Psychosocial family factors and glycemic control among children aged 1-15 years with type 1 diabetes: a population-based survey

Anne Haugstvedt1,2,3*, Tore Wentzel-Larsen4,5,6, Berit Rokne2 and Marit Graue1,3

Abstract

Background: Being the parents of children with diabetes is demanding. Jay Belsky’s determinants of parenting model emphasizes both the personal psychological resources, the characteristics of the child and contextual sources such as parents’ work, marital relations and social network support as important determinants for parenting. To better understand the factors influencing parental functioning among parents of children with type 1 diabetes, we aimed to investigate associations between the children’s glycated hemoglobin (HbA1c) and 1) variables related to the parents’ psychological and contextual resources, and 2) frequency of blood glucose measurement as a marker for diabetes-related parenting behavior.

Methods: Mothers (n = 103) and fathers (n = 97) of 115 children younger than 16 years old participated in a population-based survey. The questionnaire comprised the Life Orientation Test, the Oslo 3-item Social Support Scale, a single question regarding perceived social limitation because of the child’s diabetes, the Relationship Satisfaction Scale and demographic and clinical variables. We investigated associations by using regression analysis. Related to the second aim hypoglycemic events, child age, diabetes duration, insulin regimen and comorbid diseases were included as covariates.

Results: The mean HbA1c was 8.1%, and 29% had HbA1c ≤ 7.5%. In multiple regression analysis, lower HbA1c was associated with higher education and stronger perceptions of social limitation among the mothers. A higher frequency of blood glucose measurement was significantly associated with lower HbA1c in bivariate analysis. Higher child age was significantly associated with higher HbA1c both in bivariate and multivariate analysis. A scatterplot indicated this association to be linear.

Conclusions: Most families do not reach recommended treatment goals for their child with type 1 diabetes. Concerning contextual sources of stress and support, the families who successfully reached the treatment goals had mothers with higher education and experienced a higher degree of social limitations because of the child’s diabetes. The continuous increasing HbA1c by age, also during the years before puberty, may indicate a need for further exploring the associations between child characteristics, context-related variables and parenting behavior such as factors facilitating the transfer of parents’ responsibility and motivation for continued frequent treatment tasks to their growing children.

Background

The Diabetes Control and Complication Trial confirmed the significant association between poor glycemic control and higher risk of long-term complications among adolescents with type 1 diabetes [1]. Since then, insulin treatment and technologies for insulin delivery have improved and international guidelines for managing diabetes among children and adolescents have been established. Although some studies have reported improved glycated hemoglobin (HbA1c) among children in recent decades [2-4], no unambiguous evidence indicates that technical and medical progress has substantially improved glycemic outcomes [5,6]. Many children and adolescents still do not achieve HbA1c less than 7.5% as
recommended by the International Society for Pediatric and Adolescent Diabetes (ISPAD) guidelines [7].

Several studies have highlighted the importance of not only considering the effects of medical and technical factors but also psychosocial family factors for glycemic outcomes among children with type 1 diabetes. The results of studies focusing on associations between psychosocial factors on glycemic control are, however, mixed. In addition, most results are based on small sample sizes and considerable variation in the instruments used to assess psychosocial variables.

Sherifali & Ciliska [8] claimed that most of the parenting research literature as related to children with diabetes lacks a conceptualization of the determinants influencing parental functioning. They suggested Jay Belsky’s determinants of parenting model as a conceptual framework to guide future research on parenting children with diabetes. Belsky [9] stated that most parenting research has focused on the characteristics and consequences of parenting. By developing the determinants of parenting model Belsky drew attention to the determinants of individual differences in parenting. The model emphasizes 1) the parents' personal psychological resources, 2) the characteristics of the child and 3) contextual sources of stress and support as three important domains influencing the parenting process and subsequently the child’s development. The contextual sources of stress and support include work, marital relations and social network support [9].

Caring for a child with diabetes requires continual sensitive adaptation to the child’s growing and stage of development. Belsky [9] discussed what kind of personal psychological resources are needed to provide developmentally flexible and growth-promoting care. As part of the answer, Belsky claimed that previous research has provided some support for links between parents’ mental well-being and their parental functioning. In accordance, the Hvidøre Study Group on Childhood Diabetes [10] has demonstrated a positive association between parents’ experience of well-being and glycemic control among children with diabetes. Subjective well-being has been reported to be facilitated by a person’s trait of optimism, which has been shown to strongly protect adults who have experienced stressful life events such as the illness of a family member [11]. Based on this, it would be of interest to further examine the relationship between glycemic control among children with type 1 diabetes and variables related to the parents’ life orientation regarding optimism as a marker for competent parental functioning for parents’ caring for a child with type 1 diabetes.

