

treatment. This study builds on earlier work and shows that skills training and unrestricted food choices can be applied successfully across different healthcare systems. The follow up of our patients was, however, relatively short. We now need to establish whether similar results can be achieved in routine care and devise ways of sustaining improvement in glycaemic control.

### Conclusion

We have shown, in a group of volunteers, that skills training in insulin adjustment that provides patients with the ability to fit diabetes into their lives rather than their lives into diabetes improves quality of life and glycaemic control in the short term. The DAFNE approach has the potential to reduce the incidence of microvascular complications and thereby protect quality of life in the long term, as well as the short term, and is worthy of further investigation.

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## Association between psychological symptoms in adults and growth in early life: longitudinal follow up study

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### Abstract

**Objectives** To test the hypothesis that birth weight for gestational age and weight gain in early childhood have a long term association with psychological distress in adults.

**Design** Longitudinal study of 1958 birth cohort followed to age 42 years.

**Setting** Population based birth cohort study.

**Participants** 9731 cohort members with valid perinatal, postnatal, and adult data.

**Main outcome measures** Malaise inventory scores measured at ages 23, 33, and 42 years. Generalised estimating equations approach used to analyse repeated measures.

**Results** Psychological distress score was inversely related to birthweight z score and weight gain from birth to the age of 7 years. A unit increase in birthweight z score or childhood weight gain was associated with a mean reduction in psychological distress score of 0.10 (95% confidence interval 0.05 to 0.14) and 0.06 (0.02 to 0.10), respectively. Birth weight

and weight gain were also inversely related to the odds of having a high level of psychological distress, with odds ratios being 0.90 (0.85 to 0.95) and 0.93 (0.89 to 0.98), respectively.

**Conclusions** Psychological health in adults is related to fetal growth and growth in early childhood.

### Introduction

Although numerous studies have shown that fetal and postnatal growth can affect psychological and developmental outcomes in children, it is uncertain whether the influence persists into adulthood. We tested the hypothesis that small size at birth and slow growth in early childhood are associated with higher levels of psychological distress in adults.

### Methods

#### Participants

The national child development study (NCDS) is a cohort study of about 17 000 people born in England, Wales, and Scotland in one week in March 1958. Data



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**Table 1** Descriptive summary of explanatory variables measured at birth and 7 years. Figures are mean (SD) or percentage distribution

Variables	Men (n=4925)	Women (n=4806)
Gestational age (weeks)	39.7 (1.7)	39.8 (1.7)
Birth weight (g)	3417 (521)	3273 (504)
Birthweight z score	0.02 (1.00)	0.01 (1.00)
Father's social class:		
I	4.7	4.4
II	13.4	13.6
III	59.9	59.5
IV	11.3	11.8
V	8.7	8.3
Others	2.0	2.4
Mother's marital status:		
Married	97.4	96.8
Unmarried	2.6	3.2
Parity:		
1	36.2	36.9
2-3	48.1	47.4
≥4	15.7	15.7
Maternal smoking:		
Non-smoker	60.5	58.7
Not during pregnancy	6.3	8.2
<5 cigarettes/day	7.5	7.7
5-14 cigarettes/day	21.3	21.1
≥15 cigarettes/day	4.5	4.3
Housing tenure at 7 years:		
Owner occupier	43.7	43.5
Council tenant	39.0	39.6
Private tenant	11.4	11.2
Others	5.9	5.7
Weight gain (change in z score)	0.01 (1.17)	0.01 (1.20)

were collected at birth and then at ages 7, 11, 16, 23, 33, and 42 years from medical records, clinical examinations, and face to face as well as self administered interviews.<sup>1 2</sup>

At ages 23, 33, and 42 years participants filled in a questionnaire for the malaise inventory. A total of at least eight (psychological plus somatic) symptoms indicates a high risk of psychiatric morbidity.<sup>2</sup>

### Current study

We proportionally assigned the cut-off point of eight symptoms to the psychological and somatic subscales to indicate the high level of distress in each—that is, at least five psychological symptoms and at least three somatic symptoms. To quantify intrauterine growth retardation we standardised birth weight for gestational age

separately for each sex, giving a birth weight SD score or z score.<sup>3</sup> A unit increase in birthweight z score is an increase of 1 SD of birth weight for gestational age. Body size measured at age 7 formed the basis of the childhood growth variable. Weight at this measurement was standardised similarly for age and sex. Weight gain in childhood was measured as the difference in weight z scores at 7 years and at birth.

### Analysis

For the main analyses we used the generalised estimating equations approach to analyse psychological and somatic scores at age 23, 33, and 42 in relation to birthweight z score and weight gain, with adjustment for covariates.<sup>4 5</sup> One set of models estimated the difference in mean score (linear regression) and one estimated the odds ratio for a high level of distress (logistic regression). We first fitted a model with birthweight z score and all covariates except weight gain as explanatory variables (model I). In a second model we added weight gain (model II). A comparison of the difference in regression coefficients shows whether the influence of birthweight z score is mediated by weight gain in childhood.<sup>6</sup>

### Results

After we excluded stillbirths, infant deaths, and twin births we had complete information at birth and at 7 years on 11 115 (67%) cohort members. Of these, 9731 (88%) participated in at least one of the follow up assessments at ages 23, 33, or 42. Overall 59% of the eligible cohort members were involved in the present analysis.

