai, 2019.			X
McPherson, Oake & Stinson, 2020.		X	
Nussbaum, Kelly, Quinby, Mac, Parmanto & Dicianno, 2019.			X
Singh, MacGillivray, Mills, Adams, Sawatzky & Mortenson, 2019.			X
Stiles-Shields, Garcia, Villota, Wartman, Winning & Holmbeck, 2019.		X	
Zhou, Saptono, Setiavan & Parmanto, 2020.			X

Mobile application`s use with children with poor visual-motor integration-skills was studied by Coutinho and colleagues (2017) in randomized controlled trial. Control group focused on traditional visual-motor skills assignments and the experimental group focused more on visual motor application`s use. Results showed no significant difference in children`s visual-motor integration skills between the traditional occupational therapy group and the experimental group. Participants in the experimental group found the application`s use more motivating and engaging compared to the control group. Social interaction during the therapy session decreased in the experimental group, which should be notified. Handwriting skills improved more in the control group. It might be beneficial to use mobile application as part of traditional therapy. Results showed the importance of tailoring and flexible features of the application. (Coutinho et al., 2017.)

Study of mHealth FamilyAdapt-DS (Family Adoption for Families of Young Children with Down Syndrome) showed several benefits of mHealth intervention but the results are not generalizable because of the small sample size. Fathers felt their child`s health management easier and mothers felt it less difficult after intervention. Statistically significant was father`s improved scores in family functioning. Little children aren`t capable for self-management skills so it is important to support their parents in child`s condition management. (Choi et al., 2020.) Important Information About Me (IIAM) is an app developed for children and young adults with neurodevelopmental disabilities. App`s main function is to organize relevant health care information about the person and therefore help health care workers understand their needs and improve interaction. Families with children with Cerebral Palsy (CP) took part of this research (n = 7) and 57% of them found the app quite useful and easy to use for the parents. One family found the app useless because their child was not able to use it on her/his own and two of the families found the app quite neutral. Families requested more flexibility for the app for example individual reminders and editing options in different sections. (Jiam et al., 2016.)

SUPER-HEALTH (version 2.3) app was developed for exercise promotion and socialization for people with physical disabilities. Usability of the SUPER-HEALTH app was tested with twelve (n = 12) participants in usability testing-phase and qualitative interview-phase. Usability included effectiveness, usefulness, efficiency and

satisfaction of the app. Participants found the app to be valuable tool for promoting physical activity in the daily activities, especially among inactive users. Social media feature was useful for social point of view. App was found to be easy to use but thorough instructions before use was recommended. Participants valued the tailoring of the app. (Lai et al., 2019.)

The accessibility, usability and tailoring of the mHealth application were essential for engagement and adoption of the mHealth application among children, adolescents and people with disabilities. Those factors influence individual`s ability to manage their own health, get more information about their condition, offer support for behavior change and increase self-efficacy. mHealth applications have a potential for empowerment because they can increase participation and understanding of the health information. (Bedell et al., 2017; Bendixen et al., 2017; Choi et al., 2020; Lai et al., 2019; McPherson et al., 2020; Nussbaum et al., 2019; Stiles-Shields et al., 2019; Zhou et al., 2020.) The more detailed information about the chosen studies is presented in Appendix 1.

6.1 Factors influencing user engagement

Results show that users` variation of needs should be considered in the mHealth applications. Individual evidence-based information, interactivity, different and customized reminders and high accessibility are important factors in usability of the mHealth application for children and adolescents with neurological disabilities. The higher the usability, the higher the engagement and vice versa. Individual`s skills and positive experience of the use facilitate engagement. Results show that mHealth applications are able to increase social support and social interaction and therefore increase engagement to the application. Tailored accessibility features support user engagement. Evidence shows that unmet needs and general information decrease user engagement to the app. Lack of reminders or low interactivity level decrease also user engagement to the app. (Bedell et al., 2017; Bendixen et al., 2017; Coutinho et al., 2017; Jiam et al., 2016; McPherson et al., 2020; Singh et al., 2019; Stiles-Shields et al., 2019; Zhou et al., 2020.)