Belsky’s model emphasizes how contextual sources of stress and support such as social support, work and marital relations influence both parents’ psychological resources and how they parent [9]. Sullivan-Bolyai et al. [12] have described how social support enhances mothers’ abilities to cope with the demanding daily treatment tasks related to diabetes treatment in a child. Thus, the associations between social support and glycemic control should be further explored. The study of Sullivan-Bolyai further reported that mothers of children with type 1 diabetes had lower employment status than mothers in a control group, with the additional responsibility because of the child’s diabetes as an explanatory factor. Although the association between employment status and glycemic control has not been fully explored, fathers’ higher education level has been reported to be associated with better glycemic control among children with diabetes [13].

Parents living together have previously been stated as a robust determinant for lower HbA1c among adolescents with type 1 diabetes [10]. According to Belsky’s model the parents’ satisfaction with the marital relationship may also be important for how families handle the daily challenges related to a child’s diabetes treatment. A study among 109 children 8-18 years old and one of the parents showed that family functioning, the families’ adherence to diabetes treatment, family structure, the child’s age and age at diagnosis explained 49% of the variation in HbA1c [14].

An important part of parenting children with type 1 is the frequent daily treatment tasks required. Helgeson [15], Ziegler [16] and others have shown that the daily frequency of blood glucose measurement is correlated with better glycemic outcomes among children and adolescents with type 1 diabetes. Frequent measurement helps the parents and the child to adjust the insulin treatment and/or adjust dietary behavior. In addition, more frequent blood glucose measurement has been claimed to be a potential marker for good adherence to the diabetes management behavior [17]. Transferred to Belsky’s conceptual framework, the frequency of blood glucose measurement may be a marker for good quality of care related to diabetes-specific parenting behavior and appropriate daily management of the child’s diabetes.

Based on previous research and inspired by the Belsky’s determinants of parenting model the objectives of our study were 1) to examine associations between glycemic control among children with type 1 diabetes and variables related to the parents’ personal psychological resources (optimistic life orientation) and contextual sources of stress and support (social support, work and education and marital relations) and 2) to examine the association between glycemic control among the children and the frequency of blood glucose measurement as a marker for good quality of care related to the diabetes-specific parenting behavior. We hypothesized:

That an optimistic life orientation, higher parental education, higher degree of employment, two-parent status or higher perceived satisfaction with the marital relationship, higher degree of social support or less perceived...
social limitation because of the child’s diabetes would be associated with lower HbA1c among children with type 1 diabetes; and,

that high frequency of blood glucose measurement would be associated with lower HbA1c when controlled for important child characteristics: frequency of problematic hypoglycemic events, the child’s age, duration of diabetes, insulin regimen and comorbid diseases.

Methods
In this population-based study we invited the parents of 161 children in Hordaland County, Norway to participate. All the children had type 1 diabetes for more than 3 months and were ≤ 15 years old. We sent a study information sheet and identical questionnaires for mothers and fathers by mail to the parents. We informed the parents that completed and returned questionnaires would be considered informed consent and that data on current HbA1c and insulin regimen would be collected from medical records. The Western Norway Regional Medical and Health Research Ethics Committee and the Norwegian Social Science Data Services approved this procedure and approved an anonymous nonrespondent analysis including HbA1c values in addition to age, sex and diabetes duration. The study was performed according to the Declaration of Helsinki.

Instruments
We used standardized questions and standardized instruments recommended by the Norwegian Institute of Public Health to collect on demographic variables from the parents. We collected data on routines for blood glucose measurement, hypoglycemic events and comorbid diseases among the children from both mothers and fathers. The reports from a child’s mother and father agreed close to 100%. In the analysis, we primarily used data from the mother if they were available; if not, we used data from fathers. We used the DCA-2000 (Bayer, Elkhart, IN, USA) for the HbA1c analysis (normal range 4.5-6.1%).