### Modelling of psychosomatic distress

The subsequent analyses included only cohort members in the main analysis set—that is, members with valid data at birth and 7 years and who participated in at least one adult follow up. Table 1 gives a summary of the birth, maternal, and socioeconomic variables. Table 2 shows the number of cohort members and mean (SD) malaise inventory subscale scores, as well as the proportions with high scores, by sex and age. Women had higher psychological and somatic scores at all ages. Somatic subscale scores increased steadily with age. Psychological subscale scores were lower at age 33 than 23, suggesting transition into adulthood (age 23) was a relatively stressful stage.

In model I a unit increase in birthweight z score was associated with a reduction of 0.05 (0.01 to 0.09) in mean psychological score (table 3). The odds ratio for a high level of psychological distress was 0.95 (0.92 to 0.99). When we added weight gain to the variables of model I (model II) the reduction in mean psychological score increased to 0.10 (0.05 to 0.14). See the full version of this paper on [bmj.com](http://bmj.com) for details of model II. A higher weight gain was also associated with a lower mean psychological score, the reduction being 0.06 (0.02 to 0.10). The odds ratios were 0.90 (0.85 to 0.95) and 0.93 (0.89 to 0.98) for birthweight z score and weight gain, respectively.

We found no association between somatic distress and birthweight z score and weight gain.

### Comparison of clinical importance

The reduction in mean psychological score between having a high or low fetal growth was 0.26. This reduc-

**Table 2** Psychological and somatic subscale scores of malaise inventory by sex and age at follow up

	Men		Women	
	Psychological score	Somatic score	Psychological score	Somatic score
<b>At age 23 years</b>				
No	4211	4212	4240	4239
Mean (SD)	1.33 (1.77)	0.62 (0.99)	2.43 (2.45)	0.87 (1.14)
High distress (%)	6.3	5.9	18.3	9.4
<b>At age 33 years</b>				
No	3721	3728	3809	3809
Mean (SD)	1.20 (1.89)	0.73 (1.10)	1.85 (2.32)	0.86 (1.15)
High distress (%)	6.3	8.2	12.5	9.5
<b>At age 42 years</b>				
No	3780	3780	3889	3889
Mean (SD)	2.12 (2.50)	0.92 (1.24)	2.81 (2.78)	1.07 (1.30)
High distress (%)	15.5	10.1	22.2	12.6

**Table 3** Summary of findings in generalised estimating equations multiple linear regression (mean scores) and logistic regression (odds ratios) models of psychological scores measured at three adult ages\*

One unit increase in variable	Difference in mean (95% CI)		Odds ratio (95% CI)	
	Model I	Model II	Model I	Model II
Birthweight z score	-0.05 (-0.09 to -0.01)	-0.10 (-0.14 to -0.05)	0.95 (0.92 to 0.99)	0.90 (0.85 to 0.95)
Weight gain (change in z score)	NA	-0.06 (-0.10 to -0.02)	NA	0.93 (0.89 to 0.98)

NA=not applicable.

\*Adjusted for sex, age at follow up, and covariates in table 1.

### What is already known on this topic

Psychological outcomes in children are related to fetal growth and postnatal growth

Size at birth is also associated with psychological outcomes in adolescents and young adults

### What this study adds

Both birthweight z score and weight gain in early childhood are associated with psychological distress at ages 23 to 42

The impact of a smaller size at birth may be compensated for by a higher postnatal weight gain

tion is comparable with that between social classes I and IV, between owner occupier and council tenants, and between being a non-smoker and smoking 5-14 cigarettes per day during pregnancy (see [bmj.com](http://bmj.com)). Similarly, the possible impact of weight gain in childhood is -0.15. This is comparable with the difference between social classes I and III or between being a non-smoker and smoking 1-5 cigarettes per day during pregnancy.

## Discussion

This study of the early origins of psychological distress in the 1958 British birth cohort is unique in that the sample size was large, members were followed up to 42 years of age, and growth in childhood was measured. The analyses adjusted for major potential confounders, such as father's social class and maternal smoking. Loss to follow up in a longitudinal study over 40 years is inevitable. However, nearly three fifths of the cohort members were available for the main analyses. This proportion is much higher than in other studies with shorter follow up times. Our analysis showed that participation in adult follow up was unrelated to birthweight z score and postnatal weight gain among those with valid growth data (see [bmj.com](http://bmj.com)). Missing growth data tended to correlate with a disadvantaged socioeconomic and maternal health background as well as a higher level of distress in adults. As such, the available data tended to emphasise members with relatively good growth and psychological health status. Therefore the real magnitude of the effect of growth failure may be stronger than that estimated here.<sup>7</sup> In 1958 gestation was estimated from the date of the last menstrual period, which might make the birthweight z score imprecise. Studies with data from discordant twins will be useful to confirm our findings because they have the same gestational duration.

Our findings are consistent with those from a previous study of people followed to age 26 in that a higher birthweight z score is associated with a reduction in the psychological, but not the somatic, subscale score of the malaise inventory.<sup>8</sup> As the psychological subscale is closely related to stress,<sup>9-11</sup> the finding is in line with the hypothesis that people with impaired growth in early life will become more susceptible to stress.<sup>12</sup> It is of interest that the association between one unit increase in birthweight z score and the reduction in psychological score strengthened from 0.05 to 0.10 when we adjusted for weight gain in childhood. Small size at birth is usually followed by some degree of postnatal catch up. Our results suggest that the impact of a smaller size at birth is partly compensated by a higher weight gain in infancy.

## Conclusions

We conclude that the association of size at birth and psychological distress persists into middle age. Previous studies could only demonstrate such a relation up to the age of 18 or 26 years. Secondly, growth rate from birth to the age of 7 years was also associated with the psychological outcome. Thirdly, the potential impact of small size at birth may be partly compensated for by a faster weight gain in early childhood.

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