Good or high quality mHealth applications usually contain different strategies to activate users. The pyramid of the engagement levels presents interaction between strategy and user engagement. You can see the original figure on page 13. (Singh et al., 2016.) One application can for example contain social support, rewarding system and enable communication with clinicians, family members and care givers like SUPER-HEALTH app. General knowledge and basic reminders are easy to ignore and they aren`t engaging. That is why those engagement levels are the lowest in the engagement-pyramid. The more individual and interactive the mHealth application gets, the more engaging it is for the user. Rewarding system can motivate the user and support in behavior change like improving self-management skills. Results show difference in engagement levels of the mHealth applications. SUPER-HEALTH app, iMHere 2.0 and iMHere 2.0 with customized accessibility features contained high-levels of engagement, whereas MyDiet Coach and FamilyAdapt-DS contained lower engagement levels with general information and lack of rewarding systems. Figure 6 presents the engagement levels of the seven (n = 7) assessed applications.

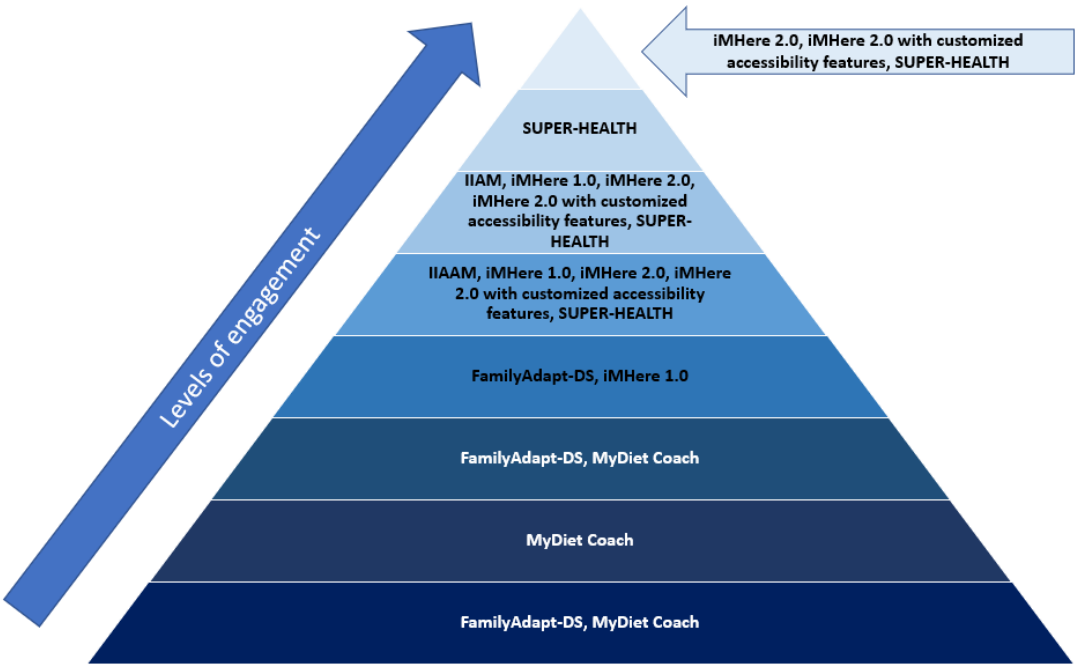

Figure 6. mHealth apps in the engagement-pyramid (Pyramid is adapted from the engagement-pyramid of Singh et al., 2016).

6.2 Factors influencing adoption of mHealth applications

The results show that the mHealth application should be flexible and easy to use, meet the needs of the user and be tailored or customized individually. Accessibility and usability increase with tailoring. Accessibility influences usability; The higher the accessibility, the higher the usability. High usability and accessibility levels increase the adoption of the application and user engagement to the application. Accessibility means application is easy to use and navigate, understandable and includes information what user needs. For example difference in font size, handedness, colour of pictures or button size could improve accessibility significantly. Different challenges in functional level requires different features in needs and applications. Usability and accessibility are comparable; If people with disabilities consider the application`s usability high, then the accessibility is usually high. (Choi et al., 2020; Coutinho et al., 2017; Jiam et al., 2017; Lai et al., 2019; McPherson et al., 2020; Singh et al., 2019; Stiles-Shields, 2019; Zhou et al., 2020.)