The questionnaire included several recognized generic scales (Additional file 1). We used the Life Orientation Test to collect data on the parents’ trait of optimism or pessimism as part of the parents’ psychological resources. The Life Orientation Test is a self-report instrument with 8 items (such as “In uncertain times I usually expect the best”) [18,19]. A sum score (range 0-32) is obtained by summing the item scores. Higher scores indicate a more optimistic life orientation. Cronbach’s alpha for the Life Orientation Test in this study was 0.81 for the mothers and 0.74 for the fathers. This is comparable with previous reports [18,19].

Concerning contextual sources of stress and support, we used the Oslo 3-item Social Support Scale sum score to measure the parents’ experience of social network support. The items in the scale include 1) number of confidants, 2) sense of concern or interest from other people and 3) sense of support from neighbors [20,21]. WHO recommends the Oslo 3-item Social Support Scale for use in health surveys, and a sum index ranging from 3 to 14 is derived by adding the scores. A higher score indicates more social support [20]. Cronbach’s alpha for the Oslo 3-item Social Support Scale in this study was 0.71 for the fathers and 0.55 for the mothers. The low Cronbach’s alpha for the mothers in this study caused an exclusion of the scale in the analysis of mother-reported data. In addition to the Oslo 3-item Social Support Scale, we added a single question exploring the parents’ experience of social limitation because of the child’s diabetes, with three categories (none or slight, somewhat or strong experience).

To assess satisfaction with the marital relationship, we used the Relationship Satisfaction Scale, with five statements on satisfaction with the marital relationship (such as “I am very happy in my marital relationship”). The items are rated on a six-point Likert scale, and the scale score is calculated by adding the item scores [22]. Cronbach’s alpha (0.88 for fathers and 0.89 for mothers) showed good internal consistency for the Relationship Satisfaction Scale in this study comparable with previous reports [22].

Overall, few data related to the parents’ answers on the Life Orientation Test, the Oslo 3-item Social Support Scale and the Relationship Satisfaction Scale were missing. We performed missing substitution to calculate the scale scores by inserting the mean when at least 4 of 8 (Life Orientation Test), 2 of 3 (Oslo 3-item Social Support Scale) or 3 of 5 (Relationship Satisfaction Scale) items were answered. We excluded one father from the Life Orientation Test and one mother and two fathers from the Relationship Satisfaction Scale because of too many missing values.

Statistical analysis
We carried out statistical analysis using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). We performed linear regression to test the hypotheses of associations between the explanatory variables and the child’s HbA1c as dependent variable. The sample size and the fact that some of the variables mutually excluded each other (marital status and satisfaction with the marital relationship) limited the possibility of including all explanatory variables in one multiple regression analysis. For comparison, we started with performing separate regression analyses for each explanatory and control variable included in the hypotheses. Further, we performed three multiple regression analyses. For the first hypothesis (including life orientation, social support, perceived social limitation, employment status, education and marital status), we performed one
analysis for mothers and one for fathers. The Relationship Satisfaction Scale was not included in these multiple regression analyses, as this would have excluded single parents. For the second hypothesis (including the frequency of blood glucose measurement and the control variables frequency of problematic hypoglycemic events, the child’s age, duration of diabetes, insulin regimen and comorbid diseases), we performed one multiple regression analysis. Additionally, we explored the relationship between age and HbA$_{1c}$ by performing a scatterplot and HbA$_{1c}$ by age groups by performing ANOVA.

**Results**

**Clinical and demographic variables**

The parents of 115 children returned the study questionnaire (response rate 72%). The participants were 103 mothers and 97 fathers. Both parents answered the questionnaire in 85 cases, only the mother in 18 cases and only the father in 12 cases.

The 115 children had a mean duration of diabetes of 3.9 years (SD 2.9, range 0.3-14.2). Five children had diabetes for less than 1/2 a year, with a minimum of 3.5 months, and additional 12 had diabetes for less than 1 year. Table 1 shows the children’s age and HbA$_{1c}$, use of an insulin pump, frequency of daily blood glucose measurement and frequency of problematic hypoglycemic events in the past year overall and by age group. HbA$_{1c}$ did not differ significantly between girls (HbA$_{1c}$ = 8.03%) and boys (HbA$_{1c}$ = 8.17%) ($P = 0.468$). All children received intensive insulin treatment with either an insulin pump or three or more insulin injections per day. Blood glucose was measured frequently (Table 1), and the parents of 27% of the children reported measurement at night at least once weekly. However, only 29% ($n = 33$) of the children had HbA$_{1c} \leq 7.5\%$ as recommended by ISPAD [7].

