

BMJ Open Parental separation and behaviours that influence the health of infants aged 7–11 months: a cross-sectional study

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ABSTRACT

Objective: Analyse the parental behaviours that are recognised as influencing the health of very young children based on family structure (parents separated or not).

Design: Cross-sectional study.

Setting: Free preventive medicine consultations in the French Community of Belgium.

Participants: Examination of 79 701 infants aged 7–11 months as part of a free preventive medicine consultation. The data came from an assessment conducted 7–11 months after birth during which information was collected, namely about the parents' use of tobacco, the infant's type of nutrition and adherence to vaccination schedules.

Main outcome measures: Parental behaviours: smoking, nutrition and compliance with vaccination schedule.

Results: The percentage of infants whose parents were separated was 6.6%. After adjusting for the cultural and socioeconomic environment as well as for other potential confounders, in the event of separation as compared with non-separated parents, the adjusted ORs (95% CI) were as follows: 1.5 (1.3 to 1.7) for the infant's exposure to tobacco; 1.3 (1.2 to 1.4) for total lack of exclusive breast feeding; 1.3 (1.1 to 1.4) and 1.2 (1.1 to 1.2) for breast feeding for a duration of less than 3 and 6 months, respectively; 1.2 (1.1 to 1.4) for non-compliance with the vaccination schedule against rotavirus. The duration of exclusive breast feeding was shorter when parents were separated ($p < 0.001$; median 10 vs 13 weeks).

Conclusions: This study reinforces the possibility that parental separation is independently associated with certain parental at-risk behaviours regarding the children's health. This observation should be verified because this could result in major consequences for the work of family doctors, in particular in terms of parent information and targeted prevention.

INTRODUCTION

Context. Separation of parental couples, whether married or not, is very common in Western countries. In the USA, in 2011, it affected between 3 and 4 children out of

Strengths and limitations of this study

- The cross-sectional nature of our study results in uncertainty with regard to time: theoretically, we do not know the direction of causality between the variables, and we have no idea of the length of time the infants were exposed to parental separation, nor whether their parents were separated or not when they were born.
- We noted some dissimilarities in comparison with the general population. For instance, very small birth weights (≤ 1999 g), when taken together, represented 1.9% in this study, as compared with 2.3% on a national level. These differences may be accounted for by socio-economic circumstances such as the families' income levels. This parameter was not available for the current study, but was replaced by the mother's education level and professional activity. Indeed, nearly 32% of the women held a higher education level, as against 25% generally in Belgium.
- All the sociocultural strata are represented in the study population, thus ensuring a good representation of infants from all the socioeconomic levels. In addition, our study results were adjusted for several essential socioeconomic and cultural indicators.
- We focused on a specific age group that had been scarcely studied beforehand in terms of the association between family structure and factors influencing health. It should also be stressed that the full data were collected by paediatric healthcare professionals.

every 10.¹ In 2001, in Canada, 25% of young people were not living with both of their parents.² The trends are the same in Europe.³ In France, in 2010, nearly 3 million children were living with only one parent.⁴ In 2002, in Great Britain, it was observed that 35% of children were not living with both of their parents.⁵ In Belgium, in 2002, 20% of children aged 0–16 were living in a single parent or blended family.⁶ Again in Belgium, in 2011, there were 67 separations for every 100 marriages,⁷ affecting an estimated

500 000 minors. Some studies have described the impact of these situations on the child on a somatic, psychological, behavioural and school level. A national study in America that targeted 102 000 families between 2002 and 2003 showed that, after adjusting for socioeconomic status, single parent and blended families saw children suffer from oral, respiratory or trauma-related problems significantly more often. These studies also reported that young people who did not live with both of their parents displayed more behavioural disorders and difficulties at school, and sought specialised care more.¹ In Denmark, a national study in a cohort that comprised children aged 0–15 born between 1977 and 2004 was carried out. The study looked for a possible association between the experiencing of traumatic events and severe infection compared with a control group of children. Expressed in relative risk, when there was parental divorce, an increase in severe infection with or without hospitalisation was observed. Besides the idea of the influence of chronic stress, the authors of this study hypothesised that parental behaviours might differ depending on family structure and have an impact on the children's health.⁸ In Canada, a literature review published in 2004 at the request of the minister of justice concluded that parental separation aided the accumulation of risk factors for the children's development—namely the lack or absence of involvement of one of the parents, parental psychopathology, conflict between parents, conflict between parents and the child or children and a changed socioeconomic environment.⁹ In Belgium, a national survey carried out between 1992 and 2002 in 27 500 families confirmed the accumulation of risk factors when the parental couple was separated. Thus, in the case of a single parent family, the children were more often at risk of never seeing their father, and the adult who looked after the children suffered from depression more often. But regardless of the type of custody, the children of parents who were separated lived on average in a materially less-well-off environment, were often absent or behind at school and their parents smoked daily in up to 40% of cases (vs 24%).⁶ In 2006, a focus-group qualitative study of the follow-up by Belgian family doctors of children of separated parents described what specifically impeded the work of family doctors in these situations: difficulty communicating with the parents about the child's health and obstacles to medical follow-up, in particular for chronic diseases or adherence to vaccination schedules, among other things. The main worry of these first-line doctors was the somatic and psychobehavioural repercussions that they were detecting in children after a divorce.¹⁰ However, we have not found any study that expressly investigated the potential impact of separation on parental behaviour that affects the overall health of very young children. We hypothesised that parental separation may already impact parental behaviour from the earliest stages in children's lives, with influence on their health. Thus, our main objective was to compare the

parental behaviours that affect children's health depending on family structure (parents separated or not, regardless of the marital status) in a large cohort of infants aged 7–11 months. The secondary objective was to identify the other factors that are useful for first-line medical practice and are associated with parental behaviours that pose a risk to the development of infants aged 7–11 months.

