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Systematic Review or Meta-analysis

A qualitative synthesis of the perceived factors that affect participation in physical activity among children and adolescents with type 1 diabetes

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Abstract

Aims To explore the qualitative literature on the perceived factors, positive and negative, affecting participation by children and adolescents with type 1 diabetes in physical activity, from the perspective of children and adolescents with type 1 diabetes, their family members, teachers or sports coaches, and healthcare professionals.

Methods MEDLINE, SPORTDiscus, PsycINFO, CINAHL and Scopus were systematically searched in July 2019. Eligible studies included any that reported qualitative findings on the perceived factors that affect participation in physical activity from either the perspective of children or adolescents with type 1 diabetes, their family members, teachers or coaches, and healthcare professionals.

Results The literature search yielded a total of 7859 studies, of which 14 (13 qualitative studies and one mixed-methods study) met the review inclusion criteria. In total there were 12 unique populations containing 270 individuals, 105 children or adolescents with type 1 diabetes,108 family members, 37 teachers and 20 healthcare professionals. The main factors thought to influence physical activity for this population were the individual characteristics of children and adolescents, the requirement for self-blood glucose regulation, support systems including friends, family, teachers and professionals, education and knowledge, and communication.

Conclusions This review synthesizes views on the perceived factors from several different perspectives. The findings suggest that it is important to consider the needs of the wider support network, as well as the child's or adolescent's concerns and preferences, when developing new or existing strategies and programmes to promote physical activity in children and adolescents with type 1 diabetes.

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Introduction

Type 1 diabetes mellitus is one of the most prevalent chronic conditions in children and adolescents [1,2]. The management of type 1 diabetes requires life-long regulation of blood glucose levels, through the careful management and planning of glucose intake and insulin injections [3-5]. The responsibility for the management of type 1 diabetes in children and adolescents is regularly placed with the child or adolescent, their family members, supervisors, including teachers, and healthcare professionals [6,7]. One aspect of optimal management for type 1 diabetes is regular physical activity, which has many recognized general benefits for physical and psychological health [8]. Physical activity in type 1 diabetes has additional health benefits including an improvement in glycaemic control, lipid profile, and body composition, as well as a reduction in the long-term cardiovascular risk associated with the condition [4]. Despite these health benefits, however, participation in physical activity poses challenges in type 1 diabetes. The exertion required during activities changes blood glucose homeostasis and can lead to low blood glucose levels, or hypoglycaemia, in individuals with type 1 diabetes [9-11]. The symptoms of hypoglycaemia include anxiety, blurred vision, dizziness, shaking and weakness. Fear of hypoglycaemia and its related side effects are often cited as barriers to physical activity participation in children, adolescents and adults with type 1 diabetes [12,13].

The current WHO physical activity recommendations are that all children, aged 5 to 17 years, should participate in at

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What's new?

- Children and adolescents with type 1 diabetes often do not meet the WHO recommendation for physical activity levels.
- This systematic review identifies all the current qualitative literature on the factors, positive and negative, that affect participation in physical activity from the view of children and adolescents with type 1 diabetes, their family members, teachers and healthcare professionals.
- The study identifies specific perceived factors that motivate and prevent children and adolescents with type 1 diabetes participating in physical activity. These factors should be considered when developing future strategies and programmes to increase and support their participation.

least 60 min/day of moderate-to-vigorous intensity activity [14]. The recommended level of physical activity is considered sufficient to have a positive impact on both the musculoskeletal and cardiovascular systems, to develop neuromuscular awareness and to maintain a healthy body weight [15]. Studies aiming to measure levels of physical activity in children and adolescents have been challenging because of the spontaneity of activities throughout the day, but moderate-to-vigorous physical activity in children and adolescents can include playground activities, running and cycling, amongst many others [16,17]. Despite the difficulties in measurement of physical activity levels, there is a consensus that children and adolescents with type 1 diabetes regularly do not meet the current WHO recommendation for physical activity, with some studies suggesting that around two-thirds of children and adolescents with type 1 diabetes are not meeting the recommended daily level [10,18-20].

