



Dietary patterns of Australian children at three and five years of age and their changes over time: A latent class and latent transition analysis

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ABSTRACT

Consuming a healthy diet characterised by a variety of nutritious foods is essential for promoting and maintaining health and wellbeing, yet the diets of Australian children continue to fall well short of national healthy eating recommendations. This research endeavours to identify patterns of dietary intake in Australian children at three and five years of age and investigate associations between early childhood dietary patterns and socio-economic and demographic indicators and Body Mass Index (BMI), as well as identify changes in children's dietary patterns over time. Cross-sectional dietary patterns were derived for 1565 and 631 children aged three and five years, respectively using Latent Class Analysis (LCA), with changes over time analysed with Latent Transition Analysis (LTA). Demographic variables of interest included child sex, parental age, family status, and use of childcare services and socio-economic variables included education, income and employment status. Three patterns of dietary intake were identified at three years (Highly Unhealthy, Healthier and Moderately Unhealthy) and two patterns at five years (Unhealthy and Healthier). Children with younger mothers, working mothers, fathers with a higher BMI and living in a two-carer household were more likely to have unhealthy eating patterns at three years, and children with working mothers and living in a two-carer household were more likely to have unhealthy patterns of dietary intake at five years. Approximately one eighth of the sample transitioned from the healthier to unhealthy pattern of dietary intake from three to five years. The quality of Australian children's diets appears to be declining through the early childhood years, continuing to highlight the importance of nutrition policies and interventions targeted towards the early years of life.

1. Introduction

Consuming a healthy diet characterised by a variety of nutritious foods is essential for promoting and maintaining health and wellbeing (National Health and Medical Research Council, 2013). Particularly during the early childhood years, fostering optimal growth as well as cognitive, behavioural and social-emotional development through good nutrition is of utmost importance (Bryan et al., 2004; Nicklas, Johnson, & American Dietetic, 2004). However, the diets of Australian children continue to fall well short of national healthy eating recommendations (Australian Bureau of Statistics, 2015). Consequently inadequate

dietary habits can hinder opportunities for enhancing child development across a broad range of outcomes (Kleinman et al., 1998; Nicklas et al., 2004) and increase the risk of diet-related chronic conditions including overweight and obesity, Type 2 diabetes and cardiovascular disease (National Health and Medical Research Council, 2013). Dietary intake is a highly modifiable determinant of health and development (Australian Institute of Health and Welfare, 2012) and remains a global public health priority (World Health Organisation, 2013).

Children's eating behaviour is influenced by an array of socio-ecological determinants and there is well-established evidence identifying socio-economic variations in eating behaviours and dietary intake

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(Zarnowiecki, Dollman, Parletta, 2014). Children of lower socio-economic position (SEP) are more likely to have poorer quality diets, characterised by lower quantities of fruit and vegetables and higher quantities of ultra-processed energy dense-nutrient poor foods and are at greater risk of overweight and obesity, compared to children of higher socio-economic position (Zarnowiecki et al., 2014, Zarnowiecki, Parletta, Dollman, 2014). Whilst the effect of SEP occurs at multiple levels, familial and individual level factors appear to be important predictors of dietary intake (Patrick & Nicklas, 2005), particularly in early childhood and more so than area level measures of SEP (Ranjit et al., 2015). Maternal level of education and employment status are consistently investigated as determinants of children's diets (Hidaka et al., 2016; Okubo et al., 2014). The association between paternal characteristics such as Body Mass Index (BMI) and level of education have also been considered regarding their influence on children's dietary intake (Kieft-de Jong et al., 2013; Walsh et al., 2015), however, other factors remain less widely explored, including indicators of family structure.

Dietary patterns analysis is an approach to examining the quality of a person's overall diet and therefore acknowledges that consumption of individual food or nutrients does not occur in isolation, which has been the focus of earlier diet-related nutritional epidemiological research (Hu, 2002; Kant, 2004). Analysis of patterns of dietary intake has several public health benefits including developing and tailoring nutrition policies and guidelines, monitoring population food consumption with reference to nutrition recommendations and identifying links between diet and disease outcomes (Hu, 2002). A review by Smithers and Colleagues (Smithers et al., 2011) surmised that dietary patterns analyses fairly consistently identified “healthy” and “unhealthy” patterns of dietary intake in children and this is also reflected in research published in more recent years (Kieft-de Jong et al., 2013; Leventakou et al., 2016; Wall et al., 2013). Healthier patterns of dietary intake were often associated with higher maternal age (Wall et al., 2013) and educational status, and less healthy patterns with a greater number of siblings (Kieft-de Jong et al., 2013), whilst there appears to be mixed outcomes for the effect of household income (Kieft-de Jong et al., 2013) and employment status (Smithers et al., 2011).

