ABSTRACT

Infant feeding guidelines regarding the introduction of solid foods are generally not well known in Canada. The guidelines recommend that solid foods be introduced between four to six months of age, depending on the developmental readiness of the infant. In order to understand the underlying factors and patterns which contribute to the introduction of solid foods in infants, data were analyzed from three cross-sectional surveys of parents of six-month-old infants from the Ottawa-Carleton region (n=373, 1988; n=330, 1992; n=338, 1996) conducted by the Ottawa-Carleton Health Department. Multivariable analysis showed that mothers who: did not breastfeed, were younger, had lower education, smoked or had partners that smoked, and lacked support after birth, were more likely to introduce solid foods before four months of age. These data support the need for nutrition education programs to increase adherence to the new Nutrition for Healthy Term Infants guidelines.

ABRÉGÉ

Les directives concernant l'introduction des solides dans l'alimentation des enfants ne sont généralement pas bien connues au Canada. Ces directives recommandent l'introduction des solides alimentaires entre quatre et six mois, en fonction du développement de l'enfant. Pour essayer de comprendre les facteurs et les tendances qui contribuent à l'introduction des aliments solides chez les enfants, les données de trois enquêtes transversales (n=373, 1988; n=330, 1992; n=338, 1996) auprès de parents de la région d'Ottawa-Carleton ayant des enfants de six mois, réalisées par le département de Santé d'Ottawa-Carleton, ont été analysées. Les analyses à variables multiples ont montré que les mères qui n'allaitent pas leur enfant, qui sont jeunes, ont un niveau bas d'éducation, qui fument ou ont des partenaires qui fument, et qui ont peu de soutien après la naissance sont plus à même d'introduire des aliments solides avant l'âge de quatre mois. Ces données mettent en valeur le besoin de programmes d'éducation nutritionnelle pour encourager l'adoption des nouvelles directives sur la nutrition des enfants sains.

Infant Feeding Practices in Ottawa-Carleton: The Introduction of Solid Foods

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In Canada from 1965 to 1971, the median age of non-milk solid food introduction was one month.¹ Surveys conducted in the 1970s²⁻⁴ showed similar trends, while in the 1980s, the median age was four months.⁵⁻¹¹ During the 1990s, while the age of solids introduction was later still, many studies continued to report this introduction before four months of age.¹²⁻¹⁶ While these studies suggest that Canadian infants are receiving solid foods at an increasingly later age and that the majority of parents are adopting the recommended guidelines of four to six months, there are few studies that have examined the determinants of early solid food introduction in infants.

The Canadian guidelines¹⁷ recommend that solid food introduction should correspond with the infant's physiological and neuromuscular maturation which usually occurs around four months. Diseases studied in association with the early introduction of solid foods include allergies,¹⁸⁻²² iron deficiency,^{23,24} and hypernatremic dehydration.^{25,26} After four to six months of age, human milk alone is unlikely to provide adequate energy and to meet mineral (iron) and vitamin (vitamin D) requirements.²⁷ Solid foods and liquids ensure that nutritional needs are covered after this time.

The objectives of this study were to describe the introduction of solid foods during the first six months of life in Ottawa-Carleton from 1988 to 1996, and to determine the relationship between socio-demographic characteristics and breastfeeding practices of infants' mothers, and the introduction of solid foods before four months of age.

METHODS

Selected data from the Ottawa-Carleton Health Department Infant Care Surveys conducted in 1988, 1992 and 1996 were used, with permission, for these analyses. Each survey included a cohort of parents with six-month-old babies. The infants were born between April 30 and June 2, 1988, May 25 and July 6, 1992, and April 1 and June 30, 1996.

In 1988 and 1992, the sampling frame was the Physician Notification of Births file, which contained all live births in Ottawa-Carleton, including home births. The 1996 sample was drawn from the Liaison Referral Forms, which consist of 95% of all live births in the Ottawa-Carleton Region hospitals. Babies not included in these records are home-births in 1996, estimated to be less than 1% of all births in the region,²⁸⁻³⁰ families who moved to the region after childbirth, and households without telephones (approximately 1% of households in Ontario).³¹⁻³³

Data were collected by telephone interviews using a standardized questionnaire,³⁴⁻³⁶ and all the interviewers were trained in proper telephone interviewing technique. Each study received approval by the Ottawa-Carleton Health Department Research Ethics Committee prior to implementation.

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Solid foods or solids were defined as any food other than breastmilk, formula, or other milks (whole cow's milk, 2% milk, etc.) but did not include juice or water. The early introduction of solid foods was defined as the introduction of such foods before four months of age. Breastfeeding at six months refers to breastfeeding with or without supplementation.

