Psychosocial well-being and functional outcomes in youth with type 1 diabetes 12 years after disease onset

Elisabeth A Northam¹,²,³ PhD
Ashleigh Lin³ BSc (Hons)
Sue Finch⁴ PhD
George A Werther³,⁵ MD
Fergus J Cameron³,⁵ MD

Department of Psychology, Royal Children’s Hospital¹; Department of Psychology, University of Melbourne²; Murdoch Childrens Research Institute³; Statistical Consulting Centre, University of Melbourne⁴; Department of Endocrinology and Diabetes, Royal Children’s Hospital⁵; Melbourne, Australia.

Corresponding Author:
Ashleigh Lin,
Email: ashlin@unimelb.edu.au

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Objective- Type 1 diabetes youth and community controls were compared on functional outcomes. Relationships were examined between psychosocial variables at diagnosis and functional outcome 12 years later.

Research Design and Methods - Participants: Type 1 diabetes (N = 110, mean age 20.7 yrs, SD 4.3) and controls (N = 76, mean age 20.8 yrs, SD 4.0). Measures: Youth/Young Adult Self Report and a semi-structured interview about functional outcomes. Type 1 diabetes participants also provided information about current diabetes care and metabolic control from diagnosis.

Results - Type 1 diabetes participants and controls reported similar levels of current well-being, but mental health referral rates over the previous 12 years were higher by 19%, and school completion rates were lower by 17% in youth with type 1 diabetes. Over one third were not currently receiving specialist diabetes care and this group had higher mental health service usage in the past (61% vs 33%) and lower current psychosocial well-being. Within the type 1 diabetes group, behaviour problems, high activity and low family cohesion at diagnosis predicted lower current well-being, but were not associated with metabolic control history. Poorer metabolic control was associated with higher mental health service usage.

Conclusions - Type 1 diabetes participants report similar levels of current psychosocial well-being to controls, but higher levels of psychiatric morbidity since diagnosis and lower school completion. Psychiatric morbidity was associated with poor metabolic control and failure to transition to tertiary adult diabetes care.
The focus on prevention, early detection and treatment of diabetes-related complications that followed the Diabetes Control and Complications Trial (DCCT) (1) has been paralleled by increased interest in promoting health-related quality of life and minimizing psychosocial morbidity in youth with type 1 diabetes. Epidemiological studies suggest that psychological difficulties are increased in children and adolescents with diabetes, as they are in youth with other chronic medical conditions (2). Mood disorders are the most frequently reported diagnosis in youth with type 1 diabetes, but anxiety, conduct problems and eating disorder rates are also elevated (3, 4). Less clear is the trajectory of these problems into adulthood, with conflicting evidence as to whether psychological difficulties persist into early adulthood or tend to diminish as reported in community samples (5). Psychiatric morbidity was high in the sample of young adults studied by Hislop et al. (6), with one third reporting elevated levels of maladjustment. Similar disorder rates were reported by Bryden and colleagues (7) in their sample of young adults with type 1 diabetes, while Grey et al. (8) found that depression in adolescence was associated with ongoing mood disorders in early adulthood. These findings suggest continuity of problems. In contrast, emotional and behavioural problem scores were not elevated in adolescents with type 1 diabetes in a controlled study conducted over three years (9), while a ten year follow-up of a young adult cohort, aged 19-26 years, also found psychiatric morbidity to be similar to that of controls (10).

Psychological maladjustment in individuals with type 1 diabetes is particularly concerning because it is associated with poor metabolic control (4, 11), which in turn increases the risk of diabetes-related complications (1). It is possible that neurohormonal changes associated with stress and mental illness affect endocrine pathways directly influencing metabolic control. It is more generally assumed, however, that psychiatric symptoms adversely affect metabolic control indirectly, by disrupting the behaviours necessary for diabetes-related self-care (12). Better documentation of the risk factors for psychological difficulties and the associated problems with metabolic control is critical if intervention and clinical support are to be targeted appropriately.

