What factors influence glycaemic control in children aged under 11 years with type 1 diabetes? A literature review

Zoe Sherwood

The incidence of type 1 diabetes is increasing each year. Targets for optimum glycaemic control in children are known to minimise the risks of long-term detrimental health outcomes; however, the majority of children do not achieve these. In this study, a literature search was conducted to determine factors associated with glycaemic control. Ten articles were identified for analysis. Two common factors arose: family support and use of technology. It became clear that both themes were linked by socioeconomic factors, which highlights the impact that health inequality has on future health outcomes. However, the studies reviewed suggested that these factors explain only around 20% of the variance in glycaemic control, and the two themes identified in this review play a minimal part of this outcome. To progress understanding further, additional research needs to be conducted.

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Article points

1. Only a very small proportion of children with type 1 diabetes are meeting the HbA_{1c} targets required to reduce the risk of complications.
2. This review of qualitative and quantitative research was conducted to identify psychosocial factors associated with glycaemic control in young children.
3. Two key factors arose: family support and use of technology. These factors were closely associated with socioeconomic background and education.

Key words

- Education
- Glycaemic control
- Health inequalities
- Metabolic control
- Technology

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Type 1 diabetes affects more than 31 000 children in the UK, and its incidence is increasing (Diabetes UK, 2015a). Poor glycaemic control is linked to reduced life expectancy as a result of increased risk of complications (Department of Health, 2007). NICE states that the optimum glucose control target for children with type 1 diabetes is an HbA_{1c} of ≤48 mmol/mol (6.5%) to reduce the risk of future complications (NICE, 2015). However, the most recent National Paediatric Diabetes Audit conducted by the Royal College of Paediatrics and Child Health (RCPCH, 2016) shows that less than 7% of children with type 1 diabetes in England and Wales are achieving this target.

The Department of Health (2012a; 2012b) identified children as key targets within public health services, as there is time to prevent damaging behaviours and attitudes from developing. There is also time to help the children establish good patterns of managing their health. This was emphasised by Jackson et al (2013), who found that early glycaemic control is predictive of long-term health. This literature review aims to explore factors that can be addressed to promote good glycaemic control and long-term health outcomes in children with type 1 diabetes.

Search strategy

A mind map was completed to identify possible words that may be used in the search. This search uncovered variations in spelling of a main key term and alternative phrase. The alternative phrase "metabolic control" was added as a key term and it was decided to use truncation and wildcards on the database searches, alongside Boolean operators, to account for variation in spellings. The keywords selected in this review were "glycaemic control" AND "diabetes" OR "diabetes mellitus". In addition, the keyword "diabetes" was combined with the following words in titles or abstracts: "child*" AND

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1. In this literature review, electronic literature databases were searched for qualitative and quantitative studies on glycaemic control in young children with type 1 diabetes.
2. Ten articles were included in the final analysis and two overarching themes were identified.
3. The first theme, family support, comprised factors related to socioeconomic background, with children from poorer families more likely to have worse glycaemic control.

"glycaemic control" OR "metabolic control". The first stage of the literature search was conducted using the electronic databases CINAHL, ProQuest, InterNurse and ScienceDirect. The initial search produced a large volume of literature hits. Inclusion and exclusion criteria were therefore applied to the searches (*Table 1*).

The decision to focus on children aged under 11 years was taken to eliminate topics such as transitional care. It is acknowledged that these issues can contribute to glycaemic control at the upper end of this particular age group; however, it was decided to focus on issues that could apply across the whole of the age range, and removing adolescent topics enabled this to occur. Articles discussing other types of diabetes were also excluded. While diabetes in children is still statistically rare, the majority of cases are of type 1 diabetes (Diabetes UK, 2015a). Grey literature (i.e. literature produced outside of traditional commercial or academic publishing) was also excluded owing to time and resource constraints.

In the second stage of the literature search, articles were selected by their abstract. Manual searches of reference lists were conducted and a further four articles matching the criteria were identified. In total, 17 articles were identified for consideration in this literature review. These articles were printed and reviewed. Two were excluded as they were clinical trials of experimental technology that is not available to most of the population under study, and a further five review articles were also excluded. The final selection, therefore, comprised 10 articles for analysis.

Table 1. Inclusion and exclusion criteria for the current literature review.

Inclusion criteria	Exclusion criteria
English language	Other types of diabetes
Published in 2009 or later	Grey literature
Children's research	Adult research
Full-text articles	Adolescent research
Qualitative studies	Systematic reviews
Quantitative studies	Literature reviews

Results

The 10 articles formed two distinct groups of research methods: six were quantitative and four were a combination of qualitative and quantitative methods. As this review focused on answering what factors contribute to glycaemic control, both research methods are useful. Two recurring themes were identified from the articles.