An understanding of both the perceived motivating and inhibiting factors that affect children and adolescents with type 1 diabetes participating in physical activity would therefore be useful to inform the development of strategies and programmes to promote physical activity. Additionally, the wider context, including the views of the important personnel supporting children and adolescents with type 1 diabetes, or stakeholders, should be considered. Previous studies have been conducted to address these perceived factors from the perspectives of children and adolescents and stakeholders, and have used differing study designs, most commonly individual interviews, questionnaires and focus groups [21-23]. To our knowledge, no reviews to date have synthesized evidence collected from children or adolescents with type 1 diabetes, their family members, teachers or sports coaches, and/or healthcare professionals. The aim of this systematic review was to identify and synthesize qualitative research findings on the perceived factors, positive and negative, that affect participation in physical activity for children and adolescents with type 1 diabetes, from the perspective of both children and adolescents themselves and all stakeholders who could both support and hinder their participation.

Methods

Search strategy

We conducted a literature search using three main concepts: children or adolescents; physical activity; and type 1 diabetes. The search strategy comprised both Medical Subject Heading terms, and equivalents, as well as free-text terms for the three main concepts (File S1) to identify potentially relevant studies through searching the MEDLINE, SPORTDiscus, PsycINFO, CINAHL and Scopus databases. The databases were searched from their inception to July 2019, with the limitations of journal articles and English language applied to the search. Additional citation tracking and hand-searching of references of the included studies was performed.

Study selection process

Predefined selection criteria for the included studies were: publication in peer-reviewed journals; a population of interest of children or adolescents with type 1 diabetes; participant age ≤18 years; assessment of perceived factors affecting participation in physical activity among children or adolescents with type 1 diabetes; and collection of the perceived factors from the perspective of children or adolescents with type 1 diabetes, their family members, teachers or sports coaches, and/or healthcare professionals using a qualitative study design (File S2). All qualitative research methods were included, including mixed-methods study designs.

Following the literature search, the titles and abstracts of selected studies were screened for eligibility independently by two review authors, K.D and H.Q. Studies were screened for eligibility at full-text stage independently by two review authors, K.D and E.G. Any disagreements were resolved by discussion and by consulting the third review author.

For studies with the same sample populations, data were merged for the analysis of study characteristics to remove the duplication of individuals. The findings of these papers were reviewed separately.

Quality assessment

The Critical Appraisal Skills Programmes (CASP) checklist for qualitative research was used to assess the methodological quality of the included studies [24]. Assessment for each included study was performed by K.D., and subsequently discussed with the additional review authors, E.G and H.Q. No studies were excluded based on quality assessment.

Qualitative synthesis

Analytical thematic analysis, as described by Thomas and Harden [25], was used for the qualitative synthesis. The first stage of the synthesis was the extraction of themes from the original studies, performed by K.D. After careful reading and re-reading of all aspects of the included studies, descriptive themes, where available, were extracted from each study. Where themes were not available, themes were created from the data available and presented in the Results section of the included studies. The second stage of synthesis was the translation of primary study themes and the creation of new analytical themes. This process was performed by K.D., who reviewed the extracted themes from each study and placed the descriptive themes into categories to create new analytical themes for comparison across all the included studies. The new analytical themes were then discussed with the review team, E.G. and H.Q., who were provided with full data extraction of the included studies.

Subgroup analysis was performed for each stakeholder's perspective and then a summary of themes from all the subgroups was created to give an overview of the key themes from all studies. Illustrative verbatim quotations from the included studies were extracted to support the new analytical themes presented in the synthesis.

The review team consider their perspective on the review as non-clinical researchers with an interest in physical activity promotion in the UK. K.D. is a medical student who has undertaken postgraduate training in public health, E.G. is a professor of public health with an interest in physical activity promotion, and H.Q. has completed a PhD addressing physical activity promotion in children and adolescents with type 1 diabetes.

The review team used the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) guidelines to support the reporting of this review [26].

Ethics

Ethical approval was not required for the review, as per the University of Sheffield research ethics guidelines.

Results

A search of the databases retrieved 7122 results. From the retrieved studies, 11 studies met the inclusion criteria following review of full texts. Citation tracking and hand-searching of references for the included studies identified an additional 737 studies, of which three met the inclusion criteria on review of the full texts. At the end of the study selection process a total of 14 studies met the inclusion criteria; of these studies, 13 were qualitative research only, and one represented mixed-methods research [22,27-39] (Fig. 1). The characteristics of the included studies are shown in Table 1. The included studies were predominantly conducted in the UK (n=9), with the other studies conducted in Australia (n=1), Brazil (n=1), Ireland (n=1), Sweden (n=1) and the USA (n=1). Of the 14 included studies there were 12 unique sample populations. The total sample population of the review was 270 individuals, including 105 children or adolescents with type 1 diabetes, 108 family members, 37 teachers and 20 healthcare professionals. The children and adolescents with type 1 diabetes included in the sample populations were aged 4–18 years, and the healthcare professionals included comprised five nurses, including one specialist nurse, nine dietitians, and six physicians, including four consultants. The most common method of data collection was interviews (n=9), followed by focus groups (n=4).