This report documents the psychosocial well-being and functional and health outcome of youth with type 1 diabetes studied prospectively from diagnosis. Immediately after diabetes-onset, these children exhibited mild symptoms of psychological distress but these had largely resolved by one year after diagnosis (13). Ten years after diabetes onset, 37% of an adolescent subset of the original cohort met criteria for a DSM-IV psychiatric diagnosis (14), a morbidity two to three times higher than community levels (15). In addition, adolescents with a psychiatric diagnosis and those with a history of poor metabolic control had exhibited more behaviour problems at diagnosis. The current report documents psychiatric morbidity and functional status in the original cohort 12 years after diagnosis with type 1 diabetes. We asked the following questions:

1. Twelve years after disease onset, does the psychosocial status and functional well-being of youth with type 1 diabetes differ from that of healthy community controls?
2. Are psychosocial, functional and health outcome twelve years after disease onset associated with
   • child behaviour and temperament at diagnosis?
   • family functioning at diagnosis?
   • history of metabolic control?

**RESEARCH DESIGN AND METHODS**
Participants. Consecutive admissions (aged 1-14 years) to the Royal Children's Hospital, Melbourne (RCH) with newly diagnosed type 1 diabetes between 1990 and 1992 (N = 133), together with age and gender stratified healthy controls (N = 126) were recruited into a longitudinal study to examine disease impact on functional outcome. Recruitment strategy has been fully described previously (13, 14). Twelve years later, all participants who could be located (125 type 1 diabetes and 93 controls, 94% and 74% respectively) using the study database, RCH and adult diabetes clinics, private endocrinologists and the Health Insurance Commission, were invited to participate in follow-up. Of those located, 110 participants with type 1 diabetes and 76 controls agreed to participate (rates of 88% and 82% respectively) in the current study.

Procedure. Participants were interviewed and completed a standardised measure of psychosocial well-being as part of a comprehensive evaluation which also included neuroimaging and neuropsychological assessments. Central nervous system outcomes have been reported separately (16). The study was approved by the Human Ethics Research Committee of the Victorian Government Department of Human Services.

Measures. Baseline psychosocial measures:
- Child behavior (Child Behavior Check List; CBCL) (17): 118-item questionnaire completed by the primary caregiver provides scores for Internalising (depression, anxiety, somatic concerns), Externalising (aggression, hyperactivity, conduct problems) and Total problem (also includes social, thought, and attention problems not categorised into either the Internalising or Externalising broadband scales). Scores are expressed as standardised T scores (μ = 50, SD = 10), with higher scores indicating greater pathology. The two broadband scales and Total behaviour problem score have excellent internal consistency (α = 0.89 - 0.96) and test-retest reliability (r = 0.89 - 0.93).
- Child temperament (EAS Temperament Scale; EAS) (18): 20 item mother-rated measure of child temperament provides scores for Emotionality, Activity, Sociability and Shyness. The EAS is scored on a five-point response scale with higher scores indicating greater expression of the trait. Internal consistency across EAS scales ranges from 0.75 to 0.83, and test-retest reliabilities range from 0.57 to 0.80.
- Family functioning (Family Adaptability & Cohesion Evaluation Scales; FACES-III) (19): A mother-rated 20-item measure that evaluates family functioning on Cohesion and Adaptability. Responses are rated on a five-point scale with higher scores reflecting more functional family relationships. The Adaptability and Cohesion scales have internal consistencies of 0.62 and 0.72, and test-retest reliabilities of 0.80 and 0.83 respectively.
- Socio-economic status: (The Daniel Scale of Occupational Prestige) (20) was used to rate the occupational status of the principal earner, on a six-point scale (1=high, 6=low).

Baseline measures were administered to type 1 diabetes participants during a home visit conducted three to four weeks after the initial diagnosis, and to controls at the time of recruitment. Child temperament and family functioning measures were administered to type 1 diabetes participants only.

