Association Between Meat and Meat-Alternative Consumption and Iron Stores in Early Childhood

*Kelly Anne Cox, MPH; Patricia C. Parkin, MD, FRCPC; Laura N. Anderson, PhD; Yang Chen, MSc; Catherine S. Birken, MD, MSc, FRCPC; Jonathon L. Maguire, MD, MSc, FRCPC; Colin Macarthur, MBChB, PhD; Cornelia M. Borkhoff, PhD; for the TARGet Kids! Collaboration**

From the Division of Paediatric Medicine and the Paediatric Outcomes Research Team (PORT), The Hospital for Sick Children (Ms Cox, Dr Parkin, Dr Anderson, Dr Birken, Dr Maguire, Dr Macarthur, Dr Borkhoff), Institute of Health Policy, Management and Evaluation, Dalla Lana School of Public Health, University of Toronto (Dr Parkin, Dr Birken, Dr Maguire, Dr Macarthur, Dr Borkhoff), Department of Pediatrics, Faculty of Medicine, University of Toronto (Dr Parkin, Dr Birken, Dr Maguire, Dr Macarthur), Child Health Evaluative Sciences, Sick Kids Research Institute (Dr Parkin, Dr Birken, Dr Macarthur, Dr Borkhoff), The Applied Health Research Centre of the Li Ka Shing Knowledge Institute (Mr Chen, Dr Maguire), and Department of Paediatrics (Dr Maguire), St. Michael's Hospital, Toronto, Ontario Canada
The authors declare that they have no conflict of interest.
Address correspondence to Cornelia M. Borkhoff, PhD, Division of Paediatric Medicine, Department of Paediatrics, The Hospital for Sick Children, Room 109801, 10th Floor, Peter Gilgan Centre for Research and Learning, 686 Bay St, Toronto, ON, M5G 0A4, Canada (e-mail: cory.borkhoff@sickkids.ca).
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Abstract

Objective: To prevent iron deficiency, 2014 Canadian recommendations for healthy term infants from 6 to 24 months recommend iron-rich complementary foods such as meat and meat alternatives 2 or more times a day. The purpose of our study was to evaluate the association between meat and meat-alternative consumption and iron status in young children and the association between red meat consumption and iron status among children meeting recommendations.

Methods: Healthy children aged 12 to 36 months were recruited. A cross-sectional study was conducted. Meat and meat-alternative consumption was measured using the Nutri-STEP questionnaire. Adjusted multivariable regression analyses were used to evaluate an association between meat consumption and serum ferritin, and iron deficiency (serum ferritin <14 μg/L).

Results: A total of 1043 children were included. Seventy-three percent of children met the recommended daily intake of meat and meat alternatives, and 66% ate red meat in the past 3 days. Eating meat and meat alternatives was not associated with serum ferritin (0.13 μg/L, 95% confidence interval -0.05, 0.31, $P = .16$), but it was associated with a decreased odds of iron deficiency (odds ratio 0.97, 95% confidence interval 0.94, 0.99, $P = .03$). Associations between red meat consumption and iron status were not statistically significant. Statistically significant covariates associated with increased odds of iron deficiency included longer breast-feeding duration, daily cow's milk intake of >2 cups, and a higher body mass index z score.

Conclusions: Daily cow's milk intake of >2 cups, longer breast-feeding duration, and a higher body mass index z score were modifiable risk factors associated with iron deficiency. Eating meat according to recommendations may be a promising additional target for the prevention of iron deficiency in early childhood.

Keywords: early childhood; iron deficiency; meat consumption

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What's New

Higher meat or meat alternative consumption among 12- to 36-month-old children modestly but significantly reduced the risk for iron deficiency. Our findings highlight that when combined with other healthy feeding practices, eating meat according to current recommendations may prevent iron deficiency in early childhood.

EARLY CHILDHOOD IS a critical period in human development.[1] Iron-deficiency anemia is known to be associated with delays in early childhood cognitive development that may be irreversible, and it has been associated with long-term educational, cognitive, and emotional impairments.[2] Iron deficiency peaks in prevalence during the toddler years (1–3 years) largely as a result of nutritional factors.[2] In Canada, studies suggest a prevalence of iron deficiency among young children of 12% or higher and a prevalence of 1.5% or higher for iron-deficiency anemia.[3] This is similar to the United States, where the prevalence of iron deficiency among 1- to 2-year-olds is 14%.[4,5] Diet and feeding practices established in early childhood have the potential to prevent iron deficiency and optimize human development.