The methodological quality of the included studies was generally good, with no study excluded because of poor methodological quality (File S3). The common weaknesses in the methodological quality of the included studies were the recruitment strategy and the consideration of ethical issues. The majority of studies used a purposeful sampling method and discussed their selection criteria, however, many studies did not include information on why individuals chose to participate or not. Assessing the risk of sampling bias within the included studies is therefore difficult. Ethical approval was reported for each of the studies, except for one [34]. However, despite the presence of ethical approval, few of the studies discussed any relevant ethical concerns, therefore, the assessment of ethical issues in many studies was not possible. Other weaknesses in individual studies included one study not presenting verbatim quotations [34] and one study not explaining who performed the interviews and the interaction between researcher and participant [32].

The perceived factors, positive and negative, affecting participation of children and adolescents with type 1 diabetes in physical activity are described below from the perspective of each stakeholder. Verbatim quotes from primary studies, with descriptive labels where available, are provided to illustrate the themes. A descriptive summary across the range of different perspectives is additionally provided and presented in Table 2.

Children and adolescents with type 1 diabetes

Eight sample populations of children or adolescents with type 1 diabetes discussed the factors affecting their participation in physical activity [28-33,35-38]. The requirement for self-blood glucose regulation, including the need for regular insulin injections, managing dietary sugar intake, and the fear of hypoglycaemia, appear to be barriers to participation in physical activity.

> *I check my own blood sugar and then, during exercise, I pause every half an hour to an hour to eat some extra carbohydrate food, whether a muesli bar or jelly beans or something, as you're running around.* (15-year-old boy) [33]