Follow-up measures.
- Psychosocial well-being (Youth Self-Report and Young Adult Self-Report; YSR/YASR) (21, 22): Self-report measures for youth aged 11-18 (112 items) and 19-30 years (110 items), respectively, which provide scores for Internalising (anxiety, withdrawal,
somatic concerns), Externalising (aggression and delinquency) and Total problems (also includes social, thought, and attention problems). Scores are expressed as standardised T scores ($\bar{X} = 50$, $SD = 10$), and are comparable across the YSR/YASR. Higher scores indicate greater psychopathology. YASR and YSR scales have excellent internal consistency ($\alpha = 0.71 – 0.96$) and test-retest reliability ($r = 0.80 – 0.92$).

- **Functional outcome:**
  A semi-structured interview was conducted to obtain information about referral rates for mental health services over the previous 12 years as an indicator of overall psychological morbidity since diabetes onset. Information about school history and current study/work participation was also recorded. Type 1 diabetes participants reported their current diabetes medical care (i.e. hospital clinic, private endocrinologist, local medical officer or other).

**Biomedical measures:** Participants were asked to report any episode of hypoglycemia associated with seizure activity or loss of consciousness since diagnosis. These reports were corroborated through scrutiny of the medical records. The sample was dichotomized into those who reported no seizure activity and those with a history of $\geq 1$ seizure/coma associated with hypoglycemia. All $Hb_{A1C}$ measurements from diagnosis were obtained for each patient (range 4-57, median 37) from hospital and clinic databases. $Hb_{A1C}$ was assessed at RCH using the BioRad (Hercules, CA, USA) affinity column chromatography method prior to 1994 and using a Bayer (Calabria, Barcelona, Spain) DCA 2000 immuno-agglutination method from 1994 to 2004. The methods used in adult clinics included Primus Boronate Affinity (Primus Diagnostics) and Bayer DCA 2000. All methods are referenced to the National Glycohemoglobin Standardization Program. In line with the DCCT finding that a mean $Hb_{A1C}$ of 9% or higher was associated with an increased risk of diabetic complications (1), the percentage of total time from diagnosis that $Hb_{A1C}$ was $\geq 9.0\%$ was calculated for each participant with type 1 diabetes to measure lifetime glycemic exposure.

**Statistical analyses:** SPSS version 15 (SPSS, Chicago Il) was used for all analyses. We used analysis of co-variance (ANCOVA) to examine group (type 1 diabetes, control) differences on YSR/YASR Total, Internalising and Externalising T scores, controlling for gender and SES. Chi-square analyses were used to investigate group differences on categorical variables, e.g. mental health referral, school completion and study/work participation rates. Analyses of school completion rates and specialist diabetes care were limited to participants no longer attending school or receiving pediatric diabetes care.

Regression analyses were used to predict outcomes within the diabetes group using binary logistic regression for categorical outcomes (school completion, study/work participation, specialist diabetes care, school completion, history of seizures) and multiple linear regression if the outcome was continuous (YSR/YASR scores, percentage of time $Hb_{A1C} \geq 9\%$). Gender was included as a predictor in all regression models. To predict functional outcome from YSR/YASR scores, Internalising and Externalising scores were entered in a separate models from Total scores to overcome the problem of multicollinearity. When using baseline variables to predict outcome (metabolic control history, YSR/YASR scores, functional outcome), CBCL Internalising and Externalising scores were included separately from CBCL Total problem scores for the same reason. SES at baseline was included when child behaviour (CBCL) or parent
functioning measures (FACES) were entered as predictors. To predict outcome from illness-related variables, the models included the percentage of time $\text{HbA}_{1c} \geq 9\%$, history of seizures and age of onset (early or later onset).

**RESULTS**

The samples consisted of participants with type 1 diabetes ($N=110$, 54 males, 56 females) and control participants ($N=76$, 37 males, 39 females). At assessment, mean age was 20.7 years ($SD=4.3$) and mean SES was 4.3 ($SD=1.1$) for type 1 diabetes. Mean age for controls was 20.8 years ($SD=4.0$) and SES was 4.1 ($SD=1.2$). Group differences on gender ratio, age and SES at baseline and 12 year follow-up were small. SES for both groups was comparable to the Australian population mean of 4.1 ($SD=1.1$) (20). SES did not differ between type 1 participants or controls who were assessed at 12 years and those who were recruited initially, but could not be located or declined to take part in the current study. Of the individuals with type 1 diabetes, 41 had early onset ($\leq 5$ years) diabetes and 47 reported at least one episode of severe hypoglycemia resulting in seizure or coma. Mean time since diagnosis that $\text{HbA}_{1c} \geq 9\%$ was 42.9% ($SD=26.6$) and the most recent mean $\text{HbA}_{1c}$ was 9.1% ($SD=1.7$).