In 2003, the World Health Organization and the Pan American Health Organization published unified, scientifically based guiding principles for complementary feeding

of the breast-fed child.[6] The guidelines recommend introducing complementary foods at 6 months of age while continuing to breast-feed, and that "meat, poultry, fish or eggs should be eaten daily, or as often as possible," to ensure that the nutrient needs of the child are met.[6]

There has been increasing interest in examining the role of meat as a first complementary food with respect to iron status in infancy.[7] However, the results of observational and randomized trials of the relationship between meat and iron status in early childhood have been inconsistent.[8–18]

In Canada, screening for iron deficiency is not recommended.[19] However, social policies, such as maternity and parental leave benefits for up to 1 year,[20] support breast-feeding and other healthy feeding practices. Breast-feeding initiation is high (90%). More than half of women report exclusive breast-feeding at 3 months and any breast-feeding at 6 months, and complementary foods are introduced on average at 4.8 months.[21] In 2014, Health Canada, the Canadian Paediatric Society, the Dieticians of Canada, and the Breastfeeding Committee for Canada published a joint statement for healthy term infants aged 6 to 24 months.[19] Introduction of complementary feeding is recommended at about 6 months of age. Parents and caregivers are advised to "first introduce iron-rich meat and meat alternatives, and iron-fortified cereals" and to offer iron-rich foods 2 or more times a day.[19] Meat is emphasized as an important source of heme iron that is highly bioavailable compared with nonheme iron sources found in meat alternatives (eg, legumes) and iron-fortified cereals.[19]

In the United States, breast-feeding initiation is 79%, and 49% of infants are breast-feeding at 6 months of age.[22] The American Academy of Pediatrics (AAP) similarly recommends iron-rich first foods, although no specific number of servings is suggested; instead, it focuses on the total amount of iron required in the diet (7 mg/d for a 1- to 3-year-old).[2]

The relationship between the consumption of meat and meat alternatives and the iron status of young children has not been previously examined in Canadian children. The purpose of this study was to evaluate the association between meat and meat-alternative consumption and iron status in young children. For our secondary objective, we sought to determine the association between red meat consumption and iron status among children meeting current Canadian recommendations for meat consumption.

METHODS

PARTICIPANTS

This was a cross-sectional study of healthy urban children aged 12 to 36 months who attended scheduled health supervision visits at a TARGet Kids! participating pediatric or family medicine primary care practice in Toronto, Canada, between March 2008 and March 2015. TARGet Kids! is a primary care practice–based research network set in Toronto, Canada (www.targetkids.ca/).[23] Study participants were recruited by research personnel embedded in 9 participating clinics. Sociodemographic, lifestyle, and nutritional information were collected during a scheduled visit through a standardized parent-completed survey instrument based on the Canadian Community Health Survey.[24] Laboratory tests were also collected at these visits; for children with more than 1 visit, the first visit with serum ferritin testing was included in the analysis.

Exclusion criteria were chronic conditions except asthma, severe developmental delay, impaired growth, and inability to communicate in English. We restricted the ages to 12 to 36 months because iron deficiency is most prevalent during this period.[3] Children with elevated C-reactive protein (CRP; $\geq$10 mg/L), a marker of inflammation, were excluded because it can distort serum ferritin levels.[25] Children receiving iron supplementation or a daily multivitamin with iron were excluded. We also excluded children with missing data on the exposure variables or outcome variable.

Consent was obtained from parents, and ethical approval was granted from the Research Ethics Boards at The Hospital for Sick Children and St. Michael's Hospital.

EXPOSURE VARIABLES

Parents completed the NutriSTEP questionnaire (Nutrition Screening Tool for Every Preschooler)[26] to assess our main predictor variable, meat and meat-alternative consumption. The NutriSTEP is a parent-administered 17-item nutrition screening questionnaire. Validity has been examined with a registered dietitian assessment (based on clinical assessment, 3 days of dietary recall, and anthropometric measurements), with area under the receiver operating characteristic curve of >73%; reliability has an intraclass correlation coefficient of 0.89. Meat and meat-alternative consumption was determined through parental response to the following question: "My child usually eats meat, fish, poultry, or alternatives (alternatives can be eggs, peanut butter, tofu, nuts, and cooked beans, chickpeas and lentils): 1) More than 2 times a day; 2) Two times a day; 3) Once a day; 4) A few times a week; 5) Not at all." The frequency of meat consumption was treated as a continuous variable and was recoded to reflect weekly meat consumption: 0 = not at all; 3 = a few times a week; 7 = once a day; 14 = 2 times a day; and, 21 = more than 2 times a day. Those who answered "more than 2 times a day" and "2 times a day" were coded as eating meat and meat alternatives according to current Canadian recommendations (yes/no).

Our second predictor variable was red meat consumption. This was determined through parental response to the following question: "Please specify your child's diet in the past 3 days. Please check all that apply." Those who checked "red meat (beef, veal, pork, lamb, etc)" were coded as eating red meat (yes/no).

OUTCOME VARIABLES

Our main outcome variable was iron status. Serum ferritin has been described as the best indicator of iron stores in the absence of inflammation.[27] The AAP notes that hemoglobin concentration as a measure of iron status