The importance of individual accessible features was shown in the results. Unmet needs, low accessibility and generalization leads to user`s frustration and decreases application adoption. One study conducted especially important information about the mHealth application`s accessibility. They focused on improving an existing self-management application`s iMHere 2.0 accessibility and identified many barriers and facilitators. (Zhou et al., 2020.) Self-management application iMHere 2.0 was developed for adolescents and young adults with chronic illness or disability in 2017. There were 5 different themes arising from the developing process of this application: make it easy, engage, educate and prepare, motivate and support and personalize. (Bendixen et al., 2017.) The accessibility features are not suitable for everyone with disability, even though the accessibility features have been developed together with the users (Zhou et al., 2020).

Good visual graphics, easy navigation, flexibility in data input and individual accessible features increase the app`s accessibility, usability and adoption of the app. mHealth applications offer support in everyday life environment and it is easy to use anywhere. mHealth application can be empowering for the children and adolescents with neurological disabilities. There were several barriers influencing adoption of the

mHealth application. Unmet needs between user and mHealth application were the most common finding. Difficulties in choosing selections, putting in personal data or lack of information were barriers for app adoption. (Bedell et al., 2017; Bendixen et al., 2017; Coutinho et al., 2017; Jiam et al., 2016; McPherson et al., 2020; Singh et al., 2019; Stiles-Shields et al., 2019; Zhou et al., 2020.) See Table 5 to get more detailed information about the overall results.

Table 5. Table of results

STUDIES	PERCEPTION	SUBGROUP	GROUP
▪ Bedell et al. 2017 ▪ Coutinho et al. 2017	▪ Fatigue ▪ Challenges in behavior ▪ Missunderstanding from peers ▪ Transportational challenges ▪ Negative feelings like isolation from social groups ▪ Time and effort among daily activities ▪ Lack of support ▪ Personal factors ▪ Decreased social interaction in ”real life”	**SOCIAL BARRIERS**	**SOCIAL PARTICIPATION**
▪ Bedell et al. 2017 ▪ Jiam et al. 2017	▪ Personal factors ▪ School friends ▪ Communication with friends ▪ Support from parents and/ or peers ▪ Social media ▪ Opportunities ▪ Transportation ▪ Improvement of communication and interaction	**SOCIAL FACILITATORS**	
▪ Bedell et al. 2017 ▪ Bendixen et al. 2017 ▪ Coutinho et al. 2017 ▪ Jiam et al. 2017 ▪ Lai et al. 2019	▪ Interactivity in an app ▪ Clear directions ▪ Unclear directions ▪ Importance of communication with someone ▪ General information vs. targeted information ▪ Skills to use mobile devices ▪ Easy to use ▪ Visual appearance ▪ Individualized information ▪ Social support ▪ Unmet needs vs. needs ▪ Personalization of an app ▪ Positive experiences ▪ Reminders ▪ Motivation	**USABILITY**	**ENGAGEMENT**
▪ Choi et al. 2020 ▪ Coutinho et al. 2017 ▪ Jiam et al. 2017 ▪ Lai et al. 2019; ▪ McPherson et al. 2020 ▪ Nussbaum et al. 2019 ▪ Singh et al. 2019 ▪ Stiles-Shields et al. 2019 ▪ Zhou et al. 2020.	▪ Decreased social interaction in ”real life” ▪ Increased social support via application ▪ User- friendliness ▪ Difficult to use ▪ Flexibility vs. not flexible to use ▪ Positive reinforcement ▪ Feasibility of an app ▪ Value in daily life ▪ Lack of instructions vs. adequate instructions ▪ Lack of tailored information vs. tailored information ▪ Empowerment ▪ Interactivity vs. not interacting ▪ Can be used anywhere ▪ iPhone vs. Android ▪ Self- reporting ▪ Data input	**ACCESSIBILITY**	**ADOPTION**
▪ Bedell et al. 2017 ▪ Bendixen et al. 2017 ▪ Coutinho et al. 2017 ▪ Singh et al. 2019 ▪ Stiles-Shields et al. 2019 ▪ Zhou et al. 2020	▪ Need for tailoring ▪ Individualized accessible features ▪ High variation of usability ▪ Diversity of disabilities ▪ Difficulty to choose selections ▪ Difficulty to see clearly ▪ Difficulty of data input ▪ Accessible features for individuals	**TAILORING**	**ENGAGEMENT/ ADOPTION**

6.3 Factors influencing social participation

Bedell and colleagues showed (2017) that adolescents with TBI (Traumatic Brain Injury) are skillful smartphone and mobile app-users. Smartphones are important for them and some of them consider interacting via smartphone more comfortable way to stay connected with peers. Adolescents with TBI consider smartphones and apps a good way to have an updated information about their condition and have an interaction with other people. SPAN (Social Participation And Navigation) is an app-based peer coaching intervention for social participation. The results of this intervention showed diverse needs of the adolescents with TBI. Tailoring and individual information and features were shown to be important in the application. Interactivity in the app, flexibility and good directions increase the usability of the social participation app and therefore might support social participation among adolescents with TBI. There was some concern about the confidentiality and data protection. (Bedell et al., 2017.)