1. **Group (type 1 diabetes/control) differences in current psychiatric status and functional outcome** There were only very small group differences on the problem scores of the YSR/YASR: Internalising problems [type 1 diabetes $\bar{X}=47.03$, controls $\bar{X}=48.18$, 95% CI for difference =-2.09–4.38, $F(1, 167)=0.06$, $p=.8$]. Externalising problems [type 1 diabetes $\bar{X}=49.75$, controls $\bar{X}=50.26$, 95% CI for difference =-2.59–3.60, $F(1, 167)=0.13$, $p=.7$], or Total problems [type 1 diabetes $\bar{X}=48.70$, controls $\bar{X}=49.54$, 95% CI for difference =-2.46–4.15, $F(1, 167)=0.08$, $p=.8$]. Mental health referral, school completion, and study/work participation rates are shown in Figure 1. Type 1 diabetes youth were more likely than controls to have had contact with mental health services (37% v 18%, $\chi^2(1)=8.30$, $p=.004$, $N=181$). Youth with type 1 diabetes who had reached school leaving age were less likely to have completed Year 12 (the final pre-tertiary year of education in Australia) than controls (68% v 85%, $\chi^2(1)=5.02$, $p=.025$, $N=131$). Group differences in the percentage currently in full time study/work were small (89% with type 1 diabetes vs. 92% of controls, $\chi^2(1)=0.50$, $p=.5$, $N=185$). Within the type 1 diabetes group, regressions models were used to predict functional outcomes from current psychosocial status (YSR/YASR scores). Mental health referral was associated with current Total problems (odds ratio=1.06, 95% CI=1.02–1.11, $p=.007$). Reduced study/work participation rates were associated with higher current Internalising (odds ratio=1.09, 95% CI=1.0-1.18, $p=0.039$) and Total (odds ratio=1.07, 95% CI=1.01-1.13, $p=0.023$) problems. School completion was not strongly associated with current psychosocial status. Of youth no longer attending RCH for medical care ($N=75$), 47 (63%) reported attendance at a hospital diabetes clinic or private endocrinologist, 11 (15%) reported receiving diabetes care from their local medical practitioner, and 17 (23%) reported crisis-driven attendance only, at either a local medical practitioner or hospital emergency clinic. Local medical practitioner/crisis only diabetes care was associated with higher current Externalising (odds ratio=1.11, 95% CI=1.03-1.19, $p=0.008$) and Total (odds ratio=1.07, 95% CI=1.02-1.12, $p=0.01$) problems. Sixty one percent of youth accessing crisis only diabetes care had a history of referral for mental health services at some time since diagnosis, compared to 33% of those receiving regular medical care ($\chi^2(1)=4.72$, $p =.03$, $N=93$). The percentage time in poor metabolic control did not differ between those receiving tertiary diabetes care
Type 1 diabetes and functional outcomes

(\(\bar{X} 39.96\%, SD 28.15\)) and those accessing local medical officer/crisis only care (\(\bar{X} 46.11\%, SD 20.84\)), \(t(68.23) =-1.22, p=.23\).

2. Associations between baseline variables and psychosocial, functional and health outcome

Regression models predicting current psychosocial and functional outcomes from baseline variables are presented in Table 1. CBCL Total problem scores at baseline predicted 15–20% of the variance in Internalising, Externalising and Total YSR/YASR scores 12 years after diabetes onset. Baseline CBCL Internalising and Externalising problem scores predicted 12–17% of variance in Internalising, Externalising and Total problem scores at follow-up. The CBCL Externalising score was a better predictor than the CBCL Internalising score. Activity was the best of the EAS predictors but, in general, child temperament variables at diagnosis were not as powerful predictors of YSR/YASR scores (2–7% of variance) as CBCL measures. FACES predicted up to 10% of the variance in Internalising, Externalising and Total problem scores at follow-up, primarily reflecting the association between lower Cohesion scores at baseline and lower levels of current psychosocial well-being.

