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Original article

A priori and *a posteriori* derived dietary patterns in infancy and cardiometabolic health in childhood: The role of body composition

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SUMMARY

Background & aims: Cardiometabolic risk has its origins in early life. However, it is unclear whether diet during early childhood is associated with cardiometabolic health, and what the role is of obesity. We aimed to study whether overall diet during early childhood is associated with cardiometabolic health and to examine if difference in body composition explain this association.
Methods: We examined associations of different types of dietary patterns in infancy with cardiometabolic health at school age among 2026 Dutch children participating in a population-based cohort in the Netherlands. Food intake at the age of 1 year was assessed with a food-frequency questionnaire. Three dietary pattern approaches were used: 1) An *a priori*-defined diet quality score; 2) dietary patterns based on variation in food intake, derived from principal component analysis (PCA); and 3) dietary patterns based on variations in fat and fat-free mass index, derived with reduced-rank regression (RRR). At the children's age of 6 years, we measured their body composition, systolic and diastolic blood pressure, and serum concentrations of insulin, triglycerides, and HDL-cholesterol, which we combined in a cardiometabolic risk-factor score.
Results: We observed that, after adjustment for confounders, children with higher adherence to a 'Health-conscious' PCA-derived pattern had a lower cardiometabolic risk-factor score (−0.07 SD (95% CI −0.12; −0.02) per SD). This association did not change after adjustment for fat and fat-free mass index. The RRR-derived dietary patterns based on variations in body composition were not associated with the cardiometabolic risk-factor score.
Conclusions: Our results suggest that diet in early childhood may affect cardiometabolic health independent of differences in body composition.

1. Introduction

Cardiometabolic risk factors – such as high blood pressure, dyslipidemia and obesity – already occur in childhood, track to later life, and predict risk of later cardiovascular disease, type 2 diabetes, and premature death [1–3]. Dietary factors are important modifiable determinants of these cardiometabolic health outcomes, which may be partly explained by changes in adiposity [4], but diet may also affect cardiometabolic risk factors directly.

Whereas many studies in adults have shown that so-called unhealthy dietary patterns are associated with higher cardiometabolic disease risk and obesity [5–11], only a few studies examined overall diet in relation to cardiometabolic outcomes in childhood, with inconsistent findings [12–17]. Also, most of these studies examined diet in school-age children or adolescents and only one study has focused on dietary patterns in preschool children [14,16]. This latter study, in a British cohort, reported associations between different

Abbreviations: BF%, body fat percentage; BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; DXA, dual-energy X-ray absorptiometry; E%, energy percentage; FFQ, food frequency questionnaire; HDL-C, high-density lipoprotein cholesterol; PCA, principal component analysis; RRR, reduced rank regression; SBP, systolic blood pressure; SDS, standard deviation score.

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dietary patterns in infancy with blood pressure, but not with blood lipids, at school-age [14,16]. Nevertheless, it remains unclear whether dietary patterns of young children are related to overall cardiometabolic health. Furthermore, some studies linked dietary patterns in early childhood to later body composition or adiposity [18–20], but it is not known if possible effects of overall diet in early life on cardiometabolic health are mediated by differences in body composition.

There are several approaches to assess overall diet. Diet quality can be assessed using an *a priori* approach, for example on the basis of dietary guidelines. Dietary patterns can also be derived using *a posteriori* approaches, for example based on variation in dietary intake of the study population. Another *a posteriori* approach is to construct dietary patterns based on variation in health-related markers [21]. We have previously used this latter approach to construct dietary patterns explaining maximal variation in children's body composition measures (i.e., fat mass and fat-free mass index) [20]. Because body composition may be part of the mechanism through which diet affects cardiometabolic health, analyzing these dietary patterns in relation to cardiometabolic outcomes can give further insight into the pathways by which diet may exert its effect on cardiometabolic health. In addition, different approaches to assess overall diet can help to identify healthy or unhealthy dietary patterns which can form the starting point for development of new dietary guidelines [22].

We examined the associations of dietary patterns of children at the age of 1 year with their cardiometabolic health at the age of 6 years. As dietary patterns we examined: 1) an *a priori*-defined diet quality score [23], based on dietary guidelines for preschool children; 2) *a posteriori*-derived dietary patterns [24], based on variations in food intake, extracted using principal component analysis, and 3) *a posteriori*-derived dietary patterns [20], based on variations in body composition measures, identified using reduced-rank regression. Cardiometabolic outcomes included systolic and diastolic blood pressure, serum concentrations of insulin, HDL-cholesterol, and triglycerides, and an overall cardiometabolic risk factor score. For all outcomes, we additionally assessed whether associations of dietary patterns with cardiometabolic health were explained by differences in body composition.