Several barriers and facilitators influencing social participation were found, which should be notified in the future. Missunderstanding from peers, fatigue and time and effort spending among daily activities were identified as barriers for social life. Personal factors was identified as a barrier and as a facilitator dependent on the individual. Support was found to be important part of social participation and positive feelings and opportunities. Social media and school friends were identified as facilitators for social participation. (Bedell et al., 2017; Coutinho et al., 2017.)

6.4 Mobile Application Rating Scale (MARS)

Chosen studies included few mobile applications (n=7), which were assessed with Mobile Application Rating Scale (MARS). The applications are presented in Table 6. Six assessments were made based on studies and pictures of the applications, because they weren`t available in the Google Play-store. One application`s assessment (MyDiet Coach) was based on studies, pictures and own user experience. Assessed mHealth applications were FamilyAdapt-DS, IIAM (Important Information About Me), iMHere 1.0, iMHere 2.0, iMHere 2.0 with customized accessibility

features, MyDiet Coach and SUPER-HEALTH. Each section was given a numeric mean score and averaged according to the MARS instructions.

Table 6. Information of the assessed applications

APPLICATION	INTRODUCTION/ FOCUS	USER GROUP	QUALITY LEVEL (MARS mean score)
FamilyAdapt-DS	Support parents of young children with Down Syndrome to adapt to the daily life challenges	Families with young children with Down Syndrome	Acceptable but recommendation should be considered carefully. (3.6)
IIAM (Important Information About Me)	Organize relevant health care information and improve interaction with health care	Adults, children and families with neurodevelopmental disabilities	Acceptable but recommendation should be considered carefully. (3.9)
iMHere 1.0 (Interactive Mobile Health and Rehabilitation)	Support self-management skills	Adults with disabilities (Spina Bifida and Spinal cord injury)	Low quality (2.6)
iMHere 2.0 (Interactive Mobile Health and Rehabilitation)	Support self-management skills	Youth and young adults with Brain and Spinal cord Anomalies (BSA)	Low quality (2.8)
iMHere 2.0 with customized accessibility features	Support self-management skills	Youth and young adults with Brain and Spina cord anomalies (BSA)	Preferable (4.0)
MyDiet Coach	Support independent and healthier life	Adolescents and young adults with Spina Bifida	Low quality (2.8)
SUPER-HEALTH	Promote physical exercise and social interaction/life	People with disabilities	Accaptable but recommendation should be considered carefully. Doesn`t include tailoring on its own. (3.7)

Only one application`s quality level was 4 out of five, recommendable. Three application`s quality level was below three (3) and three application`s quality level was acceptable (between three and four), but recommendation must be considered carefully. iMHere 2.0 with customized accessibility features was only recommendable mHealth application based on MARS-assessment. Engagement, functionality and aesthetics were very good in it because of the customized features. It showed the importance and influence of tailoring. The main limitations in three (n = 3) mHealth applications were the lack of interactivity, untailored content, problems in navigation and app function, low quality of information and the lack of evidence-based information. However, there were also good features like visual appearance and app description. Three (n = 3) application`s quality were good and the limitations in evidence-based information and functionality like navigation or interactions were minor. See Table 7 to get more detailed information about the quality scores.