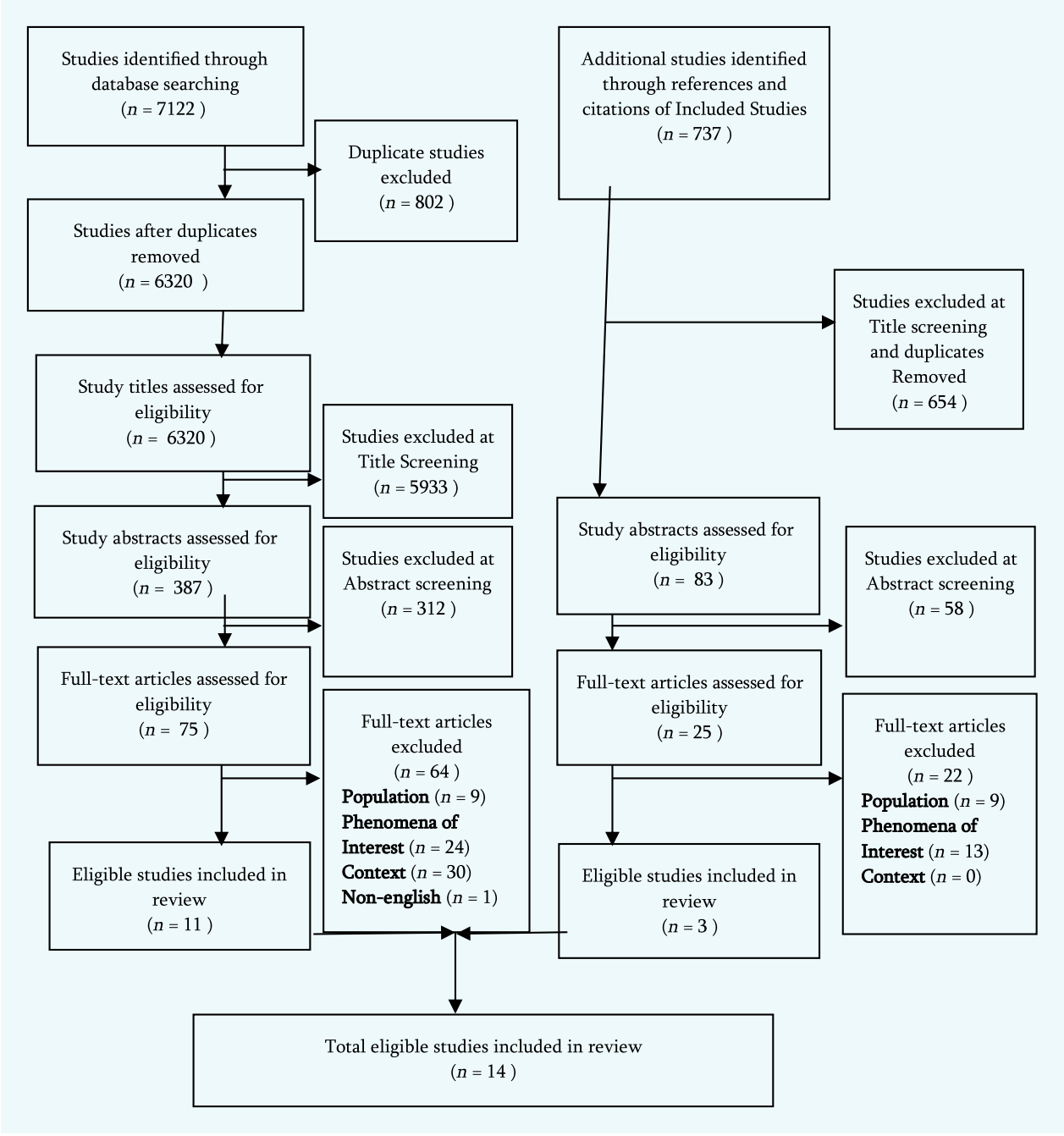

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram showing number of studies included at each stage of the literature review.

Apart from the barrier of blood glucose regulation, children and adolescents also report motivating factors for participation in physical activity, which include the support they receive from friends, family and teachers, the enjoyment of activities, and the health benefits. Co-participation with friends and family in activities seemed to facilitate their level of engagement, with adults commonly seen as 'role models' and facilitators through encouragement and logistical support, for example, by driving children or adolescents to activities.

> *My two brothers play on the trampoline and what we got to do is see who jumps the highest; sometimes I play football with my dad.* [28]

> *There's an assistant called Mr Rogers at PE* [physical education]*. . .He helps you get healthy and make it, make you really want to do it.* [28]

Overall, it appears children and adolescents with type 1 diabetes have a positive outlook on engaging in physical

Table 1 Characteristics of the included studies

First author (year)	Location	Study sample	Study design	Data collection method	Sampling method	Data analysis method	Quality rating (CASP* checklist)
Blake (2018) [27]	UK	11 family members	Qualitative	Interviews	Purposeful + snowball sampling	Thematic analysis	9
Burke (2007) [32]	Ireland	5 children/ adolescents with type 1 diabetes	Qualitative	Interviews	Purposeful sampling	Descriptive phenomenological analysis	8
Fereday (2009) [33]	Australia	14 children/ adolescents with type 1 diabetes + family members (not disclosed)	Qualitative	Focus groups	Purposeful sampling	Thematic analysis	9.5
Freeborn (2013) [34]	USA	21 family members	Qualitative	Focus Groups	Convenience sampling	Thematic analysis	7
MacMillan (2015, 2016) [35,36]	UK	16 children/ adolescents with type 1 diabetes , 16 family members, 37 teachers, 9 HCPs	Qualitative	Interviews + focus groups	Purposeful sampling	Thematic analysis	9.5 and 8.5
Mitchell (2017) Wilkie (2017) [37,38]	UK	16 children/adolescents with type 1 diabetes, 16 family members	Mixed-methods + qualitative	Interviews	Purposeful sampling	Thematic analysis	9 and 8.5
Quirk (2014) [39]	UK	20 family members	Qualitative	Interviews	Purposeful and snowballing sampling	Thematic analysis	9
Quirk (2015) [22]	UK	11 HCPs	Qualitative	Interviews	Purposeful sampling	Thematic analysis	9
Quirk (2016) [28]	UK	12 children/ adolescents with type 1 diabetes	Qualitative	Interviews	Purposeful sampling	Thematic analysis	9.5
Ryninks (2015) [29]	UK	12 children/ adolescents with type 1 diabetes	Qualitative	Focus groups	Purposeful sampling	Interpretative phenomenological analysis	8.5
Sparapani (2015) [30]	Brazil	19 children/ adolescents with type 1 diabetes	Qualitative	Interviews	Purposeful sampling	Content analysis	9
Wennick (2009) [31]	Sweden	11 children /adolescents with type 1 diabetes, 24 family members	Qualitative	Interviews	Purposeful sampling	Content analysis	9

CASP, Critical Appraisal Skills Programme; HCP, healthcare professional.
*Score out of 10.

activity, once they achieve optimal glycaemic control, and a positive attitude to diabetes.