Initially, infant feeding and maternal characteristics were tested singly using two-sided Mantel Haenzel chi-square tests at the 5% level of significance, odds ratios and 95% confidence intervals were generated using univariate analyses. In order to examine the associations between the explanatory variables and the introduction of solid foods before four months of age, multivariable models were created, based upon theoretical constructs and the results of the univariate modelling. Variables were forced into different models, by adding one variable at a time.³⁷ Interaction terms, age and income, and age and education were also included in the initial models. All analyses were done using the Statistical Analysis System (SAS), version 6.12 (SAS Institute Inc., Cary, NC).

RESULTS

The total number of respondents was 373, 330 and 338, in 1988, 1992 and 1996, respectively, corresponding to response rates of 81%, 76%, and 77%. This represented 4% of total births in the region during 1988, and 3% in both 1992 and 1996.

The mean age (95% CI) of solid food introduction was 4.2 (2-6), 4.0 (2.5-5), and 4.1 (1-6) months for 1988, 1992 and 1996, respectively. The age of the infant at solid food introduction is presented in Table I. Cereal was the first solid food for 94%, 89% and 92% of the 1988, 1992, and 1996 infants, respectively.

The pattern of solid food introduction in each of the milk feeding groups resembles the overall pattern of introduction, with a peak at four months. For breastfed infants, the distribution was skewed to the right, whereas for formula-fed infants, it was skewed to the left. This indicated that more formula-fed infants were introduced to solids in their first four months than

Age (Months)	1988		1992		1996	
	n	%	n	%	n	%
1	7	2	6	2	4	1
2	14	4	13	4	20	6
3	57	15	56	17	30	9
4	139	37	171	52	151	45
5	99	27	53	16	81	24
6	43	11	1	<1	39	11
>6	13	3	30	9	13	4
Missing	1	<1	0	-	0	-

	1988		1992		1996	
	n	%	n	%	n	%
Feeding at Birth		bl		***		***
Breast	60	20	39	18	24	11
Formula	21	29	22	41	18	42
Breast and formula	-	-	15	59	12	16
Milk Feeding at 6 Months		***		***		***
Breastmilk	13	11	17	11	8	6
Formula	37	21	51	30	39	20
Cow's milk ('88 only)†	25	34	-	-	-	-
Mother's Age (Years)		*				***
< 23	6	38	8	42	11	61
23-29	41	25	28	23	25	22
≥ 30	30	16	39	21	18	9
Marital status		*				***
No partner	8	40	6	29	9	36 ‡
Partner	70	20	68	22	44	14
Education		***		***		*
≤ High school	37	33	26	33	19	22
Some post-secondary	9	18	15	31	11	27
College graduate	10	14	20	27	12	14
≥ University graduate	22	137	13	10	12	10
Family income						***
< \$20,000	11	31	7	26	16	39
\$20,000-29,999	9	24	7	29	7	24
\$30,000-49,999 ('92 and '96)	-	-	14	23	13	17
≥ \$50,000 (>\$30K in '88)	51	18	33	19	14	9
Mother's Parity						**
1 child	34	21	32	25	35	22
2 children	28	20	27	21	10	8
≥ 3 children	16	24	16	22	9	15
Mother Received Help/Advice						bl
Occasionally (no - '92, '96)	10	17	4	23	10	27
Often (yes - '92, '96)	69	22	50	16	45	15
Mother Smoked When Pregnant		*				***
Yes	20	31	16	30	15	44
No	59	19	58	21	39	13
Mother Smoked After Birth		*		bl		***
Yes	24	29	19	32	17	45
No	55	19	54	20	36	12
Exposure to ETS at Home		*				***
Yes	25	27	27	28	28	35
No	44	18	46	20	26	10

† The number of children given cow's milk in 1992 and 1996 was too small to include in the chi-square test.

‡ p = 0.005

bl border line (>0.05-0.1)

* ≤ 0.05

** < 0.01

*** < 0.005

were breastfed infants (X^2 test: 1988 $p > 0.05$; 1992 $p < 0.005$; 1996 $p < 0.005$). Infants who were fed both breastmilk and formula at birth, received their first solid

food between the two groups. In general, they were given solids later than formula-fed babies but earlier than those who were breastfed.