Nearly all parents (97%) were of Norwegian ethnicity. The mothers’ mean age was 39.6 ± 5.7 years and the fathers’ 42.6 ± 6.4 years. Fifteen percent of the mothers and 12% of the fathers reported single-parent status. About half the parents (45% of the mothers and 55% of the fathers) reported education at university or university college level. Five percent had not graduated from upper-secondary school. Of the fathers, 92% reported full-time employment, whereas only 37% of the mothers reported this. Many mothers (45%) reported part-time employment. Of the fathers, 45% reported perceived social limitation somewhat or strongly because of the child’s diabetes. Of the mothers, 48% reported the same.

The parents of 46 (28%) children did not return the study questionnaire. The HbA$_{1c}$ did not differ significantly between the children of nonrespondents and respondents, but the children of nonrespondents were

| Table 1 Characteristics of 115 children (aged 1-15 years) with type 1 diabetes by age group |
|---------------------------------------------------------------|
| Mean age (years)                                                |
| 1-5 years                                                      |
| 6-11 years                                                     |
| 12-15 years                                                    |
| HbA$_{1c}$ (%)                                                  |
| 1-5 years                                                      |
| 6-11 years                                                     |
| 12-15 years                                                    |
| Insulin pump                                                   |
| 1-5 years                                                      |
| 6-11 years                                                     |
| 12-15 years                                                    |
| Blood glucose measurements per day*, 4-6/≥ 7                   |
| 1-5 years                                                      |
| 6-11 years                                                     |
| 12-15 years                                                    |
| Problematic hypoglycemic events in the past year*, ≥ 7         |
| 1-5 years                                                      |
| 6-11 years                                                     |
| 12-15 years                                                    |

*The mothers’ reports were used if available; if not, data from fathers were used (the data showed close to 100% agreement between mothers’ and fathers’ reports on these items).
1.7 years older ($P = 0.005$) and the duration of diabetes was 1.3 years longer ($P = 0.016$) than that of the children of respondents.

Characteristics of parents and child HbA$_{1c}$

Regarding the first hypothesis of associations between the children’s HbA$_{1c}$ and the parents’ personal psychological resources and contextual sources of stress and support, the analyses indicated no significant associations between the children’s HbA$_{1c}$ and the parents’ trait of optimism or pessimism as measured by the Life Orientation Test, the fathers’ experience of social support (Oslo 3-item Social Support Scale) and the parents’ satisfaction with the marital relationship (Relationship Satisfaction Scale) (Table 2). Further, the children’s glycemic control was not significantly associated with the parents’ employment status or marital status. However, a higher education level among the mothers was significantly associated with better glycemic control in their children in both bivariate and multivariate analysis (Table 2). In addition, and in contrast to what we hypothesized, lower HbA$_{1c}$ among children was significantly associated with strong versus no or slightly perceived social limitation among the mothers in the multiple regression analysis. The same trend was identified between HbA$_{1c}$ and the fathers’ experience of social limitation, but this association was not statistically significant (Table 2). Strong experience of social limitation because of the child’s diabetes was reported by 20% of the mothers and 17% of the fathers in the study.

Blood glucose measurements, child characteristics and HbA$_{1c}$

In relation to the second hypothesis of associations between frequency of blood glucose measurement as a marker for good quality of care related to the diabetes-specific parenting behavior and HbA$_{1c}$, we identified a significant association between ≥ 7 blood glucose measurements per day and lower HbA$_{1c}$ in the bivariate analysis (Table 3). This significant association did not appear