> *You control diabetes rather than it controlling you. So if it controls you then yes it will stop you doing some certain things 'cause you're too unhealthy and you know you're not feeling right. But if you control it well then you know you're just normal, you're a normal person so you can do it like anyone else can.* (15-year-old boy) [29]

Family members

Six sample populations discussed the factors affecting participation in physical activity from the perspective of family members of children or adolescents with type 1 diabetes [27,31,34-39]. Family members appear to experience anxiety around children or adolescents participating in physical activities when not under their supervision. The anxiety of parents is often attributed to their confidence in a child or adolescent's ability to self-regulate their blood glucose levels or in a supervisor's ability to manage any problems that arise. Parental anxiety is seen as a factor that could prevent participation in activities or even necessitate parents accompanying their child to all activities.

> *For Taekwondo I'm always there, because his teacher and everything, they're not trained in how to treat him if he suddenly has a hypo or comes hyper or his cannula comes out.* [39]

Family members appear to see their role in facilitating physical activity as a planning one, which ranges from regulating their child's dietary intake in relation to the requirement of activities to logistical and financial support.

Table 2 Summary of themes across stakeholders

Theme	Description	Stakeholder identification	Illustrative verbatim quotations
Individual characteristics	The individual characteristics and motivation of children and adolescents affect participation. Children and adolescents who are intrinsically motivated will participate whilst children who are not motivated will not, and may use diabetes as an excuse	Family members, teachers, healthcare professionals	*'He'll do anything, he loves PE at school and he'll have a go at whatever they're doing, it doesn't matter what it is, he'll enjoy it and have a go'* [39] *'Sometimes the diabetes can be used as a nice convenient excuse but you usually find out that these were children who never did anything beforehand'* (Consultant) [22]
Self-blood glucose regulation	The need to check blood glucose levels, administer insulin and plan dietary intake of glucose can be a barrier to participation. Additionally hypoglycaemia symptoms can prevent participation.	Children/adolescents with type 1 diabetes, family members, healthcare professionals	*'Sometimes with football when my bloods go low and stuff…I have to you know, come off or not go on or don't go on, just need to wait for them to come back up.'* [28] *'If she goes swimming then her sugars are all over the place and so being honest, I don't encourage her to do it'* (Mother) [27] *'You've got a child…who suddenly decides to go out and bounce on the trampoline for half an hour and then their blood sugars go low'* (Consultant) [22]
Support systems	Support comes from peers, family and teachers. Peers can impact participation through co-participation and offering advice. Family members provide support through logistics and planning. Supervisors can help adapt and provide a comfortable environment to support participation.	Children/adolescents with type 1 diabetes, family members, teachers and healthcare professionals	*'Because all my friends, they're running across fields and well, since all my friends are active, I am. Just makes me want to be like them'* [28] *'A buddy next to them or someone that, that knows them quite well that they feel safe with'* (Secondary PE teacher student 109) [35] *'Making sure that they've had enough to eat, that they've always got Lucozade or whatever there to [take on] … check a wee [little] bit more regular their blood sugars.'* (Mother) [36]
Education and knowledge	Delivery of education from healthcare professionals and the perception of supervisor's knowledge level can facilitate or prevent participation. A fear of hypoglycaemia appears due to a lack of knowledge.	Children/adolescents with type 1 diabetes, family members, teachers and healthcare professionals	*'A lot of parents will be … too frightened to put their kids to certain activities for fear of them having a hypo. So a lot of it's due to confidence of the parents as well.'* (Father) [36] *'We talk about exercise if they're sporty'* (Dietitian) [22]
Communication between stakeholders	Communication between stakeholders can help facilitate participation as it allows for planning of glucose intake and the limitations of children and adolescents.	Family members, teachers and healthcare professionals	*'I would plan the week before and say to them next week we're going to be doing a higher level of exercise … so that they could … adjust their sugars … But the thing is you need to know that a diabetic needs to know that.'* (Primary specialist teacher 119) [35]

PE, physical education.
Italics highlight verbatim quotations from primary studies.

