Early Life Protein Intake: Food Sources, Correlates, and Tracking across the First 5 Years of Life

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ABSTRACT

Background High consumption of protein has been associated with accelerated growth and adiposity in early childhood.

Objective To describe intake, food sources, correlates, and tracking of protein in young children.

Design Secondary analysis of Melbourne Infant Feeding Activity and Nutrition Trial (InFANT). Dietary data were collected using three 24-hour dietary recalls at ages 9 and 18 months as well as 3.5 and 5 years.

Participants/setting First-time mothers and their child (n=542) participated in an 18-month intervention to prevent childhood obesity and the cohort was followed-up with no intervention when children were aged 3.5 and 5 years.

Main outcome measures Protein intake, food sources, correlates, and tracking of protein.

Statistical analyses performed Child and maternal correlates of protein intake were identified using linear regression and tracking of protein intake was examined using Pearson correlations of residualized protein scores between time points.

Results Mean protein (grams per day) intake was 29.7±11.0, 46.3±11.5, 54.2±13.8, and 60.0±14.8 at 9 and 18 months and 3.5 and 5 years, respectively. Protein intakes at all ages were two to three times greater than age-appropriate Australian recommendations. The primary source of protein at 9 months was breast/formula milk. At later ages, the principal sources were milk/milk products, breads/cereals, and meat/meat products. Earlier breastfeeding cessation, earlier introduction of solids, high dairy milk consumption (≥500 mL), and high maternal education were significant predictors of high protein intake at various times ($P<0.05$). Slight tracking was found for protein intakes at 9 months, 18 months, and 5 years ($r=0.16$ to 0.21; $P<0.01$).

Conclusions This study provides unique insights into food sources and correlates of young children's high protein intakes, and confirms that early protein intakes track slightly up to age 5 years. These finding have potential to inform nutrition interventions and strategies to address high protein intakes and protein-related obesity risk.
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A YOUNG CHILD'S CONSUMPTION OF A PROTEIN-RICH diet has been long considered the fulcrum for healthy growth and development. Historically, the focus has been on ensuring that rapidly growing infants consume enough protein to meet increased needs for growth, with predominant interest focused on the association between inadequate protein and constrained growth or malnutrition (eg, the description of kwashiorkor in the 1930s).[1] Although a focus on protein malnutrition remains vitally important in many countries with developing economies, there has been a shift in countries with developed economies, to concerns regarding the association of high protein consumption and childhood health.

A recent systematic review of protein intake and health across the first 18 years of life reported that there was convincing evidence (grade 1) that higher protein intakes were associated with increased growth and high body mass index (BMI) in childhood.[2] This review also reported limited-suggestive evidence (grade 3) that intake of animal protein, especially from diary, has a stronger positive association with growth than vegetable protein, and that bone density in childhood is positively associated with increased protein intake.

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The timing of the introduction of higher protein intakes also appears likely to be an important determinant of growth. The review by Hornell and colleagues[2] concluded that the available data suggested it was probable that children will be most sensitive to high protein intakes during the first 2 years of life. Since that review, Mihrshahi and colleagues[3] identified infant formula consumption as one of only two modifiable predictors (the other being parent feeding infants to a schedule) of rapid weight gain (birth to age 4 to 7 months) in a sample of Australian infants and hypothesized that this growth was likely to have been stimulated by the increased protein intakes associated with formula feeding. In an older sample of children, Günther and colleagues[4] suggest that the transition from breastmilk or infant formula to "family foods" at around age 12 months is a critical phase for increased protein intake and subsequent childhood obesity.

Despite the potential negative health consequences of high protein intakes, many protein-dense foods are also nutrient-dense, and in some instances may be a child's principal source of key nutrients such as calcium and iron. It is important, therefore, to ensure that any proposed reduction in protein intake will not compromise other essential nutrients. Identifying food sources of protein (and sources of other nutrients) is necessary to inform these considerations. In addition, describing modifiable correlates of high protein intakes in early life will identify appropriate targets for interventions seeking to reduce early protein intake. Because there is evidence that children's diets track over time, it is important also to understand whether early protein intakes set a trajectory for higher protein intake across childhood.