| Table 2 Bivariate and multiple linear regression analysis for mother- and father-related variables associated with HbA$_{1c}$ among children ($n = 115$) with type 1 diabetes |
|----------------------------------------|----------------|----------------|----------------|
|                                       | Bivariate regression | Multiple regression* |
|                                       | Coefficient | $P$ | Coefficient | $P$ |
| **Mother-related variables**          |              |    |              |    |
| Life Orientation Test                  | 0.01         | 0.756 | -0.02 | 0.388 |
| Education - university or university college vs. not | -0.47 | 0.016† | -0.58 | 0.008† |
| Employment status                      |              |    |              |    |
| Working part time vs. full time        | -0.23        | 0.329 | -0.36 | 0.116 |
| Unemployed vs. working full time       | -0.16        | 0.588 | -0.52 | 0.079 |
| Oslo 3-item Social Support Scale§      | -            | -   | -            | -   |
| Experience of social limitation        |              |    |              |    |
| Somewhat vs. none or slight            | -0.08        | 0.733 | -0.04 | 0.853 |
| Strong vs. none or slight              | -0.43        | 0.116 | -0.62 | 0.022† |
| Marital status - single mother vs. not | 0.25         | 0.414 | 0.32  | 0.268 |
| Relation Satisfaction Scale            | -0.01        | 0.540 | -     | -     |
| **Father-related variables**           |              |    |              |    |
| Life Orientation Test                  | 0.00         | 0.984 | 0.00  | 0.849 |
| Education - university or university college vs. not | -0.16 | 0.484 | -0.07 | 0.763 |
| Employment status                      |              |    |              |    |
| Working part time vs. full time        | -0.12        | 0.912 | -0.38 | 0.723 |
| Unemployed vs. working full time       | 0.30         | 0.463 | 0.41  | 0.337 |
| Oslo 3-item Social Support Scale       | 0.00         | 0.995 | 0.01  | 0.884 |
| Experience of social limitation        |              |    |              |    |
| Somewhat vs. none or slight            | -0.47        | 0.054 | -0.50 | 0.063 |
| Strong vs. none or slight              | -0.37        | 0.213 | -0.33 | 0.314 |
| Marital status - single father vs. not | 0.48         | 0.169 | 0.64  | 0.111 |
| Relation Satisfaction Scale            | -0.01        | 0.626 | -     | -     |

*One multivariate analysis for mother-related variables ($R^2 = 0.17$) and one for father-related variables ($R^2 = 0.07$).

†$P < 0.05$.

§ The Oslo 3-item Social Support Scale was excluded in analyses among the mothers because of low Cronbach’s alpha (0.55).
in the multiple regression analysis. Only the child’s age was significant positively associated with HbA1c in the multiple regression analysis related to the second hypothesis (Table 3).

After performing the analyses related to the two hypotheses we explored further the association between the children’s age and HbA1c. The exploratory analysis of variance showed significant differences in mean HbA1c between the age groups 1-5 years, 6-11 years and 12-15 years ($P = 0.004$). Higher age group indicated higher HbA1c levels (Table 1). The scatterplot of HbA1c by child age, including only the children < 12 years of age, showed a close to linear relationship between higher age and higher HbA1c between 7 and 12 years of age. Figure 1 illustrates the relationship by both a loess and a linear line.

**Discussion**

The results of this population-based study highlight the importance of revealing the factors associated with glycemic control among children with type 1 diabetes since only 29% of the children in the study achieve the recommended treatment goals with HbA1c $\leq 7.5\%$ [7]. According to the Belsky’s determinants of parenting model, we did not identify any significant associations between contextual sources of stress and support related to the fathers and the children’s glycemic control, although we have previously reported a quite similar experience of diabetes-related burden among the mothers and the fathers in this population-based study [23]. In accordance with previous reports [24], the results support a presumption of the mother as most often the primary caregiver of children with type 1 diabetes.

**Perceived social limitation and maternal education**

The social limitation experienced by the parents in our study appeared to be associated with lack of options to transfer the responsibility for the child to someone else. Sullivan-Bolyai et al. [12] found that only 36% of the mothers of children with diabetes reported having access to child care versus 83% of the mothers in a control group. There seems to be a substantial need for help in building and educating a network around the families: a network of people the parents easily can trust and to whom the responsibility for the child can be delegated occasionally. The association between perceived social limitation and better glycemic control may

---

Table 3 Bivariate and multiple linear regression analysis of frequency of blood glucose measurement and child-related control variables associated with HbA1c among children ($n = 115$) with type 1 diabetes

|                      | Bivariate regression | Multiple regression* |
|----------------------|----------------------|----------------------|
|                      | Regression coefficient | $P$ | Regression coefficient | $P$ |
| Blood glucose measurement per day |                      |      |                      |      |
| 4-6 times versus $\leq$ 3 times         | -0.44               | 0.155 | -0.17               | 0.586 |
| $\geq$ 7 times versus $\leq$ 3 times   | -0.79               | 0.019† | -0.28               | 0.403 |
| Problematic hypoglycemia in the past year |                      |      |                      |      |
| 1-2 episodes versus 0 episodes           | 0.07                | 0.793 | -0.07               | 0.774 |
| 3-6 episodes versus 0 episodes           | 0.04                | 0.896 | 0.22                | 0.403 |
| $\geq$ 7 episodes versus 0 episodes      | -0.12               | 0.662 | -0.02               | 0.936 |
| Age                                  | 0.13                | $<0.001$† | 0.12                | $<0.001$† |
| Duration of diabetes                 | 0.11                | 0.001† | 0.01                | 0.775 |
| Insulin pump - yes versus no           | 0.41                | 0.033† | 0.32               | 0.109 |
| Comorbid disease - yes versus no       | 0.23                | 0.292 | 0.21               | 0.329 |

* $R^2$ for the multivariate analysis $= 0.25$.
† $P < 0.05$.