Factor Analysis (FA) and Cluster Analysis (CA) are some of the most widely used methods for deriving dietary patterns (Smithers et al., 2011). Whilst the available research using these techniques is extensive, Latent Class Analysis (LCA) and Latent Transition Analysis (LTA) are relatively underutilised statistical methods for deriving dietary patterns cross-sectionally (Harrington et al., 2014; Sotres-Alvarez, Herring, & Siega-Riz, 2010; Torgersen et al., 2015) and over time (Sotres-Alvarez, Herring, & Siega-Riz, 2013), respectively, despite their increased application to health-related data more generally. Additionally, LCA and LTA offers several advantages over these other techniques including the ability to model complex categorical data; allowing for partial class membership, rather than classifying people in to clusters on an all-or-none basis (Vermunt and Magidson, 2002); and being a person-centred approach in which sub-groups of people are identified based on similar patterns of individual characteristics (Collins & Lanza, 2010).

Most dietary patterns research has come from analysis of cross-sectional data and as such, few studies have investigated how patterns of dietary intake evolve longitudinally within the childhood years (Camara et al., 2015; Northstone & Emmett, 2008; Northstone et al., 2013). Whilst there is a relatively limited contribution from Australian research in terms of identifying dietary patterns in childhood; especially in the early childhood years (Bell et al., 2013; Grieger, Scott, & Cobiac, 2011; Lioret et al., 2013), there appear to be no studies investigating patterns of dietary intake in Australian children using LCA or LTA techniques, and only one Australian study investigating changes in childhood dietary patterns over time (Gasser et al., 2017). Research utilising the aforementioned methods for deriving patterns of dietary intake in early childhood in the Australian context will strengthen the available evidence-base regarding dietary patterns analysis.

It is evident the association between socio-economic factors and dietary intake is complex, multifaceted and still not fully understood (Zarnowiecki et al., 2014c, 2016). Given that eating habits tend to be established early in life and track throughout the adult years (Birch & Fisher, 1998) it is crucial to further our understanding regarding factors that influence eating behaviours during early childhood. The aim of the present study is to: 1) identify patterns of dietary intake in Australian children at three and five years of age using LCA and investigate associations between early childhood dietary patterns and demographic and socio-economic indicators; and 2) identify if there are changes in children's dietary patterns from three to five years of age using LTA.

2. Materials and methods

The current research is a secondary analysis of longitudinal birth cohort data.

2.1. Sample/participants and recruitment

Environments for Healthy Living (EFHL) is a longitudinal birth cohort study which aimed to investigate multiple genetic, individual, familial, and environmental factors and their influence on child development and health outcomes. The study recruited offspring during public maternal antenatal clinic appointments for births occurring at Logan, Gold Coast and Tweed Hospitals within South East Queensland and Northern New South Wales, Australia. Recruitment commenced in 2006 with a pilot year and occurred annually during a four-month period until 2011, resulting in six waves of baseline data. Between 2006 and 2011 there were 3368 pregnant women recruited to EFHL, resulting in 3404 live births. Participants were followed up at twelve months, three and five years via a postal self-administered questionnaire completed by the participant's primary caregiver. Extensive detail on the background and methods of EFHL are reported elsewhere (Cameron et al., 2012). Ethical approval was obtained from the Griffith University Human Research Ethics Committee (HREC) (Ref: MED/16/06/HREC, renewed MED/23/11/HREC), as well as the three participating hospitals (Refs: Logan Hospital HREC/06/QPAH/96; Gold Coast Hospital HREC/06/GCH/52 and The Tweed Hospital NCAHS HREC 258 N) and all caregivers provided written informed consent.

The current study reports on multiple cross-sections of children aged approximately three and five years who were enrolled between 2006 and 2010 and were successfully followed-up at three years post recruitment, as well as children who were enrolled between 2006 and 2008 and were successfully followed-up at five years post recruitment. A total of 2907 participants were recruited during this five-year period, resulting in 1565 and 647 participants who were eligible for inclusion based on their availability of follow-up data at three and five years respectively. Information on recruitment and retention rates is shown in Fig. 1.

2.2. Measures

2.2.1. Outcome

Dietary intake: The EFHL study collected child dietary intake information from the child's primary caregiver at the three- and five-year follow-ups using a modified version of the Child and Diet Evaluation Tool (CADET) (Cade, Frear, & Greenwood, 2006). Six variables were consistently reported at three and five years including consumption of fruit, vegetables, added sugar, sugary snacks, pre-prepared foods and take-away foods and were thus used to derive the dietary patterns in this study. The corresponding questions and responses for collecting the dietary data are presented in Supplementary Table 1.

Response categories for fruit and vegetable variables were recoded to reflect the number of serves consumed in line with current Australian consumption recommendations proposed under the Australian Dietary Guidelines and The Australian Guide to Healthy Eating (National

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