2. Methods

2.1. Study design and subjects

This study was embedded in the Generation R Study, an ongoing population-based prospective cohort in Rotterdam, the Netherlands [25]. The study was approved by the Medical Ethics Committee of Erasmus Medical Center and written informed consent was provided by caregivers for all children. To avoid the influence of cultural differences in dietary patterns, our analyses were restricted to children with a Dutch ethnicity [24]. A total of 4215 Dutch children participated in the preschool follow-up [25]. Data on dietary patterns were available from 2413 children [23,24]. At the age of 6 years, 2026 of these children visited the research center and had one or more cardiometabolic outcomes available. The population for analysis for the different outcomes ranged from 1297 to 1931 (Fig. 1).

2.2. Dietary patterns

At the children's median age of 12.9 months (95% range 12.2–19.2), caregivers completed a 211-item semi-quantitative food-frequency questionnaire (FFQ), which included foods that are frequently consumed by Dutch children between 9 and 18 months old [23,24]. The FFQ was validated against three 24 h-recalls in a representative sample of 32 Dutch children. Interclass correlation coefficients for nutrient intakes ranged from 0.4 to 0.7 [23,24].

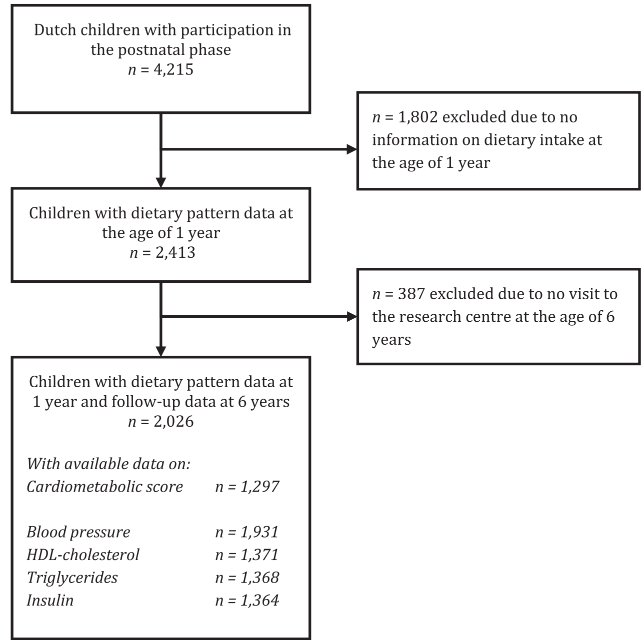

Fig. 1. Flow-chart of study participants included in the analyses.

We applied three approaches to identify dietary patterns, as described in detail previously [20,23,24]. Briefly, as *a priori*-defined dietary pattern we used a previously constructed diet quality score for preschool children [23], which was developed on the basis of dietary guidelines. The score includes the following ten components: sufficient intake of vegetables; fruit; bread and cereals; rice, pasta, potatoes, and legumes; dairy; meat, poultry, eggs and meat substitutes; fish; and fats and oils; and moderate intake of candy and snacks; and sugar-sweetened beverages (Supplemental Table 1), with a higher score representing a healthier diet [23]. Additionally, we used *a posteriori*-derived dietary patterns explaining the maximum variation in food group intake, which were previously extracted using principal component analysis (PCA) [24]. A ‘Health-conscious’ dietary pattern was extracted, characterized by high intakes of fruits, vegetables, oils, legumes, pasta, and fish; and a ‘Western-like’ dietary pattern was extracted, characterized by high intakes of snacks, animal fats, refined grains, confectionery and sugar-containing beverages (Supplemental Table 2).

Furthermore, we used *a posteriori*-constructed dietary patterns explaining the maximum variation in fat mass index (FMI) and fat-free mass index (FFMI), which were identified using reduced-rank regression (RRR) [20]. Age- and sex-adjusted FMI and FFMI were used as response variables and two dietary patterns were extracted. The first RRR-derived pattern was positively correlated with both FMI and FFMI and was characterized by high intake of refined grains, meat, potatoes, fish, soups and sauces, and sugar-containing beverages. The second RRR-derived pattern was positively correlated with FFMI, but inversely with FMI, and was characterized by high intake of whole grains, pasta and rice, dairy, fruit, vegetable oils and fats, and non-sugar-containing beverages (Supplemental Table 1) [20].

2.3. Cardiometabolic health

At a median age of 5.9 years (95% range 5.6–6.6), children visited our dedicated research center. Non-fasting blood samples