Figure 1 HbA1c by child age among children $\leq$ 11 years ($n = 70$). A scatter plot of the relationship between age and HbA1c.

---
be interpreted as ambitious mothers who have high aims for the child’s diabetes treatment. Families who are coping well may be able to successfully integrate the disease into their daily routines, but these efforts have certain costs, since they might spend much of their total available energy on treatment issues related to the child with diabetes. High ambitions may also create difficulty in transferring responsibility to other people. It is demanding to be among the best, and health care providers should not ignore severe experiences of burden and distress that may require somewhat different support and guidance compared with the needs of parents of children with poor glycemic control. Further research is needed to enhance overall knowledge on the effects of social support and assistance for the parents of children with type 1 diabetes.

The effects of mothers’ education may indicate that current diabetes management plans require knowledge and resources that more highly educated people have to a higher degree than other people. Diabetes teams therefore face challenges in fitting treatment plans for all families. Diabetes affects all strata of society, and support and interventions need to be adjusted for contextual factors related to families with various psychosocial and sociodemographic backgrounds. Nevertheless, one could question whether today’s diabetes treatment plans are too complicated and too time-consuming for some families. Most families do not achieve treatment goals despite many daily treatment tasks.

Blood glucose measurements and the child’s age
An important part of parenting children with type 1 diabetes is the high number of blood glucose measurements required to achieve treatment goals. In this study, the parents reported a high frequency of measurement, and it appeared that more frequent measurement was associated with a significant decrease in HbA1c (Table 3). Higher frequency of blood glucose measurement has also previously been shown to be associated with lower HbA1c [3,15,16]. In accordance with Helgeson et al. [15] and Ziegler et al. [16], we identified the highest frequency of blood glucose measurement in the youngest age group (1-5 years) (Table 1). The explanation could be that the parents of the youngest children are more motivated for frequent treatment tasks than the parents of older children or older children themselves.

The association between higher child age and higher HbA1c may also be explained by factors related to transferring responsibility, knowledge and motivation from the parents to the child or significant others in the child’s social network. It is well known that HbA1c is higher among adolescents than among younger children [4,16]. During puberty, increasing HbA1c can partly be explained by the additional challenges related to hormonal changes and reduced insulin sensitivity during this period. Previous research studies have not highlighted and discussed the explanations for increasing HbA1c among children 7-12 years old, but the reasons might be other than physical ones. As a child grows, the roles change, and the responsibility for daily treatment tasks is transferred from the parents to the child. Too early transfer of responsibility has previously been reported to be associated with poor glycemic control [25]. Our findings may support this. Children can manage technical treatment tasks quite early, but the age at which they can take responsibility for the medical decisions is probably much higher and varies from child to child. In accordance, parents need to receive better-adjusted guidance in the process of transferring responsibility and motivation for treatment tasks to their child. Interventions for both children and significant others are needed to increase knowledge, ability and motivation for the important treatment tasks required, also when the parents are not present.

Strengths and limitations
The study has strengths and limitations. The cross-sectional design presents limitations, especially concerning the impossibility of identifying causality. However, the inclusion of parents of all children with type 1 diabetes up to 16 years of age in a population-based study is strength of the study. Further, to our knowledge no previous studies have included both the mother and the father of such a large number of children with type 1 diabetes in the same study.

While HbA1c may be less stable shortly after diabetes onset one could suggest excluding the children with less than 1 year duration of diabetes from the analyses. A sensitivity analysis performed in this study did, however, not indicate substantially different results when excluding the ones with less than one year duration of diabetes. Mean HbA1c among the 98 children with ≥ 1 year duration of diabetes was 8.2% compared with 8.1% among the total group of 115 children.