TABLE III
Maternal and Infant Characteristics Associated with the Likelihood of Solids Being Introduced Before 4 Months, by Year of Study

Characteristic	Univariate Odds Ratio (95% Confidence Interval)		
	1988	1992	1996
Breastfed at birth	0.57 (0.32-1.04)	0.44 (0.26-0.75)	0.35 (0.19-0.64)
Formula-fed at birth	1.76 (0.97-3.12)	2.85 (1.52-5.29)	5.18 (2.56-10.42)
Breast- and formula-fed at birth	-	1.18 (0.60-2.23)	1.02 (0.49-2.01)
Breastfed at six months	0.37 (0.19-0.68)	0.29 (0.16-0.52)	0.23 (0.09-0.51)
Formula-fed at six months	1.09 (0.66-1.81)	-	-
Cow's milk at six months	2.50 (1.40-4.41)	-	-
Mother's age	0.93 (0.87-0.98)	0.94 (0.89-1.00)	0.86 (0.80-0.91)
Mother's marital status	0.37 (0.15-0.98)	0.72 (0.28-2.08)	0.30 (0.13-0.74)
Mother's education	0.71 (0.58-0.87)	0.64 (0.51-0.80)	0.72 (0.56-0.91)
Family income	0.71 (0.49-1.03)	0.84 (0.64-1.11)	0.53 (0.40-0.70)
Mother received support/help after birth	1.33 (0.66-2.92)	1.61 (0.52-7.07)	0.46 (0.21-1.06)
Mother smoked while pregnant	1.96 (1.06-3.54)	1.60 (0.81-3.03)	5.32 (2.48-11.34)
Mother smoked after birth	1.77 (1.00-3.08)	1.86 (0.98-3.43)	5.71 (2.74-11.83)
ETS exposure at home	1.73 (1.04-2.88)	1.50 (0.86-2.59)	4.76 (2.59-8.84)

Maternal and milk feeding characteristics associated with the introduction of solid foods before four months of age, by year of study are presented in Table II. Univariate analysis odds ratios and 95% confidence intervals associated with these characteristics are presented in Table III. In general, infants had a higher likelihood of receiving solids before four months if they were formula-fed at birth or if the mother smoked during or after pregnancy, or if there was exposure to tobacco smoke in the home. Being breastfed at birth or at six months, having an older mother who was married, well educated and with a higher income had a protective effect against early solid food introduction.

Logistic regression models are presented in Table IV. In 1988 (models 1 and 2) and 1992 (models 3-5), education, and breastmilk at birth and at six months had a protective effect against early solid food introduction, while receiving formula at birth, and being fed cow's milk at six months increased the likelihood of the infant having received solids before four months.

Three models in the 1996 cohort, were found to have all variables significantly associated with age of introduction (models 6-8). In these models, infants were less likely to be given solids before four months if they were breastfed at birth or six months, were not exposed to environmen-

tal tobacco smoke (ETS) at home, or had an older mother who received support after birth. For each of the cohorts, none of the interaction variables were significantly associated with solid food introduction and therefore were dropped from their respective model.

DISCUSSION

This study showed that the majority of infants were introduced to solid foods shortly after four months, in accordance with general guidelines that solids should normally be introduced between four and six months.¹⁷ While this is reassuring, our results also showed that a significant proportion of infants were receiving solids earlier than four months of age.

The majority of infants given solids shortly after the fourth month suggests that developmental cues may not be taken into account. Mothers, or the primary caregivers, should be encouraged by physicians, nutrition professionals and other health care providers to watch for signs that the infant is ready for solid foods, rather than using a specific age as the deciding factor. Mothers should be reassured that until six months of age, their infants can receive adequate nourishment from breastmilk (and/or formula) alone.

TABLE IV
Selected Characteristics Associated with the Introduction of Solid Foods Before 4 Months After Adjustment for Other Variables for the 1988, 1992 and 1996 Cohorts

Characteristics	Adjusted Odds Ratio (95% Confidence Interval)							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Breastfed at birth	-	-	-	0.33 (0.15-0.72)	-	3.69 (1.78-8.77)	0.39 (0.20-0.73)	-
Formula-fed at birth	-	-	2.15 (1.11-4.12)	-	-	-	-	-
Breastfed at 6 months	0.45 (0.22-0.89)	-	-	-	0.32 (0.17-0.58)	-	-	0.32 (0.12-0.74)
Cow's milk at 6 months	-	0.43 (0.19-0.80)	-	-	-	-	-	-
Mother's age	-	-	-	-	-	0.88 (0.82-0.94)	0.87 (0.81-0.93)	0.88 (0.81-0.95)
Mother's education	0.76 (0.61-0.94)	0.76 (0.61-0.94)	0.69 (0.55-0.87)	0.70 (0.50-0.96)	0.72 (0.57-0.91)	-	-	-
Mother received support	-	-	-	-	-	0.36 (0.15-0.89)	-	0.31 (0.13-0.81)
ETS at home	-	-	-	-	-	4.18 (2.15-8.23)	4.07 (2.12-7.85)	4.36 (2.16-8.88)