Theme 1: Family support

The main philosophy of children's nursing is family-centred care. NICE (2015) acknowledge that type 1 diabetes can have a major impact on the child, family and carers. Marmot (2010) reported that the conditions in which we are born, live and work have a direct impact on health. It is therefore no surprise that this review identified topics concerning family support and its influence on the glycaemic control of children with type 1 diabetes.

Cutfield et al (2011) conducted a longitudinal study identifying factors that influence glycaemic control in children with type 1 diabetes. Data collected from the clinical records of 229 children were analysed, and a highly significant correlation was found between poorer socioeconomic backgrounds and worse glycaemic control. These results are supported by a similar study by Galler et al (2011), who analysed clinical data from the records of 296 children. This identified a highly significant correlation between living in a higher socioeconomic area and having better glycaemic control. Both of these studies were conducted at only one clinic, and so demographic variability was limited. However, a further study by Harron et al (2012) supports these findings. This was a retrospective study of the clinical records of 2042 children from 21 different areas. It identified a highly significant correlation between socioeconomic status and glycaemic control, concluding that children living in the most deprived areas had, on average, an 11 mmol/mol (1.0%) higher HbA_{1c} level than those living in affluent areas. This supports the validity of the previous two studies, particularly as the studies were conducted in different countries, extending the

demographical variance.

The report by Marmot (2014) and the studies by Cutfield et al (2011), Galler et al (2011) and Harron et al (2012) highlight how influential socioeconomic status can be in long-term health determinants, and how it can affect glycaemic control. Connelly et al (2014) reported how socioeconomic variables can impact educational attainment. Those from higher socioeconomic groups are more likely to obtain higher levels of education, particularly literacy and numeracy skills. Further studies discussed how educational attainment can affect the glycaemic control of children.

Housiaux et al (2010) conducted a study of 45 children with type 1 diabetes and found a highly significant correlation between better glucose control in children whose parents/carers had higher educational attainment. A further study by Hassan and Heptulla (2010) supported these findings. The authors conducted a study of 200 children and found highly significant correlations between the literacy and numeracy standards of parents/carers and the glycaemic control of their children with type 1 diabetes. Both of these were single-centre studies, reducing demographic variability. However, a longitudinal study conducted by O'Hagan and Harvey (2010) had similar findings that add credit to the validity of these two studies. The authors collected data from the records of 1689 children from 12 different areas in Wales. A highly significant correlation between education and glycaemic control was identified. Unlike the previous two studies, which focused on the educational attainment of the parent/carers, this study identified a link among the children themselves. The authors noted that the educational attainment of younger children did not significantly affect glycaemic control, whereas the effect was more significant in older age groups. This could be explained by the fact that the educational attainment of parents/carers is more likely to influence glycaemic control in younger children, who have a higher level of carer dependency.

It is important to note that the study by Galler et al (2011) made reference to other studies investigating glycaemic control in children and adults with type 1 diabetes. The authors concluded that the studied factors only influenced 18% of the variance in HbA_{1c}, and this was similar to the 20% concluded in other studies. Without further research, it is uncertain whether these figures are accurate. However, if they are correct, then the impact of socioeconomic status and education is only a small consideration in factors affecting glycaemic control in this population.

Theme 2: Technology

Medical technology, understanding and practice constantly change and adapt. Within the last 5 years, type 1 diabetes treatment has seen new insulin formulations, practices and an increase in use of insulin pumps and continuous glucose monitors (Diabetes UK, 2015b). While factors and inequalities such as those previously discussed can impact access to information, services and understanding, they can also impact the likelihood of accessing newer treatments and technologies. Four studies identified in the literature review described the impact newer technology can have on the glycaemic control of children with type 1 diabetes.

Hughes et al (2012) conducted a study to evaluate the efficiency of insulin pumps and their impact on glycaemic control. Data on 67 children were analysed, revealing that pump therapy significantly improved glycaemic control in motivated families (those that completed the study). The retrospective nature of the study meant that outcomes could not be influenced in this paper. The results echo a similarly sized study by Sulmont et al (2010). These authors analysed clinical data and found that pump therapy significantly improved glycaemic control and was associated with a lower incidence of reported severe hypoglycaemia compared with multiple daily insulin injection regimens.