Table 7. Quality level of the mHealth applications

APPLICATION	SECTION A Engagement (Mean score)	SECTION B Functionality (Mean score)	SECTION C Aesthetics (Mean score)	SECTION D Information (Mean score)	APP QUALITY MEAN SCORE	APP SUBJECTIVE QUALITY SCORE (SECTION E)	QUALITY LEVEL
FamilyAdapt - DS	3.8	3.5	3.3	3.6	**3.6**	3.75	Acceptable
IIAM	4.2	4.0	4.3	3.6	**3.9**	3.75	Acceptable
iMHere 1.0	2.6	2.5	2.3	2.7	**2.6**	2.0	Low quality
iMHere 2.0	2.8	2.5	3.0	3.0	**2.8**	2.5	Low quality
iMHere 2.0 with customized accessibility features	4.4	4.25	4.3	3.6	**4.0**	3.75	**Preferable application**
My Diet Coach	3.2	2.75	3.0	2.6	**2.8**	2.25	Low quality
SUPER-HEALTH (version 2.3)	3.8	3.75	4.0	3.6	**3.7**	3.75	Acceptable. Free download but doesn`t include tailoring on its own.

7 Discussion

There is a little evidence-based knowledge in terms of children and adolescents with neurological disabilities and mHealth applications. The lack of research in the field of disability and mobile technology is clear. The randomized controlled trials are needed to show the facilitators and barriers of the mHealth applications for children and adolescents with neurological disabilities. The diversity of children`s and adolescents` neurological disabilities and their needs should be assessed with care. The users should be included to the developing process and more usability testing made. The purpose of this literature review was to analyze and synthesize the existing evidence-based knowledge about the usability of mHealth applications for children and adolescents with neurological disabilities. The purpose, objectives and research questions of this review was given an answer.

World Health Organization (WHO) has identified and underlined the importance and power of everyday settings in health in the past decade. Health empowerment is one

of the most important features in health promotion. Empowerment helps individuals to understand and make decision about their health but the information and interventions should be tailored for the individuals. mHealth applications could improve the access to the health services and programmes for children and adolescents with neurological disabilities, when they are tailored for them. The use of the mHealth applications aims to influence health factors in everyday lives and therefore could enable health empowerment. The WHO Global Disability Action Plan`s principles are based on human rights for example equal opportunities, full participation of society and respect disabled children`s developing capacities.

The diversity of different disabilities is wide and thus challenging in the field of disability research. Sample sizes are small in usability, accessibility and qualitative studies and therefore generalization can`t be done without thorough consideration. Factors influencing user engagement and adoption of the application were essential findings of this literature review. Value of individual information and tailoring of the mHealth applications should be noticed in the future research. Diversity of disabilities challenges the developing process of accessible and usable mHealth applications.

Interesting finding was the lack of the ICF framework in the studies and developing work in the field of mHealth applications. Only one study, McPherson and colleagues (2020) used the ICF-CY for the health and disability classification of the participants. International Classification of Functioning, Disability and Health (ICF) is used generally with adults and International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) is used with children and youth under 18 years old. The ICF and ICF-CY would offer great fundament for disability research. The use of the ICF-CY could standardize the research and make the comparison between studies easier. The ICF-CY could help the developing work by identifying different facilitators and barriers which influence individual`s function, activity and participation and therefore influence usability and accessibility of the mHealth application. The results showed that tailoring was important factor for the user engagement and adoption of the mHealth application. The lack of understanding the individual`s needs and diversity of children and adolescents` neurological disabilities was clear.

Results show that even though the accessibility features were developed together with the users, the accessibility features are not suitable for everyone with disability. The diversity in children`s and adolescents` function and participation level is extensive. The diversity in reporting and classification of health and disability is also extensive. Comparison between studies is a bit challenging because of the different styles in health and disability classification. The use of ICF-CY would offer an universal fundament for research work. The ICF could help recognising significant factors- physical, social and attitudinal- influencing individual`s functioning participation and therefore help in developing work as well. mHealth application`s user engagement and adoption are dependent on application`s usability and accessibility. Recognising different aspects of functioning could help identifying the needed accessibility features and increase the usability and accessibility. The higher the usability and accessibility is, the higher the user engagement and adoption of the mHealth application is. Good engagement levels empower children and adolescents with neurological disabilities to manage their own health.

It should be considered that the mHealth application use might decrease the “real life” social interaction. On the other hand, some might prefer social interaction via smartphone and the use of mHealth application could increase social participation. Studies included different views of the participants. Some studies focused only on opinions of the children and adolescents with neurological disabilities and some took into account parent`s or care giver`s opinions. Opinions could be different and therefore influence results. On the other hand, the different point of views gave depth to the analysis and results. There is usually people helping the children and adolescents with neurological disabilities and they might recognise factors the child or adolescent will not. Caution should be used, so that the opinions of children and adolescent`s with neurological disabilities are taken account and the opinions of the others will not displace them.