For each cohort, mothers who chose not to breastfeed, or to stop breastfeeding shortly after birth, were more likely to introduce solid food earlier, compared with mothers who breastfed their infants at birth and at six months. Mothers who were younger, had a lower income, had achieved a lower education level and smoked during and after pregnancy were more likely to introduce solid foods earlier. A consistent pattern throughout the three cohorts as to which variable was most indicative of solid food introduction before four months was not observed.

This study investigated, to a certain extent, the independent influence of some demographic and lifestyle measures on the introduction of solid foods, analyses that have not been available in other Canadian studies. A significant association of these variables with breastfeeding, however, is well founded.³⁸⁻⁴⁰ These results were in agreement with international studies in which significant associations between early solids introduction and variables such as no or decreased breastfeeding, maternal smoking, and lower maternal education have been reported.⁴¹⁻⁴⁸ Health care workers can thereby identify and ensure that these mothers are aware of the guidelines regarding solid food introduction. Strategies should be developed to ensure that all health professionals are giving a positive and consistent message.

Compared with other regions in Canada, results from this study indicate that the percentage of infants introduced to solid foods at the appropriate age was increasing.^{15,16, 49} A greater percentage of infants in the current study was introduced to solids after three months when compared to an Ottawa-Carleton cohort sampled in 1984.¹³ This is a step in the right direction. There have not been any public health initiatives specific to the Ottawa-Carleton region in the past decade to explain these changes.⁵⁰

The presence of ETS in the regression model raises some interesting issues. The relationship between ETS and early solid food introduction could be biologically plausible. Women who smoke tend to wean their babies earlier than non-smokers,⁵¹⁻⁵³ the earlier cessation of breastfeeding has been associated with a nicotine-

induced reduction of prolactin,⁵⁴⁻⁵⁶ and lack of breastfeeding is strongly linked with early solids introduction. Increased rates of behaviour problems,⁵⁷ lower respiratory tract infections, asthma and middle ear infections⁵⁸⁻⁶¹ have been reported in children exposed to tobacco smoke. It is possible that illness may be misinterpreted as fussiness, leading the parents to give solids in an attempt to calm their child. A non-biological explanation suggests that mothers find smoking and breastfeeding to be a contradiction of terms, in that mothers want to provide the best possible environment for their child.⁵² Taken together, these studies provide a hypothesis for the earlier introduction of solid foods in children exposed to passive and prenatal tobacco smoke.

Women with less education were more likely to introduce solid foods earlier than recommended, and were also less likely to breastfeed their infants. The reasons why women do not breastfeed are complex; a number of factors have created a culture in which breastfeeding is not considered the normal way for women to feed their children.⁶² Factors that helped create this attitude towards breastfeeding include industrialization and urbanization,⁶² the promotion of infant formula by manufacturers and the latter's relationship with physicians,^{62,63} the medicalization of childbirth,⁶⁴⁻⁶⁷ and cultures in which sex is linked with breastfeeding.⁶⁸

Strengths of this study include a large sample size which enabled multivariate analysis, and a representative sample of "new mothers" due to random sampling and high response rates. Limitations include a lack of information on maternity leave, ethnicity/culture, and qualitative data providing reasons why mothers introduced solids. Furthermore, demographic risk factors, such as education, are often difficult if not impossible to modify, whereas having an impact on a person's knowledge or behaviour may be more likely. Non-response bias and recall bias were also concerns. Although it is possible that the mother did not accurately remember when solid food was introduced, there is good validity of retrospective infant feeding patterns.⁶⁹ Determining a response bias was not possible because information was

not collected from mothers who refused to participate, and data were not available from mothers who could not be contacted. Finally, there are many different approaches to building multivariate models, and the models described above are a product of the modeling procedure chosen for this analysis.⁷⁰

In conclusion, this study was successful in providing a better understanding of the factors associated with the early introduction of solid foods and thereby in identifying mothers who will benefit most from health initiatives. Public health programs and policy should address breastfeeding and support issues for expectant and new mothers identified in this study as least likely to follow the guidelines. Given the complexity surrounding these issues, a population health perspective should be used, with programs that focus on substantially more than health information. This will help ensure that the many different factors of one's life are addressed. These programs and policies must work towards a supportive environment that will enable a mother to practise optimal infant feeding methods.

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