Following the findings of Hughes et al (2012) relating to motivation in families, a randomised controlled trial of 146 children was conducted by Mauras et al (2012), which found that the use of continuous glucose monitoring had the potential to significantly improve glucose control. However, for their use to be successful, integration into day-to-day management was required, and a number of barriers to this needed

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1. Families from higher socioeconomic groups are more likely to have better education, particularly literacy and numeracy skills.
2. The educational attainment of parents or carers is a particularly important factor for young children, who are more reliant on caregivers to achieve good glycaemic control.
3. The second theme identified in the review was technology, with access to newer treatments and devices such as insulin pumps associated with better glycaemic control.

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1. Interventions are required to reduce the effects of external influences, such as social inequality, on glycaemic control.
2. Chief among these initiatives is education, which can improve the skills required to manage diabetes, build up health-promoting habits early in life and increase awareness of what treatments and services are available.
3. All articles shared another conclusion: that more research is needed to determine the other factors associated with glycaemic control in this age group.

to be overcome.

In another randomised controlled trial conducted in 48 children, Toscos et al (2012) found that access to and use of the GlucoMON automated diabetes management system (Diabetech, Dallas, Texas, USA) significantly improved glycaemic control compared with conventional care. However, its success was dependent on the motivation of the families.

The results of all four of these studies were statistically significant and demonstrated that the technologies of insulin pump therapy, continuous glucose monitoring and advanced glucose monitoring equipment can have a positive impact on glycaemic control. Although the studies were small and undertaken at single clinics, with limited background information available on social demographics, they were conducted in different countries and so would appear to be generalisable. They highlighted how other factors such as motivation, interest and family support can impact on the effective use of technology. They also identified that, as children are key targets for addressing health promotion and long-term health outcomes, interventions need to minimise the effect of negative external influences (such as inequalities of demographic area, socioeconomic status and education; Marmot, 2010) that can reduce the availability of positive health interventions such as advanced technology.

Recommendations and conclusions

All the articles reviewed share three main recommendations. Mauras et al (2012) and Cutfield et al (2011) recommended the implementation of educational initiatives to support literacy and numeracy skills. This is a view supported by the International Society for Pediatric and Adolescent Diabetes, who state that effective education is vital to successful diabetes management (Lange et al, 2014).

Hassan and Heptulla (2010) emphasised the importance of culturally appropriate education initiatives for ethnic minorities. Hughes et al (2012) identified that, by investing in education, children and their parents/carers would be more empowered, resulting in the need for less intensive support from their diabetes team, and that this would continue to positively impact resource availability. Children are influenced by, and learn from, their surroundings. Long-standing behaviours will therefore influence them, as they copy what they see in their everyday life with their personal, social and environmental interactions. Thus, children face additional challenges when attempting to change negative health behaviours, as they may not have responsibility or the ability to alter situations they are placed in. It is therefore vital that they receive education as early as possible, and further consideration could be given to additional educational initiatives, such as online, multilingual study sessions.

O'Hagan and Harvey (2010) identified that there was also a link between education and awareness of what services and treatments were available. Social inequalities can impact the ability of families to access this information. Harron et al (2014) recommended that further investment and improvements in service availability need to be considered. A recommendation to implement a local support group could therefore be made. This would be a good platform to provide information about services and examine what the needs and wishes of families are, which could help identify weaknesses or shortcomings in any current services.

All these articles share a further conclusion: the need for further research. This review highlighted the limited number of easily available studies conducted within the last 5 years on the subject of factors that influence glycaemic control in children with type 1 diabetes. Possible reasons for this include ethical concerns of conducting studies in children and the fact that the prevalence of type 1 diabetes in children is quite low.

Both qualitative and quantitative research is needed. Polit and Beck (2010) and Barker (2013) noted that quantitative research has an evidence-based approach; therefore, it is useful and appropriate for measuring validity and reliability. However, Parahoo (2006) recognised that quantitative research can overlook the social and psychological aspects of life experiences. Thus, qualitative research can also be useful,

as it accesses direct information on feelings, experiences and beliefs (Bowling, 2009). However, it can be criticised for not answering a specific question, reducing its validity and reliability (Parahoo, 2006). The use of both types of research methods is particularly important to this literature review question. Particular studies, such as randomised controlled trials and intervention studies, would be useful to test knowledge and provide an evidence base.

To conclude, the targets recommended by NICE (2015) to help reduce the risk of long-term complications are not successfully achieved in the majority of cases in children with type 1 diabetes. This highlights the importance of understanding which factors influence glycaemic control. Further study is needed to increase awareness of these issues, along with investment in accessible multicultural educational initiatives. ■

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