The factors influencing social participation, user engagement, accessibility and adoption of the mHealth applications were identified. Several social barriers and facilitators were influencing social participation. Tailoring the application, usability and accessibility of the application influenced the user engagement and adoption of the mHealth application. If the child or adolescent with neurological disabilities

found the application suitable, easy to use and useful for her/him, the user engagement and adoption of the mHealth application were more likely.

Findings of tailoring the mHealth applications support previous findings of user-sensitivity. Terrill and colleagues suggested in 2019 the importance of user-sensitivity to the usability of the application. They suggested that the app developer`s way of focusing on average users instead of diverse needs of the user, may reduce the usability and accessibility of the application. (Terrill et al., 2019.) The focus should be in developing usable and accessible mHealth applications for children and adolescents with neurological disabilities regardless of the diversity of needs. It may be unrealistic to develop a mHealth application, which is usable and accessible for everyone, but there are potential for improving the accessibility features and improve accessibility and usability. Indiviual`s ability to use and be part of community are essential aspects of empowerment.

Results support earlier findings of the user engagement. Personalization and motivating the user with rewards improve user engagement and adoption of the mHealth application. Different levels of engagement like rewarding systems, interaction with clinicians, family members and care givers were essential for engagement and motivation. However the other aspects of engagement, like entertainment and visual aspects of the application, may be weakening or strengthening to the user engagement.

Different styles in health and disability classification was decreasing trustworthiness of the results. However, every included study conducted valuable information of the needs and the unmet needs of children and adolescents with neurological disabilities. It should be considered that diversity of disabilities and therefore different needs of the user are challenging. Accuracy and honesty on reporting should be focused. Children and adolescents with neurological disabilities should have an equal opportunity to use mHealth applications as in their peers.

The Mobile Application Rating Scale (MARS) is a good way to assess the quality of the mHealth application. It should be used more to give a reliable information about the quality of the mHealth application and whether it can be recommended to the clients. MARS was used rarely in the studies. It is easy to use and the use of MARS

would help comparison of the studies in the future. The quality assessment of the mHealth applications was made with MARS and it was based on the studies and pictures instead of actually using those applications. That limits the quality of the assessment and should be notified when looking at the results. Only one person used MARS to assess the quality of the mHealth applications, which should be notified in the results. However, the assessment gave an important information and depth to the analysis of the mHealth application`s quality.

7.1 Reliability and ethics of the review

This Master`s Thesis is an integrative literature review and did not need an ethical forecast. The topic gives an information about the usability of the mHealth applications for children and adolescents with neurological disabilities. The results show that the accessibility features do not always meet the needs of the users, but there is a real potential to increase the accessibility and usability. The results show both strength and limitations of the mHealth applications. The results are presented straightforward. There was little research available in the field of disability and mHealth applications. Finding high quality research on children and adolescents with neurological disabilities and mHealth application use was challenging. The views and analysis methods between studies differed. The results should be considered carefully because of the small sample sizes and generalization should be avoided.

The title and abstract clarify the background, purpose, method, analysis, results, conclusions and future recommendations. The introduction defines the topic and presents available knowledge about it. This literature review consisted of eleven studies, which were focused on mHealth applications for children, adolescent or adults with neurological disabilities. The different point of views in the studies and data collection methods challenged the synthesizing process so the synthesis must do precisely. The data search gave an extensive number of studies, but the inclusion and exclusion criteria helped the process. Different keywords were used in different studies and databases, thus the use of different keywords was justified. The decision of using only free full-text articles may have narrowed the outcome of the data search. The chosen studies were published between 2017-2020, giving quite new

information about the accessibility and usability of the mHealth applications and their use for children and adolescents with neurological disabilities.

The main focus was to examine the usability and accessibility of the mHealth applications for children and adolescents with neurological disabilities. However the review included also studies of adults with neurological disabilities because of the lack of available, high-quality studies of children and adolescents. Opinions and experience of the use of mHealth applications among children and adolescents with neurological disabilities need more research, but this review presents valuable aspects of present situation. It offers valuable aspects for the future research. Health equity and digital health promotion interventions are essential values in these days and the rights of the children and adolescents with neurological disabilities in the field of digital health should be respected and focused more.