We support him by financing the football things and taking him to various places that he needs to go. [39]

The current provision of education and advice around physical activity for children and adolescents with type 1 diabetes is highlighted as a major perceived limitation by family members. Parents appear to feel that education around managing physical activity could be improved and not just targeted at 'sporty' children, adolescents or parents. Suggestions from family members to promote higher levels of education and support around physical activity include the use of digital resources and technologies, for example, telephone applications, to facilitate participation.

Talking about the provision of education around physical activity 'if they're not, well it's probably not seen as an issue, and it doesn't really come up in clinics…they don't see it as priority if the kid's not sporty'. (Mother) [27]

Parents acknowledge that the individual characteristics of children or adolescents are an important influence on

physical activity participation. There is a perception is that if children or adolescents are not intrinsically motivated to engage in activities they will not, and, in some instances, will use diabetes as an excuse to exclude themselves.

> *He will make up excuses about a hypo and check his bloods and get out of doing it.* [39]

Teachers and sports coaches

One study discussed the factors affecting children and adolescents with type 1 diabetes participation in physical activity from the perspective of teachers [35]. No study captured the perspective of sports coaches or physical activity providers. The study conducted from the perspective of teachers suggests that teachers perceive their own personal attitude to motivating children and adolescents with type 1 diabetes as a factor affecting the latters' participation. The teachers recognized the importance of creating an environment where children and adolescents feel comfortable to participate and recognize the ability of peers to help create this supportive environment.

> *I think having a positive approach … that's probably the most important thing.* (Secondary PE teacher) [35]

> *It's a case of you making them feel comfortable in the environment and not feel isolated.* (Secondary PE teacher) [35]

Teachers also highlighted that communicating and adapting plans to suit children and adolescents with type 1 diabetes can help promote physical activity levels.

> *I would plan the week before and say to them next week we're going to be doing a higher level of exercise … so that they could … adjust their sugars … But the thing is you need to know that a diabetic needs to know that.* (Primary specialist teacher) [35]

Whilst teachers report mainly positive factors they do see individual characteristics as a factor affecting participation. The study appears to suggest that some children and adolescents may have a mental barrier or use their diabetes as an excuse to not participate in activities.

> *There's not really a … diabetic barrier. There's … a mind-set barrier. But I'm not certain that that mind-set doesn'ae [doesn't] always come from protecting themselves from diabetes. I think it's the mind-set of eh 'I don't like physical education' or 'I don't like school' or some kind of combination of that.* (Secondary PE teacher) [35]

Healthcare professionals

Two sample populations discussed the factors affecting children and adolescents with type 1 diabetes participation in physical activity from the perspective of healthcare professionals [22,35,36]. Self-blood glucose regulation appears as a perceived barrier to children and adolescents with type 1 diabetes participating in physical activity. However there is an acknowledgement within the studies that there appears to be a perceived level of overprotection which could be overcome with appropriate management.

> *With most patients you can find a pattern to say look the child tends to go a bit hypo maybe two hours after the activity, so we need to make sure that we give them a good carbohydrate meal, we cut down the insulin or work out a strategy that works.* (Consultant) [22]

> *In many years of diabetes camps, I've seen one child 'slump' with a hypo … I've never seen anyone have a convulsion … I've never had to, for example, give glucagon or had to give them a drip. . . So uhm I think the dangers are over-stated.* (Physician) [35]

Other inhibitory factors discussed by healthcare professionals were the individual character of children and adolescents, who can use diabetes as an excuse to not participate, and the current provision of education. Healthcare professionals across the studies appear to acknowledge additionally that current deliverers of education may have a lack of time to cover all areas of diabetes management which could result in a lack of physical activity advice for specific people with diabetes.

> *The ones that have always been active carry on and find a way to do that with the diabetes.* (Nurse) [22]

> *If it's a child who's got a weight problem as well then we might address it.* (Consultant) [22]

Healthcare professionals also appear to value the importance of support from parents, friends and teachers as facilitative of physical activity.