Elevated CBCL Total problem scores at diagnosis were associated with higher mental health referral rates (see Table 1). Other baseline CBCL, EAS and FACES scores were not strong predictors of mental health referral, school completion, current study/work participation rates or current diabetes care. Lower SES at baseline was strongly associated with lower school completion rates. CBCL, EAS and FACES scores at baseline were poor predictors of metabolic control since diagnosis, accounting for approximately 2–6% of variance in the percentage of time HbA1C was \(\geq 9\%\).

3. Associations between illness variables and current psychosocial and functional outcome

Metabolic control variables (% time HbA1C \(\geq 9\%\), history of seizures, early or later onset of illness) and gender were entered into regression analyses to identify their relationship to YSR/YASR scores and functional outcome (Table 2, Online-Only Appendix available at http://care.diabetesjournals.org). A history of hypoglycemic seizures was associated with higher Externalising and Total problems on the YSR/YASR, explaining 4% and 6% of the variance respectively. Poorer metabolic control (i.e. higher % of time with HbA1C levels \(\geq 9\%\)) was associated with higher rates of mental health referral since diagnosis and lower rates of study/work participation, but not with school completion or type of diabetes care. Males were less likely than females to be receiving specialist diabetes care currently (51% vs 72%), but over time since diagnosis, females spent a higher average percentage of time than males in poor metabolic control (\(\bar{X} 48\%\) vs 38\%), \(t (108)=2.06, p=.042\).

DISCUSSION

Youth with type 1 diabetes reported similar levels of current psychosocial well-being to healthy controls. Referral for mental health services over the previous 12 years, however, was 19% higher, and school completion rates 17% lower in youth with type 1 diabetes, suggesting higher rates of overall psychological morbidity over the twelve years since diagnosis. Within the diabetes group, there were associations between higher mental health referral rates since diagnosis and lower study/work participation rates and current levels of psychosocial well-being. Over one third of youth no longer attending RCH had failed to make the transition to specialist diabetes care, and of these, the majority had been referred for mental health services in the past, and also had higher levels of current psychosocial maladjustment.
Taking a longitudinal perspective, behavior problems at diagnosis predicted higher mental health referral rates over the ensuing 12 years and greater current psychosocial difficulties. Higher child activity levels and lower levels of family cohesion at baseline were also associated with lower current levels of psychosocial well-being. A history of hypoglycemic seizures was related to current psychosocial maladjustment, but not to functional outcomes. Those with a history of poorer metabolic control were more likely to have been referred for mental health services at some point since diagnosis and less likely to be in fulltime study or work.

The findings that youth with type 1 diabetes reported similar levels of psychological symptoms to those described by the healthy community controls on the YSR/YASR contrasts with evidence of higher levels of psychopathology in youth with diabetes in a number of previous reports (3, 4, 6, 7, 8), but is similar to that found in several other longitudinal studies (9, 10). Sampling and methodological differences may contribute to inconsistent findings. Studies reporting elevated psychopathology tended to lack normative controls (3, 4, 6, 7, 8), assess participants cross-sectionally (4, 6) and/or focus on a single disorder, usually depression (4, 8). They also tended to study younger samples (3, 4, 8), and rely, at least in part, on parent reports. It is possible that as youth with type 1 diabetes move through adolescence, they achieve a degree of physiological and psychological equilibrium as the hormonal perturbations of puberty recede, their sense of personal identity consolidates, and they develop a greater sense of control and acceptance of their illness. This might then be reflected in similar levels of self-reported psychosocial well-being to that of their healthy peers.