The strength of this review was the transparency of the methodology and reporting. All the choices were explained and justified. The used keywords were explained. However, it is good to notify that different keywords could have led to different outcome. Preliminary search was made before the main search and the main search gave satisfied results. The quality analysis of the studies was made by one person, which weakens the quality of the review. Confirmation regarding the study analysis method was asked from another student, but the final analysis was made by one person. In the future, it should be done by two persons so the results could be discussed thoroughly and the trustworthiness would improve.

According to Boland and colleagues, the methodology of the review should be transparent. This review followed the guideline by being transparent in writing process. The data search was presented written and using figures and tables. The data search strategy was made with the librarian of JAMK University of Applied Sciences to get more effective data search. The quality assessment of the studies were made carefully to address their trustworthiness and meaningfulness for the literature review. Critical assessment in the synthesis was made and the conclusions were made with caution as they should be in an integrative literature review. (Boland et al., 2014.)

The reliability of this review is good. The research questions have been answered and the strenght and limitations have been discussed. The development of the mHealth applications is fast and therefore the accuracy of the results is good at present. However the research of the usability of the mHealth applications for children and adolescents with neurological disabilities will increase in the future, which may change the evidence-based information about this topic.

7.2 Conclusions

Even though the evidence-based knowledge about the use of mHealth application for children and adolescents with neurological disabilities is small, the potential and need for efficient interventions are actual. The purpose of the review was to analyze and synthesize the existing evidence-based knowledge about the usability of the mHealth applications for children and adolescents with neurological disabilities. The primary objective was to examine the accessibility of the mHealth applications for children and adolescents with neurological disabilities. The second objective was to find factors which influence user engagement and adoption of the mHealth applications. Results showed several facilitators and barriers influencing usability, accessibility and user engagement and adoption of the mHealth application.

The use of mHealth applications with children and adolescents with neurological disabilities is quite minor, but there is a real potential to support them in self-management skills and health empowering. The quality of the mHealth application should be assessed and the guidance for the use should be thorough and understandable. The topic is current in terms of health promotion, health equity and digital health. The mHealth application meet the need of the user when the accessibility factors are evaluated accurately, individual`s different functional levels and health are considered.

Many of the studies focused on developing the mHealth application or assessing the needs of the children and adolescents with neurological disabilities. In the future, the efficacy of the mHealth application use for children and adolescents with neurological disabilities should be focused more. Randomized controlled trials are needed to get more evidence-based knowledge. The difference of using the mHealth

application in the clinical surroundings or in the actual living environment should be considered in the future research because the actual use will happen in the living environments of the individuals.

The future research should focuse on mHealth applications and children and adolescents with neurological disabilities. The use of ICF-CY as a framework for health and disability classification should be recommended to ensure the comparison of different studies. The effectivity of the use of accessible mHealth applications among children and adolescents with neurological disabilities in the living environments should be studied more. The use of rewarding systems and gamification could motivate and engage the youth to the behavior change better. The more engaging the mHealth application is, the more empowering it is for the individual.

The children and adolescents with neurological disabilities need more accessible mHealth applications to support their autonomous life, self-management skills and increase the quality of life. mHealth applications could be used as part of a rehabilitation or other health service. The use of mHealth applications could be part of a rehabilitation and health management in the future, but it will not replace entirely the “traditional” health care services. The mHealth applications could have a real potential for empowerment of the children and adolescents with neurological disabilities and therefore increase health equity.

