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Original article

Lower birth weight is associated with alterations in dietary intake in adolescents independent of genetic factors: A twin study

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SUMMARY

Background & aims: Lower birth weight is associated with an increased risk of cardiovascular and metabolic disease. These associations may, at least in part, be explained by alterations in dietary intake in later life. The aim of this study is to examine whether lower birth weight is associated with alterations in dietary intake in later life, and whether this association is due to intrauterine environmental or genetic factors.

Methods: In this observational study birth weight and dietary intake were investigated in 78 dizygotic (DZ) and 94 monozygotic (MZ) adolescent same-sex twin subjects. Birth weight was obtained from the mothers. Dietary intake was assessed by two-day dietary records.

Results: In the total group of twins, lower birth weight was associated with higher intake of saturated fat after adjustment for current weight (1.2 per cent of total energy intake (*E*%) per kg increase in birth weight, $P < 0.01$). Intra-pair analysis in all twin pairs demonstrated that twins with the lower birth weight had a 115 kcal higher total energy intake and a 0.7 *E*% higher saturated fat intake compared to their co-twins with the higher birth weight ($P < 0.05$). Intra-pair differences in birth weight were negatively associated with differences in energy intake and differences in intake of saturated fat after adjustment for differences in current weight ($P = 0.07$ and $P < 0.05$, respectively). Intra-pair differences in birth weight were positively associated with intra-pair differences in intake of dietary fibres ($P < 0.05$). These intra-pair differences and associations were similar for DZ and MZ twins (P for difference > 0.6).

Conclusions: Lower birth weight was related with higher intake of energy and saturated fat within twin pairs, and these associations were independent of zygosity, suggesting that the association between birth weight and alterations in dietary intake in later life is explained by intrauterine environmental rather than genetic factors.

1. Introduction

In the last twenty years, many epidemiologic studies have shown that lower birth weight, a measure of reduced foetal growth, is associated with increased incidence of hypertension, type 2 diabetes and cardiovascular disease [1–4]. Several studies in singletons suggested that the association between lower birth weight and the increased risk to develop metabolic and cardiovascular disease may, at least in part, be explained by changes in dietary intake [5–8].

The origin of the possible association between birth weight and dietary intake in later life is not completely understood. The leading hypothesis proposes the programming of dietary preferences in reaction to a poor intrauterine environment. Such adaptive programming would be favourable if nutrition remained insufficient after birth. However, if nutrient availability becomes abundant, maladaptive consequences, such as obesity and type 2 diabetes, may occur [9]. This hypothesis is supported by two studies demonstrating that early prenatal exposure to undernutrition during the Dutch famine is associated with higher energy intake and a favour for diets rich in fat in later life [10,11].

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An alternative explanation states that the association between birth weight and dietary intake arises from pleiotropic genetic factors [12,13]. In other words, the genotype responsible for the intake of an unhealthy diet may itself cause reduced foetal growth in utero. Such a genetic effect cannot be ruled out by the Dutch famine studies since these studies might have been influenced by selection bias. During the Dutch famine, the number of conceptions was about 50% lower than the pre-famine level and perinatal mortality as well as mortality in the first year after birth were higher in those who were born during the famine [14]. Thus, if women with specific dietary intake conceived more often and/or if their children survived more often, a genetic effect on dietary intake would cause these children to eat more or differently in later life.

If genetic factors are responsible, improving the intrauterine environment will not likely influence dietary intake in later life. If the association between birth weight and dietary intake is due to an intrauterine environmental factor, and if this factor is amenable to intervention, improving the intrauterine environment may be used to improve dietary intake and reduce the risk of adverse consequences in later life.

Twin studies offer a unique opportunity to distinguish between environmental and genetic influences [15]. Differences within dizygotic twin pairs can be a function of both genetic and non-genetic factors, whereas differences within monozygotic pairs are nearly always caused by non-genetic factors [16]. If genetic factors do not play a major role in the association between birth weight and dietary intake, one would expect that *both* for dizygotic and for monozygotic twins, the twin with the lower birth weight from each pair will also have the unhealthiest dietary intake compared to the co-twin with the higher birth weight. If, however, genetic factors do play a role, this association would hold true only for dizygotic twins, and not for monozygotic twins.

The aim of this twin study is to investigate whether lower birth weight is associated with dietary intake in later life, and whether, based on the comparison of the association in monozygotic and dizygotic pairs, the association is due to intrauterine environmental or genetic factors (Fig. 1).