However, it is also possible that, with greater maturity, the desire of youth with a chronic illness to portray themselves in a positive light, to identify with healthy peers and to minimise differences and difficulties may increase. That is, youth with type 1 diabetes may deny or minimise problems that really exist. This phenomenon, sometimes referred to as “response shift” (23), may be particularly strong when respondents are aware that comparison will be made with healthy peers, as was the case in two previous studies (9, 10) reporting similar levels of psychosocial well-being. Psychosocial maladjustment has been higher in our cohort at previous assessment points.

For example, ten years after diagnosis, over one third of an adolescent subset of the original sample met DSM-IV criteria for a psychiatric disorder (14). Furthermore, higher mental health service referral and lower school completion rates, and poor transition to specialist diabetes care documented in the current assessment, suggest there is a psychiatric morbidity associated with growing up with diabetes, even if one accepts at face value, current reports of psychosocial well-being.

The association between child variables at diagnosis and longer-term psychological and functional outcomes is a key finding of the study. Youth with behaviour problems and high activity levels at diagnosis were more likely to have ongoing psychological difficulties and to have correspondingly increased rates of referral for mental health services. However, in contrast to our findings at 10 years post-diagnosis (14), behaviour problems at diagnosis were not directly associated with poor metabolic control history, although they did predict higher mental health referral rates, which in turn were associated with poor metabolic control. Lower family cohesion at baseline predicted higher levels of psychological symptoms in youth twelve years after diagnosis, consistent with previous findings (24) suggesting the importance of family support for youth.
Type 1 diabetes and functional outcomes

Growing up with a chronic illness. Family functioning measured at diabetes onset did not predict longer-term metabolic control histories, in contrast to previous reports of such associations (e.g., 4). It is possible that as distance between assessment time points increases and measurement of variables becomes more distal, other factors attenuate direct relationships between family dysfunction and poor metabolic control. Metabolic control in this cohort of youth with type 1 diabetes was less than optimal. Almost half of the sample had experienced a seizure or loss of consciousness associated with hypoglycemia and, as a group, they had spent a mean 42% of time since disease onset in poor metabolic control. Mean current HbA1C level exceeded that associated with accelerated risk of diabetes complications in the DCCT (1). Over one-fifth of the cohort currently access medical treatment only in times of metabolic crisis, and a further 15% received diabetes care, albeit irregularly for some, from their local medical practitioner. These are similar figures to those reported by Pascaud et al. (25) in their study of youth over the first few years in the adult health care system. Together, these findings raise serious questions about the efficacy of current transition procedures. Participants who had experienced one or more hypoglycemic seizure reported higher levels of current psychosocial maladjustment, as did those accessing suboptimal diabetes care. A history of poor metabolic control was associated with higher mental health referral rates over diabetes lifetime, consistent with previous findings (11, 12) and with lower rates of study/work participation. These findings reinforce the interdependence of psychological and medical factors in influencing health outcomes.

This report describes psychosocial, functional and health outcomes in a controlled study of youth with type 1 diabetes followed prospectively from diagnosis for 12 years. The findings highlight the fact that outcome should be considered as a multi-faceted concept incorporating psychosocial well-being, successful mastery of life-stage developmental tasks such as school completion and study/work participation, as well as ongoing participation in specialist diabetes care and optimal metabolic control. Behavior problems evident at diagnosis should become a focus for clinical attention and early intervention given their association with ongoing mental health problems. Refinement of transition processes is also indicated if we are to ensure that youth who have benefited from tertiary level diabetes care in childhood continue to receive such care as they enter adulthood.

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Table 1. Baseline predictors of psychosocial, functional and health outcome for type I diabetes group