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Appendices

Appendix 1. (1/3) Original studies

Study	Purpose of the study	Participants	Data collection and analysis method	Main results
Bedell, Wade, Tursktra, Haarbauer- Krupa & King 2017.	Find out different perspectives for design and development of a social participation-app for teenagers with TBI.	Total n = 39 n = 6 teenagers with TBI n = 7 their parents n = 6 teenagers without TBI n = 7 college students with TBI n = 13 college students without TBI	Survey and interview or focus group chosen by the participant	Several barriers and facilitators for social participation were found. The importance of customization, interactivity, social support and engaging features in an app were recognized.
Bendixen, Fairman, Karavolis, Sullivan & Parmanto 2017.	To collect more information from users regarding the use of the iMHere-app and understand better the needs of the adolescents with spina bifida and therefore help developing iMHere 2.0.	n = 16 persons with brain and spinal cord anomalies n = 11 caregivers	Focus groups Data-analyses from demographics, follow-up surveys, transcribed focus group sessions and observations.	The app should be easy to use, be more engaging and offer more detailed, educative information, be personalized, motivating and supportive.
Choi & Van Riper 2020.	Explore the feasibility of an app, which was designed to support family adaptation in families of young children with Down Syndrome.	n = 16 (eight families of young children with Down Syndrome)	Pre-test and pro-test questionnaires, introduction to the app, therapeutic conversations, educational moduls.	Several benefits of mHealth intervention was shown but the results aren`t generalizable because of the small sample size. Fathers felt their child`s health management easier and mothers felt it less difficult after intervention. Statistically significant was father`s improved scores in family functioning.
Coutinho, Bosisio, Brown, Rishikof, Skaf, Zhang, Perlman, Kelly, Freedin & Dahan-Olief 2017.	Compare the effectiveness of an iPad application use and traditional occupational therapy on visual- motor integration.	n = 20 children with poor visual-motor integration	Tests in the beginning and at the end of the trial. Control group and experimental group sessions.	No significant difference in visual-motor integrations between groups but the experimental group found the sessions more motivating and engaging. Handwriting skills improved more in the control group. Use of an app could be beneficial as a part of therapy.

Appendix 1. (2/3)

Study	Purpose of the study	Participants	Data collection and analysis method	Main results
Jiam, Hoon Jr, Hostetter & Khare 2017.	Describe the developmental phase of a new version of IIAM-application for adults, children and families with neurodevelopmental disabilities.	n = 7 parents of children with neurodevelopmental disabilities	Focus groups and online survey about the user experience of the beta version of the app.	App was useful and easy to use but more tailoring is needed to increase the accessibility of the app.
Lai, Wilroy, Young, Howell, Rimmer, Mehta & Thirumalai 2019.	Find out the usability of SUPER-HEALTH-app (version 2.3) among people with disabilities.	n = 12 people with physical disabilities	Qualitative interview and usability testing	App was useful and easy to learn. It also helped to increase physical activity into the daily life. Social media feature was good for social support. More instructions before the use would be recommended and more tailoring and individualization.
McPherson, Oake & Stinson 2020.	Find out the needs of the adolescents with disabilities in terms of healthy lifestyle and weight management. Find out the mHealth app´s ability to respond to the needs of the adolescents with disabilities.	total n = 22 n = 7 adolescents with disabilities n = 6 parents of adolescents n = 9 health care professionals	Qualitative focus groups Descriptive thematic analysis	mHealth apps have potential to offer individualized support and be engaging if it is tailored right. It could support in empowerment and lifestyle change.
Nussbaum, Kelly, Quinby, Mac, Parmanto & Dicianno 2019.	Synthesize an available information about the use of mHealth applications in rehabilitation.	n = 102 studies included	Systematic review with data synthesis	Apps were useful for different measurements. Usability and accessibility increase with tailoring and interactivity.
Singh, MacGillivray, Mills, Adams, Sawatzky & Mortenson 2019.	Find out opinions of people with spinal cord injury about a mHealth app for self-management.	n = 20 people with spinal cord injury	Mobile app training sessions, qualitative questionnaires and researchers` notes. Thematic analysis and participant`s usability scale scores of tool usage and self-reports.	Accessibility and easy adoption of the app are important factors in self-management app. Also flexibility and interactivity were important for the users.

Appendix 1. (3/3)

Study	Purpose of the study	Participants	Data collection and analysis method	Main results
Stiles- Shields, Garcia, Villota, Wartman, Winning & Holmbeck 2019.	Evaluate usability of an mHealth app among adolescents and young adults with spina bifida.	n = 28 adolescents and young adults with spina bifida	Learnability measurements (quantitative data), self-reported questionnaires and qualitative feedback after using the app	App was found to be potential for use but tailoring and good instructions before use were recommended. It was found easy to use, individualization and more interactivity was found to increase user engagement.
Zhou, Saptono, Setiavan & Parmanto 2020.	Find out ways to improve accessibility of a mHealth app.	n= 5 people with neurological disability (cerebral palsy and spinal cord injury)	Tests for vision, cognitive level and dexterity. Instructions for the use of an app. Participants used the app by doing certain tasks. Observation of the use and interviews. Implementing individualized accessibility features into the app and then observation and questionnaires for the users.	Participants found several difficulties using the app before customized accessibility features. Customized accessibility features improved accessibility and usability of the mHealth application. App was found to be useful.