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Consumption of ultra-processed food products and its effects on children's lipid profiles: A longitudinal study

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Abstract *Background and Aims:* Cardiovascular disease development is related to known risk factors (such as diet and blood lipids) that begin in childhood. Among dietary factors, the consumption of ultra-processing products has received attention. This study investigated whether children's consumption of processed and ultra-processing products at preschool age predicted an increase in lipid concentrations from preschool to school age.
Methods and Results: Cohort study conducted with 345 children of low socioeconomic status from São Leopoldo, Brazil, aged 3–4 years and 7–8 years. Blood tests were done to measure lipid profile. Dietary data were collected through 24-h recalls and the children's processed and ultra-processing product intake was assessed. Linear regression analysis was used to assess the relationship between processed and ultra-processed product intake at 3–4 years on changes in lipid concentrations from preschool to school age. The percentage of daily energy provided by processed and ultra-processed products was 42.6 ± 8.5 at preschool age and 49.2 ± 9.5 at school age, on average. In terms of energy intake, the main products consumed were breads, savoury snacks, cookies, candy and other sweets in both age groups. Ultra-processed product consumption at preschool age was a predictor of a higher increase in total cholesterol ($\beta = 0.430$; $P = 0.046$) and LDL cholesterol ($\beta = 0.369$; $P = 0.047$) from preschool to school age.
Conclusion: Our data suggest that early ultra-processed product consumption played a role in altering lipoprotein profiles in children from a low-income community in Brazil. These results are important to understanding the role of food processing and the early dietary determinants of cardiovascular disease.

Introduction

Cardiovascular disease remains the leading cause of premature death worldwide [1,2]. The development and progression of cardiovascular disease is related to a number of risk factors that begin in childhood, such as diet and specific blood lipid levels [3,4]. Dietary habits that are formed early are likely to track later in childhood and form the basis for adult eating patterns [5]. Evidence from the "Cardiovascular Risk in Young Finns" study showed

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substantial tracking of dietary patterns, reflecting food choices from childhood to adulthood [6]. In subsequent longitudinal analyses, such patterns were found to be associated with several cardiovascular risk factors [7,8].

Furthermore, it has been reported that elevated lipid concentrations track from childhood to adulthood, as lipid and lipoprotein results in childhood are predictive of future adult lipoprotein profiles [4]. There are a number of specific nutrient intake factors that are associated with cardiovascular disease, including high saturated and trans fat intake [9], low dietary fiber intake [10] and low poly-unsaturated fat intake [11]. Among the various dietary factors that have been identified as contributors to the development of cardiovascular risk factors, the consumption of processed and ultra-processed products has received attention [12–14].

Processed products are foods that have been altered to add substances that substantially change their nature or use, while ultra-processed products are food products formulated mainly or entirely from processed ingredients, typically including little or no whole foods [12]. Evidence has shown that these products (particularly ultra-processed products) are more energy-dense and have more fat, sugar and sodium than fresh or minimally-processed foods and culinary ingredients (such as oils, sugar, and salt) [15,16]. Moreover, the sale and consumption of ultra-processed products is rapidly increasing throughout the world [13,17-20].

Therefore, there is reason to believe that consumption of processed and ultra-processed products may play a role in the development of chronic diseases [21,22]. Thus far, only a limited number of studies have addressed the relationship between food processing and cardiovascular disease risk. One study reported that processed and ultra-processed product consumption increased the risk for metabolic syndrome in adolescents [23]. A second study demonstrated a positive and independent association between the household availability of ultra-processed products and obesity in a national representative sample of the Brazilian population [24]. However, the association between processed and ultra-processed product consumption and lipid profiles in children has not been studied and is poorly understood.

Our objective was to assess whether children's consumption of processed and ultra-processed products at preschool age predicted an increase in lipid concentrations from preschool to school age. Given that processed and ultra-processed product consumption is associated with low diet quality in adults [15,16] and cardiovascular risk factors in youths [23], we hypothesized that the consumption of these products at preschool age would be a positive and significant predictor of an increase in blood lipid levels from preschool to school age.

Methods

Study population

This study used data from children who participated in a randomized trial of dietary counseling on breastfeeding and dietary practices during the first year of life [25]. Five hundred mother–child pairs were recruited between October 2001 and June 2002 in the maternity ward of a hospital that attends to low-income population, in São Leopoldo, Brazil, and the same children have been followed since. Inclusion criteria were full-term (>37 weeks) babies with a birth weight ≥2500 g. Exclusion criteria were HIV-positive mothers, congenital malformations, and children admitted to the intensive care unit. The study protocol was approved by the Ethics Committee of the Universidade Federal de Ciencias da Saude de Porto Alegre and informed consent of the mother was obtained at study entry.

Data collection

Fieldworkers conducted face-to-face structured interviews in home visits with the mothers at 6 months, 3–4 years, and 7–8 years following birth. Data were authenticated at monthly intervals by randomly calling 10% of the households and repeating several questions in the survey. Identification and data required for locating the family in the community were collected at the time of recruitment. Sex, birth length, and birth weight information was obtained from hospital records. Socioeconomic and family characteristics were assessed when the children reached an age of 6 months by face-to-face interviews with mothers. Anthropometric data was obtained at 7–8 years old using a digital scale (Techline, São Paulo, Brazil) to the nearest 0.1 kg and a stadiometer (SECA, Hamburg, Germany) to the nearest 0.1 cm. BMI-for-age z-scores (BMIz) were estimated based on the World Health Organization standards [26].

Dietary data

At 3–4 years (preschool age) and 7–8 years (school age) old, two 24-h dietary recalls for each child were collected on two non-consecutive days that were chosen randomly within two weeks to one month. For preschool children, the recall was provided by mothers or other caregivers; recalls of school age children were self-reported with assistance from mothers or other caregivers. If children spent time with multiple caregivers (e.g., during school hours), all or most of them were interviewed to record all items the children consumed during the previous day. To quantify food portion size, pictures were used to illustrate standard household measurements, such as teaspoons, tablespoons, and cups. A nutritional support program with a database of Brazilians foods (NutWin, version 1.5, Sao Paulo, Brazil) was used to quantify energy intake.

To determine the relationship between processed and ultra-processed product intake on lipid profiles, the consumption of these products by children was assessed using the food classification system proposed by Monteiro and colleagues [12] – recently named the "NOVA Classification System" by the authors of a systematic review [14]. The NOVA system gives primary importance to the nature, extent and purpose of food processing and is based on three groups: unprocessed and minimally processed foods, including all