| Outcomes at follow-up | Mental health referral | School completion | Fulltime study/work | Specialist diabetes care |
|-----------------------|------------------------|-------------------|---------------------|--------------------------|
| Explanatory variables | Odds ratio | 95% CI | p | Odds ratio | 95% CI | p | Odds ratio | 95% CI | p | Odds ratio | 95% CI | p |
| CBCL Total | 1.05 | 1.00, | 0.05 | 1.00 | 0.95, | 1.05 | > 0.9 | 1.05 | 0.98, | 1.11 | 0.2 | 1.04 | 0.99, | 1.09 | 0.1 |
| Problems | Odds Ratio (95% CI) | Regression Coefficient | p-value |
|----------|--------------------|------------------------|---------|
| Gender   | 1.35 (0.54, 3.42)  | 0.5 (0.16, 1.44)       | 0.2     | 0.91 (0.26, 3.19) | 0.9 | 0.47 (0.17, 1.29) | 0.1 |
| SES      | 1.01 (0.68, 1.50)  | > 0.9                  | 2.02    | 1.20 (3.39)       | 0.008 | 1.15 (0.67, 1.99) | 0.6 | 0.99 (0.65, 1.51) | > 0.9 |
| CBCL Internalising | 1.02 (0.96, 1.07)  | 0.6                     | 0.98    | 0.92 (1.04)       | 0.5 | 1.02 (0.95, 1.09) | 0.7 | 1.00 (0.95, 1.06) | > 0.9 |
| CBCL Externalising | 1.03 (0.98, 1.09)  | 0.2                     | 1.02    | 0.96 (1.08)       | 0.6 | 1.03 (0.96, 1.10) | 0.5 | 1.04 (0.99, 1.11) | 0.1 |
| Gender   | 1.24 (0.48, 3.21)  | 0.7                     | 0.44    | 0.14 (1.38)       | 0.2 | 0.87 (0.24, 3.18) | 0.8 | 0.41 (0.14, 1.18) | 0.1 |
| SES      | 1.00 (0.67, 1.50)  | > 0.9                  | 1.98    | 1.17 (3.34)       | 0.01 | 1.17 (0.67, 2.02) | 0.6 | 0.95 (0.62, 1.47) | 0.8 |
| EAS Shyness | 0.93 (0.64, 1.35)  | 0.7                     | 0.81    | 0.47 (1.41)       | 0.5 | 1.17 (0.68, 1.98) | 0.6 | 1.04 (0.62, 1.73) | 0.9 |
| EAS Emotionality | 1.04 (0.89, 1.23)  | 0.6                     | 0.94    | 0.77 (1.16)       | 0.6 | 1.05 (0.82, 1.34) | 0.7 | 1.14 (0.93, 1.39) | 0.2 |
| EAS Sociability | 0.78 (0.59, 1.04)  | 0.09                    | 0.93    | 0.64 (1.35)       | 0.7 | 1.03 (0.69, 1.54) | 0.9 | 0.81 (0.57, 1.16) | 0.2 |
| EAS Activity | 1.16 (0.88, 1.53)  | 0.3                     | 1.38    | 0.93 (2.04)       | 0.1 | 0.83 (0.57, 1.21) | 0.3 | 1.09 (0.77, 1.56) | 0.6 |
| Gender   | 1.05 (0.45, 2.45)  | > 0.9                  | 0.51    | 0.17 (1.51)       | 0.2 | 0.84 (0.24, 2.89) | 0.8 | 0.30 (0.10, 0.90) | 0.03 |
| FACES Cohesion | 0.88 (0.70, 1.11)  | 0.3                     | 0.90    | 0.66 (1.25)       | 0.5 | 0.94 (0.70, 1.25) | 0.7 | 0.86 (0.64, 1.16) | 0.3 |
| FACES Adaptability | 1.25 (0.97, 1.60)  | 0.08                    | 0.86    | 0.62 (1.18)       | 0.4 | 0.83 (0.59, 1.18) | 0.3 | 1.04 (0.78, 1.40) | 0.8 |
| Gender   | 1.21 (0.51, 2.85)  | 0.7                     | 0.27    | 0.08 (0.94)       | 0.04 | 0.93 (0.27, 3.23) | > 0.9 | 0.34 (0.12, 1.01) | 0.05 |
| SES      | 1.15 (0.78, 1.69)  | 0.5                     | 1.93    | 1.07 (3.50)       | 0.03 | 1.12 (0.62, 2.03) | 0.7 | 1.10 (0.68, 1.77) | 0.7 |