> *I suppose parents' lifestyle influences. . .whether they have those opportunities to be active or whether their parents want to get on with other things and leave them to watch TV or play on the PlayStation.* (Dietitian) [22]

> *Who they make friends with and whether they are into [physical activity], if they've got friends who play football they'll go join them and play football after school.* (Dietitian) [22]

Summary of stakeholder themes

Five key themes appeared through the analysis of literature from each subgroup of stakeholders. These themes were, the individual characteristics of children and adolescents with type 1 diabetes, the requirement for self-blood glucose regulation, the support systems, the current provision of

education and knowledge level of stakeholders, and the communication between stakeholders (Table 2).

The individual characteristics of children and adolescents with type 1 diabetes was acknowledged by all the stakeholders as a factor that can both positively and negatively affect participation in physical activity [22,29,33,36,39]. It appears that the intrinsic motivations of children and adolescents with type 1 diabetes affect their level of participation in physical activities, such that if they are interested in an activity they will participate and if they are disinterested they will avoid activities, and even use diabetes as an excuse to remove themselves. Another clear factor identified by all stakeholders is the barrier of blood glucose regulation required during activity [22,30-31,33,36,39]. The constant need to check and adjust blood glucose levels through the planning of glucose intake and insulin injections, as well as the fear of low blood glucose levels, are seen as a common barrier to participation. This fear of mismanagement can also manifest in both children and adolescents, or in their parents withdrawing them from activities. Conversely, the support received from peers, family and professionals was mainly shown to facilitate participation in physical activity by all stakeholders [22,28,35,37,38]. Positive support systems are present in many ways, commonly through co-participation in activities, which appears to motivate children and adolescents, or through logistical support, for example, ensuring children and adolescents have access to sugary drinks or foods before and during activities.

Other factors identified across the stakeholder groups appear to be the provision of education, the knowledge level of supervisors and the communication between stakeholders [28-29,35,38,39]. Currently, it appears that stakeholders believe that education for children and adolescents, as well as family members, is not sufficient and could be negatively affecting participation in physical activities. However, despite the difficulties with the current provision, it was suggested that introducing new electronic technologies could help facilitate participation. Additionally, effective communication between all stakeholders appears to facilitate participation in physical activity, in terms of allowing planning of glucose intake and insulin injections, as well as easing the levels of anxiety among parents.

Discussion

This review presents a synthesis of perceived factors, both positive and negative, that affect participation in physical activity by children and adolescents with type 1 diabetes from the perspective of different stakeholders. The findings are largely consistent with other reviews that have studied factors affecting participation in children and adolescents without type 1 diabetes [40-42]. Similarities in the factors affecting participation include the influence of individual characteristics of children and adolescents and the importance of support systems. It is apparent that from the many perspectives obtained within this review and from previous literature around school-aged children, that the individual interests of each child or adolescent appear to influence their level of participation and therefore this should be considered in the design and evaluation of programmes to promote physical activity in this population [43]. Additionally, physical activity in all children and adolescents, including those with type 1 diabetes, appears to be strongly linked to the level of support they receive from their family, friends and supervisors. Positive support that children and adolescents with type 1 diabetes receive appears particularly important in promoting levels of physical activity as the support not only enables them to overcome perceived barriers to participation, but has also been shown to positively impact on management of diabetes by children and adolescents [44,45].

The present review adds to the current literature by highlighting some of the factors that appear to be unique to children and adolescents with type 1 diabetes. These additional unique factors include the need for self-blood glucose regulation, the fear of hypoglycaemia, education provision, and communication between children and adolescents with type 1 diabetes and individuals who supervise physical activities. The need for self-blood glucose regulation is currently an unavoidable aspect of type 1 diabetes management and creates apparent barriers to the participation of children and adolescents in physical activity [6]. Despite this, the present review suggests that this barrier could be reduced through the provision of sufficient education or technologies that could help facilitate children and adolescents with type 1 diabetes to participate in physical activity; however, studies evaluating the effectiveness of this theory appear only to be in early stages [27,37]. Other controllable factors highlighted within the present review are the apparent fear of hypoglycaemia, especially amongst parents, and the lack of current education provision which can potentially be associated with the fear of hypoglycaemia. Parental anxiety about the management of type 1 diabetes in children and adolescents, especially around hypoglycaemia and physical activity, has previously been identified in studies, but the present review gives us a greater understanding from the view of parents of the measures they take to negate the potential risks to their child [46,47]. The idea of communication about physical activity among children, adolescents, families and professional groups appears to be increasingly important in the population of interest, with effective communication creating a level of trust that can reduce levels of anxiety and make children and adolescents more comfortable in their management of type 1 diabetes [48].