Therefore, the aims of this study were to describe dietary protein intakes, food sources, and modifiable child and maternal correlates of protein intake in a cohort of young Victorian (Australian) children over the first 5 years of life (9 and 18 months and 3.5 and 5 years). In addition, this study examined tracking of protein intake across these early years.

MATERIALS AND METHODS

Study Design and Participants

The Melbourne Infant Feeding Activity and Nutrition Trial (InFANT) Program was a cluster randomized controlled trial (Clinical Trial registration: Current controlled Trials ISRCTN81847050) involving first-time mothers attending parents' groups, from when their infants were aged 3 to 20 months. This lifestyle intervention was conducted during 2008 to 2010 within Melbourne, Australia (population ~4 million), and the cohort was followed-up (no further intervention) when children were approximately age 3.5 and 5 years. Primary aims of the Melbourne InFANT Program focused on reducing a range of children's obesity-risk behaviors. There was no focus on protein consumption at that time and no difference in protein consumption was observed between trial arms (data not shown). The study design has been previously reported.[5,6] Eighty-six percent of eligible parents consented to participate (n=542). The Melbourne InFANT Program was approved by the Deakin University Human Research Ethics Committee (ID no. EC 175-2007) and the Victorian Government Department of Human Services, Office for Children, Research Coordinating Committee (Ref no. CDF/07/1138). This study was deemed exempt under federal regulation 45 46.101 (b) CFR.

Because there were no differences at any time in protein intakes between intervention and control group children, data for this article have been pooled. We present data from children at approximately ages 9 and 18 months and 3.5 and 5 years, herein referred to as time two (T2), three (T3), four (T4), and five (T5) for consistency with other publications arising from these data.[7] As outlined in the Figure, data were excluded for children from non–first-time mothers (n=14) and those missing key baseline maternal variables (mother's marital status, country of birth, education, employment, age, and BMI) or missing data on age of breastfeeding cessation and starting solids (n=76). A total of 86 participants were excluded (some participants were excluded on more than one criteria), leaving an initial sample of 456 children. From this sample, further time point-specific exclusions were made to be consistent with our previously published data from this cohort.[8] Children aged younger than age 7 months or older than age 11 months were excluded from the T2 sample (n=14), whereas children younger than age 16 months or older than age 20 months were excluded from the T3 sample (n=32). In addition, children lost to follow-up since baseline (T2 n=2, T3 n=14, T4 n=122, and T5 n=123), children with fewer than 3 days of dietary recalls (T2 n=61, T3 n=89, T4 n=94, and T5 n=97), children with outlier (±3 standard deviations) total energy intakes (T2 n=1, T3 n=4, T4 n=3, and T5 n=1), and children with missing BMI *z* score data (T2 n=0, T3 n=15, T4 n=4, and T5 n=0) were excluded from their respective time-specific sample. After exclusion of children who met one or more of these criteria, the final analysis samples were n=381 for T2, n=321 for T3, n=237 for T4, and n=235 for T5. Analyses were undertaken to examine the difference between participants included in the study and those excluded at each time point. Children included in each of the time point-specific samples were significantly younger and had higher maternal education than children who were excluded. In addition, children included in the T2 analysis sample (mean=0.1±1.0) had lower T2 BMI *z* scores than those excluded (mean=0.3±1.0), whereas children included in the T3 analysis sample (mean=46.3±0.5 g) had lower T3 protein intake than children excluded from T3 analyses (mean=49.8±14.9 g), and finally children included in the T5 analysis sample (mean=0.6±1.0) had higher T5 BMI *z* scores than those excluded (mean=0.4±0.9). No differences were found with regard to children's sex or maternal age (data not shown).

Maternal Factors

Self-administered paper-based questionnaires were provided to parents at the recruitment meeting and returned to program staff at the first InFANT Program session. These provided demographic and socioeconomic data at baseline (T1=children aged 3 months), including maternal age, maternal employment, education level, and country of birth. Maternal employment was dichotomized as not currently employed in paid work or currently employed full- or part-time. Maternal education level was dichotomized as university educated or non–university educated. Country of birth was classified as born in Australia or overseas. Mothers

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