Life Orientation Test, Oslo 3-item Social Support Scale and Relationship Satisfaction Scale are valid and recommended instruments. However, they might be too general to reveal the specific contextual factors or psychological resources of importance to achieve satisfactory diabetes treatment outcomes. The somewhat weak Cronbach’s alpha for the mothers’ Oslo 3-item Social Support Scale scores may be a result of few items in the Scale or a result of the mothers’ mixture of perceived general social support and disease-specific social support.

Conclusions
Only 29% of the families in the study achieved HbA1c ≤ 7.5% in their child with type 1 diabetes. According to Belsky’s determinants of parenting model, the study
identified some important associations between contextual sources, the characteristics of the child and parenting. The families who successfully reached diabetes treatment goals had more highly educated mothers and experienced more social limitations because of the child’s diabetes than the parents of children with poor glycemic control. Based on these results, one may question whether modern diabetes treatment plans are too complicated or not well adapted for each individual family. The increasing HbA1c by age, also during the childhood years well before puberty, may indicate a need for further exploring the associations between child characteristics and parenting behavior such as factors facilitating the transfer of parents’ responsibility and motivation for continued frequent treatment tasks to their growing children.

Additional material

**Additional file 1: Questionnaire** The scales included in the study.

Acknowledgements

We thank all the parents and children who participated in this study. We also thank Oddmund Savik for useful contributions in the discussion of results. The Diabetes Research Foundation of Western Norway, the Norwegian Diabetes Association, the Norwegian Nurses’ Association, the Western Norway Regional Health Authority, the University of Bergen and Bergen University College supported the study.

Author details

1. Faculty of Health and Social Sciences, Bergen University College, Norway.
2. Department of Public Health and Primary Health Care, University of Bergen, Norway.
3. Centre for Clinical Research, Haukeland University Hospital, Bergen, Norway.
4. Centre for Child and Adolescent Mental Health, Eastern and Southern Norway, Oslo, Norway.
5. Norwegian Centre for Violence and Traumatic Stress Studies, Oslo, Norway.

Authors’ contributions

AH researched data, wrote the manuscript, contributed to discussion and reviewed and edited the manuscript. TW-L researched data, contributed to discussion and reviewed and edited the manuscript. ER researched data, contributed to discussion and reviewed and edited the manuscript. MG researched data, contributed to discussion and reviewed and edited the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Received: 13 May 2011 Accepted: 20 December 2011 Published: 20 December 2011