Future practice should look to address the lack of knowledge about physical activity for children and adolescents with type 1 diabetes through widening support and education for children and adolescents, parents, teachers and healthcare professionals. Improvement to current education could enhance the coverage and amount of time that children

and adolescents, along with family members, have with a trained healthcare professional during clinic time, and through the creation of additional platforms, for example, the use of digital technologies. By identifying and addressing the concerns highlighted, for example, fear of hypoglycaemia and the anxiety of parents, future education could help decrease the current fears associated with physical activity.

In light of the importance of social support networks, future practice would benefit from considering and including agents of support, for example, peers and family members, in attempts to promote physical activity among children and adolescents with type 1 diabetes. This review suggests that considering these members in future programmes may encourage higher levels of engagement for children and adolescents with type 1 diabetes. Additionally, any future strategies to promote physical activity in children and adolescents with type 1 diabetes should consider the communication channels available in order to build trust and rapport with families and professional groups. This review suggests that, when communication is effective, both children or adolescents and family members feel safer in participating in physical activity and it also gives them information to improve planning for activities and potential risks. Although there is currently no specific guidance for designing school or extracurricular programmes, the integration of the views in the review ensures that the concerns addressed by teachers, sports coaches and parents will be considered in addition to what motivates or concerns children and adolescents themselves.

In regard to future research, the review identified a small number of studies using questionnaires that were originally created for adult populations [21,49]. These tools can be used to gather data from a larger number of individuals, therefore, future research could design or adapt tools to increase our understanding of the perceived factors among children and adolescents. Additionally, no study was identified from the perspective of sports coaches and few addressed the views of teachers and healthcare professionals. Future research exploring the perceived factors in these individuals could help to build a greater understanding of the motivators and barriers among the support network for children and adolescents with type 1 diabetes. When addressing the development of future interventions, studies should also explore ways in which children or adolescents, families, health professionals and teachers could all be targeted and how to maximize opportunities to ensure that programmes or services consider the wider social context in which children and adolescents with type 1 diabetes are active.

The present review provides the opportunity to explore the differences and similarities in perspectives of children and adolescents, families and different relevant professional groups with whom they interact [50]. By using qualitative research the review provides insights into the lived experience of people affected by a condition of interest. This synthesis of evidence across a number of qualitative studies builds an understanding that can be used to inform service planning. The review used well-established methods for reviewing, appraising and synthesizing qualitative studies.

The results of this review should, however, be considered in light of some limitations. A major limitation within the review is the low overall sample size. From the included 14 studies there were only 12 unique study samples, with the overall sample containing a low number of teachers and healthcare professionals, meaning that there were limited data on the perceived factors in these groups; therefore, whilst the findings should be considered for use in future practice, they should be interpreted with caution.

The review is also limited by the search strategy used. The terms included in the search strategy were based around sport and exercise in general, and terms for specific sports, for example, athletics or football, were not included. The review was therefore not exhaustive in terms of retrieving all studies, particularly those related to specific sports. Additionally, the review aimed to retrieve data on sports coaches' perceptions, but the search strategy used did not identify any such studies and the views of sports coaches are therefore not represented in the review.

Another potential limitation involving the sample populations is that there may have been a sampling bias within the included studies. Methods used for recruitment in the included studies were purposeful sampling, with two studies additionally using snowball sampling. The risk within the included studies is that the sampling methods may have led to the participants included in the studies having a higher interest in physical activity in comparison to the general population and may not represent other children and adolescents with type 1 diabetes. This review was additionally limited to qualitative research published in peer reviewed journals, so excluded potentially relevant unpublished 'grey literature', for which quality was likely to be both relatively poor and difficult to assess.

In conclusion, the present review synthesizes views on the perceived factors affecting participation in physical activity by children and adolescents with type 1 diabetes from the perspectives of children or adolescents, families and relevant professional groups with whom they interact. The findings suggest that it is important to consider the needs in the wider social context, as well as the children's and adolescents' own concerns and preferences, when developing new or existing strategies and programmes to promote physical activity in children and adolescents with type 1 diabetes.

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Competing interests

None declared.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

File S1. Search strategy.
File S2. Review inclusion and exclusion criteria.
File S3. Critical Appraisal Skills Programme quality appraisal of included studies.