Overall model

| Outcomes | χ² (df, p) | χ² (df, p) | χ² (df, p) |
|----------|------------|------------|------------|
| Seizure at follow-up | 4.3, 4, 0.4 | 15.4, 4, 0.004 | 2.4, 4, 0.7 |
| Metabolic control at follow-up | 5.0, 4, 0.3 |          |            |
### Table 1: Functional outcomes for type 1 diabetes and controls

| Explanatory variables          | Estimate | 95% CI     | p   | Estimate | 95% CI     | p   |
|-------------------------------|----------|------------|-----|----------|------------|-----|
| CBCL Total problems           | 1.02     | 0.98, 1.06 | 0.4 | 0.49     | —0.05, 1.03 | 0.08 |
| Gender                        | 0.74     | 0.30, 1.79 | 0.5 | 9.91     | —1.68, 21.49 | 0.09 |
| SES                           | 0.98     | 0.67, 1.44 | > 0.9 | 0.27     | —4.67, 5.21 | > 0.9 |
| Overall model                 |         |            |     | χ² = 1.3, df = 3, p = 0.7 | F (3, 77) = 2.2, p = 0.09, R² = 4.3 |
| CBCL Internalising            | 1.06     | 0.91, 1.10 | 0.1 | 0.20     | —0.46, 0.86 | 0.5 |
| CBCL Externalising            | 1.05     | 1.00, 1.11 | 0.07 | 0.35     | —0.34, 1.04 | 0.3 |
| SES                           | 0.97     | 0.66, 1.42 | 0.9 | 0.23     | —4.79, 5.24 | > 0.9 |
| Overall model                 |         |            |     | χ² = 4.4, df = 4, p = 0.4 | F (4, 76) = 1.6, p = 0.2, R² = 2.7 |
| EAS Shyness                   | 0.82     | 0.56, 1.19 | 0.3 | —2.04    | —6.76, 2.69 | 0.4 |
| EAS Emotionality              | 1.14     | 0.96, 1.35 | 0.1 | 1.40     | —0.70, 3.51 | 0.2 |
| EAS Sociability               | 0.91     | 0.69, 1.20 | 0.5 | —0.29    | —3.78, 3.20 | 0.9 |
| EAS Activity                  | 1.27     | 0.97, 1.67 | 0.08 | —2.25    | —5.58, 1.08 | 0.2 |
| Gender                        | 0.73     | 0.32, 1.69 | 0.5 | 6.70     | —4.01, 17.41 | 0.2 |
| Overall model                 |         |            |     | χ² = 7.2, df = 5, p = 0.2 | F (5, 96) = 1.4, p = 0.2, R² = 1.8 |
| FACES Cohesion                | 1.00     | 0.80, 1.24 | > 0.9 | —0.07    | —2.89, 2.74 | > 0.9 |
| FACES Adaptability            | 0.83     | 0.65, 1.05 | 0.1 | 2.71     | —0.25, 5.66 | 0.07 |
| Gender                        | 0.59     | 0.26, 1.35 | 0.2 | 12.75    | 2.21, 23.28 | 0.02 |
| SES                           | 0.87     | 0.60, 1.27 | 0.5 | 4.86     | 0.07, 9.65 | 0.05 |
| Overall model                 |         |            |     | χ² = 4.0, df = 4, p = 0.4 | F (4, 95) = 2.7, p = 0.04, R² = 6.3 |

**Notes for Table 1:** R² value is the adjusted R². Gender was coded as male = 0, female = 1. Hence in the logistic regression models, males are the baseline category. SES is an abbreviation for socioeconomic status. A higher score on this measure represents lower SES. For analysis, EAS scores were divided by 2, and FACES scores were divided by 3 to aid meaningful interpretation of estimates.

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**Figure 1. Functional outcomes for type 1 diabetes and controls.**
Type 1 diabetes and functional outcomes

Mental health referral
- Type 1 diabetes
- Control

Completed school
- Type 1 diabetes
- Control

Full-time study/work participation
- Type 1 diabetes
- Control

Endocrine care for Type 1 diabetes group
- Specialist endocrinologist
- Crisis care
- GP