References

1. Diabetes Control and Complications Trial Research Group: Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. J Pediatr 1994, 125:177-188.
2. Gerstl E, Rabl W, Rosenbauer J, Gröbe H, Hofer SE, Krause U, Holl RW: Metabolic control as reflected by HbA1c in children, adolescents and young adults with type-1 diabetes mellitus: combined longitudinal analysis including 27,035 patients from 207 centers in Germany and Austria during the last decade. Eur J Pediatr 2008, 167:447-453.
3. Svensson J, Johannessen J, Mortensen HB, Nordsild S, on behalf of the Danish Childhood Diabetes Registry: Improved metabolic outcome in a Danish diabetic paediatric population aged 0-18 yr: results from a nationwide continuous registration. Pediatr Diabetes 2008, 10:461-467.
4. Margeidtodd H, Larsen JR, Krummenes SJ, Brunborg C, Dahl-Jørgensen K, on behalf of the Norwegian Study Group for Childhood Diabetes: The establishment of a new national network leads to quality improvement in childhood diabetes: implementation of the ISPAD Guidelines. Pediatr Diabetes 2010, 11:86-95.
5. De Beaufort CE, Swift PG, Skinner CT, Aanstoot HI, Áman J, Cameron F, Mantul P, Chiarelli F, Damman D, Danne T, Dorby H, Hoey H, Kaprio EA, Kaufman F, Kocva M, Mortensen HB, Njølstad PR, Phillip M, Robertson KJ, Schoenfelt EJ, Uraikami T, Vaneli M, The Hvidøre Study Group on Childhood Diabetes: Continuing stability of center differences in pediatric diabetes care: do advances in diabetes treatment improve outcome? Diabetes Care 2007, 30:2245-2250.
6. Skinner CT, Cameron FJ: Improving glycaemic control in children and adolescents: which aspects of therapy really matter? Diabet Med 2010, 27:369-375.
7. ISPAD Clinical Practice Consensus Guidelines 2009 compendium. In Pediatr Diabetes Edited by: Haran R, Donaghue K, Klingensmith G, Swift PG 2009, 10(Suppl 12).
8. Sherifali D, Ciliska D: Parenting children with diabetes and Belsky’s determinants of parenting model: literature review. J Adv Nurs 2006, 55:636-642.
9. Belsky J: The determinants of parenting: a process model. Child Dev 1984, 55:93-96.
10. Hoey H: Psychosocial factors are associated with metabolic control in adolescents: research from the Hvidøre Study Group on Childhood Diabetes. Pediatr Diabetes 2009, 10(Suppl 13):9-14.
11. Wrosch C, Scheier MF: Personality and quality of life: the importance of optimism and goal adjustment. Qual Life Res 2003, 12(Suppl 1):59-72.
12. Sullivan-Bolyai S, Deatrick J, Gruppuso P, Tamborlane W, Grey M: Mothers’ experiences raising young children with type 1 diabetes. J Spec Pediatr Nurs 2002, 7:93-103.
13. Faulkner MS, Chang L: Family influence on self-care, quality of life, and metabolic control in school-age children and adolescents with type 1 diabetes. J Pediatr Nurs 2007, 22:59-68.
14. Levin AB, Heidgerken AD, Geffken GR, Williams LB, Storch EA, Gelfand KM, et al: The relationship between family factors and metabolic control: the role of diabetes adherence. J Pediatr Psychol 2006, 31:174-183.
15. Helgeson VS, Honcharuk E, Becker D, Escobar O, Siminerio L: A focus on blood glucose monitoring: relation to glycemic control and determinants of frequency. Pediatr Diabetes 2011, 12:25-30.
16. Ziegler R, Heidtmann B, Hilgard D, Hofer S, Rosenbauer J, Holl R, the DPV-Wiss-Initiative: Frequency of SMBG correlates with HbA1c and acute complications in children and adolescents with type 1 diabetes. Pediatr Diabetes 2011, 12:11-17.
17. Urbach SL, LaFranchi S, Lambert L, Lapidus JA, Daneman D, Becker TM: Predictors of glycose control in children and adolescents with type 1 diabetes mellitus. Pediatr Diabetes 2005, 6:69-74.
18. Scheier MF, Carver CS: Optimism, coping and health assessment: implications and generalizations of outcome expectancies. Health Psychol 1985, 4:219-247.
19. Thuen F, Rise J: Psychological adaptation after marital disruption: the effects of optimism and perceived control. Scand J Psychol 2006, 47:121-128.
20. Meltzer H: Development of a common instrument for mental health. In EUROMHS: Developing Common Instruments for Health Surveys. Edited by: Nosikov A, Gudex C. Amsterdam, IOS Press (on behalf of WHO); 2003.
21. Daßgard OS, Dowrick C, Lehtinen V, Vazquez-Barquero JL, Casey P, Wilkinson G, Ayuso-Mateos JL, Page H, Dunn G, Odin Group: Negative life events, social support and gender differences in depression. Soc Psychiatry Psychiatr Epidemiol 2006, 41:444-451.
22. Dyrdal GM, Raysamb E, Nis RB, Vittersæ J: Can a happy relationship predict a happy life? A population-based study of maternal well-being during the life transition of pregnancy, infancy and toddlerhood. J Happiness Stud 2010, doi: 10.1007/s10902-010-9238-2.
23. Haugstvedt A, Wentzel-Larsen T, Rokne B, Graue M. Perceived family burden and emotional distress: similarities and differences between mothers and fathers of children with type 1 diabetes in a population-based study. Pediatr Diabetes 2011, 12:107-114.

24. Dashiff C, Morrison S, Rove J. Fathers of children and adolescents with diabetes: what do we know? J Pediatr Nurs 2008, 23:101-119.

25. Anderson B, Ho J, Brackett J, Finkelstein D, Laffel L. Parental involvement in diabetes management tasks: relationships to blood glucose monitoring adherence and metabolic control in young adolescents with insulin-dependent diabetes mellitus. J Pediatr 1997, 130:257-265.

Pre-publication history
The pre-publication history for this paper can be accessed here:
http://www.biomedcentral.com/1471-2431/11/118/prepub

doi:10.1186/1471-2431-11-118
Cite this article as: Haugstvedt et al: Psychosocial family factors and glycemic control among children aged 1-15 years with type 1 diabetes: a population-based survey, BMC Pediatrics 2011 11:118.