2. Materials and methods

2.1. Participants

Between 1985 and 1990, 160 adolescent (age 13–22 years) twin pairs and their parents took part in a study on cardiovascular risk factors [17–22]. All twins were still living were their parents. Details of the study have been described previously [19]. Parents of offspring underwent assessment for cardiovascular risk factors and responded to a large number of inventories. A survey on birth weight and gestational age was sent to the mothers a few weeks ahead of their visit to our department, allowing them to obtain these data from birth certificates. After visits to the department, including blood draws for zygosity assessment, data on dietary intake were collected in 120 twin pairs and their parents. The previously collected data were now analysed since it was only recently that Dutch hunger winter studies suggested an effect of the intrauterine environment on dietary intake in later life.

A flow chart of the study population selection and final study sample is presented in Fig. 2. Data from opposite-sex dizygotic twin pairs ($n = 17$) were excluded because of sex differences within a pair on birth weight. Data from eight twin pairs were not used because of missing information from one or both co-twins on either birth weight or dietary intake. Data from another 9 twin pairs were excluded from analysis because information written in the dietary records was too vague or unreadable to make a proper interpretation of foods actually consumed. Thus, data of 39 dizygotic and 47 monozygotic twin pairs was available for analysis. The study was approved by an institutional review committee and all subjects gave informed consent.

2.2. Measurements

Height and weight measurements and body mass index (BMI; in kg/m^2) calculations were done in a standardized way. Dietary intake was assessed using a two-day dietary record on one weekday and one weekend day. Dietary records and detailed written instructions were given to the participating families on the day of the study visit. In addition, oral instructions were given by trained dieticians. For the sake of clarification each dietary record contained an example of a completed record for one day. Parents were asked about preparation of dinner in a detailed manner. Within three weeks after

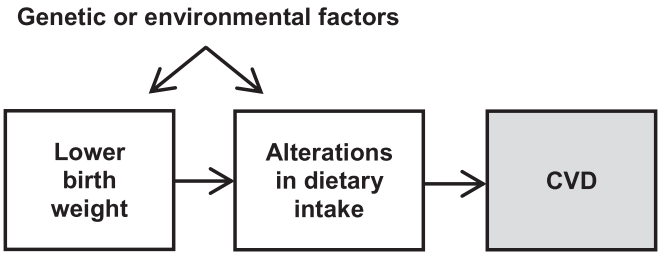

Fig. 1. The postulated relations among birth weight, alterations in dietary intake and metabolic and cardiovascular disease. The aim of the study is to investigate whether the previously observed association between lower birth weight and alterations in dietary intake is influenced by genetic or environmental factors. CVD, cardiovascular disease.

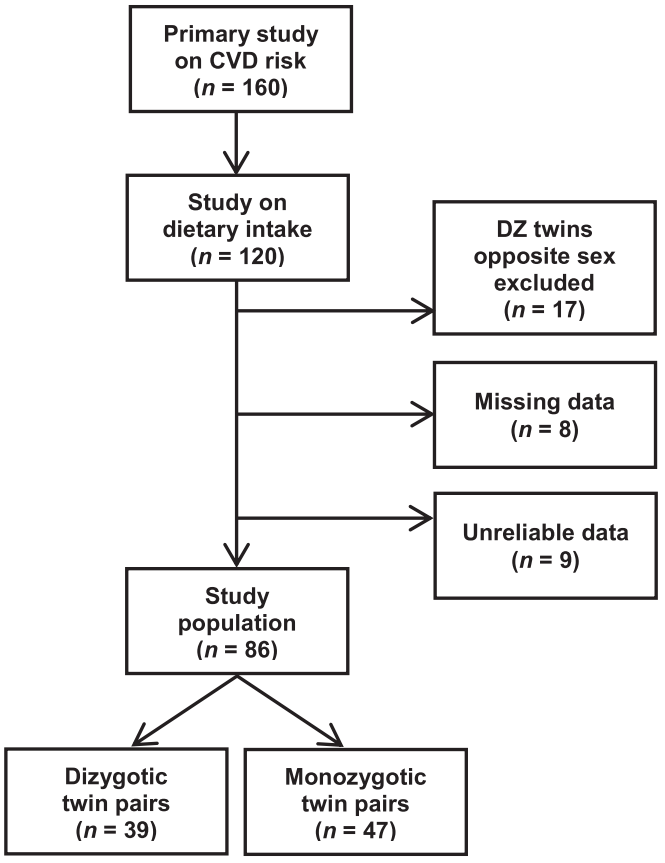

Fig. 2. Flow chart of the study population. CVD, cardiovascular disease; DZ, dizygotic.