Methods: Cross-sectional study.

Study population

In the French Community of Belgium, the Office de la Naissance et de l'Enfance, or Office of Birth and Childhood (ONE),¹¹ offers a free preventive check-up programme from pregnancy up to the age of 6, with the data being centralised in a computerised databank. For very young infants, the data are collected at five time points: at birth in the maternity hospital, after the return home, between 7 and 11 months, between 16 and 20 months and between 28 and 32 months. For each time point of this check-up programme, a data collection sheet is completed by a nurse, midwife, social worker, paediatric doctor or family doctor who is specifically trained for this task. Once completed, these sheets are anonymised and encoded in the central database. This system is in place for evaluation purposes and facilitates the adapting of policy in the perinatal and early childhood medical-social field. We analysed the data of 79 701 infants who were entered in the ONE database between 2006 and 2012 and for whom there was a preventive health assessment 7–11 months after birth.

Assessment of main exposure

Family structure came under six categories: parents together, parents separated, the child only sees one parent, the infant is in a children's home/home/foster home, other situations (grandparents, other parents) and unknown. For our analyses, only non-separated and separated parents (n=78 008) were included, with children who only see one parent falling under the second category.

Assessment of other covariates

The other independent variables included in the analyses were the age of the mothers at childbirth, their standard of French, their level of education and their occupation. Maternal age was categorised by separating very young mothers (<17, the age of consent in Belgium) from older mothers (≥ 38 , the age at which amniocentesis is automatically recommended). The sex and birth weight of the child were also used for the analysis of breast feeding. The corresponding paternal characteristics were not taken into account, because they very closely correlated with those of the mother, were only available between 2010 and 2012 and, what is more, a large quantity of data were missing.

The 'unknown' answers were eliminated from the analyses. However, we observed beforehand that the

distribution of variables of socioeconomic status did not significantly differ among these 'unknowns'.

For the multivariable analyses, the categories of the independent variables were grouped according to the categories presented in the tables.

Outcome ascertainment

During this assessment, the dependent variables that were taken into account based on our research topic were children's exposure to smoking, type of nutrition and adherence to vaccination schedules. For smoking behaviour assessment covering the years between 2006 and 2009, there was only one question: "At least one person of the household smokes daily in the house." For the years between 2010 and 2012, there were two questions in the following order: "At least one person of the household smokes daily" and "At least one person of the household smokes daily in the house." For our study, we have only kept the variable pertaining to smoking behaviour in the house. Because the percentages were so different, the analysis was conducted over two separate periods, which did not pose a problem given the size of the sample. The vaccinations were evaluated using the number of doses already received at the time of the assessment. By taking into account the recommended schedule for each type of vaccine¹² and the age in months of the infant, we were able to determine whether the child was in order or behind in the vaccination schedule, or whether the child had not received any dose at all. Furthermore, unlike the other variables, we kept the 'unknowns'. For clinicians, a lack of information regarding the vaccination status makes it necessary to act such as in the event of an incomplete or missing vaccination.¹³ For the hexavalent (DTaP-polio, *Haemophilus influenzae* type b, hepatitis B) and pneumococcal vaccinations offered free of charge by ONE, given the small number of infants who were not vaccinated or poorly vaccinated, the variables were dichotomised (vaccination in order for age/not in order for age or unknown). It should be noted that the vaccination against pneumococcal disease has only been recommended in the vaccination schedule since 2007. An oral vaccine (RotaTeq) is used at the ONE against rotavirus. It is administered in three doses (2, 3 and 4 months) and no catch-up dose is recommended after 6 months of age. Thus, this variable was divided into three categories: in order (three doses administered), behind schedule (one or two doses) and absence of vaccination or status unknown. This vaccine has been recommended since 2007. However, unlike the previous vaccines, parents must buy it in a pharmacy and it is not totally free. Regarding exclusive breast feeding, two variables were available: the first was split into three categories stating whether the child was still being breast fed at assessment, had been breast fed, or had never been breast fed (ever breast fed; cfr. table 2); the second was the number of weeks of exclusive breast feeding. We categorised this last variable into number of months

(3 or 6 months) while taking into account both the recommendations in this area¹⁴ and the fact that in Belgium, maternity leave lasts on average 3 months after the birth of the child.

Statistical analysis

The χ^2 test was applied and the ORs were derived to compare the two groups of infants aged 7–11 months (exposed/not exposed to parental separation). Multivariable logistic regression analyses were used to adjust the effect of exposure. The models were designed using a backward elimination method for potential confounders, and the variable describing parental situation was automatically included in the models. Interactions between this variable and the other predictors were tested; no significant interaction was found. Given that the sample was very large (more than 30 000 observations), the Hosmer-Lemeshow goodness-of-fit test was not used with the standard number of 10 groups but with many different numbers of groups according to the strategy described in the article by Paul *et al.*¹⁵ However, as the size of the sample exceeded 25 000, a graphic method correlating the numbers observed and expected was also applied. The absence of collinearity between the predictors included in the model was verified by means of variance inflation factors. For the analysis of exclusive breast feeding, Kaplan-Meier survival curves were also worked out and compared with the log-rank test. The analyses were conducted using the STATA V.12.0 software (<http://www.stata.com>).

RESULTS

Of the 79 701 observations, there were a few more boys than girls, and the proportion of infants with a very low birth weight (<2000 g) was close to 2%. Nearly 40% of mothers were aged between 25 and 30, around one-third held a higher education degree and a little less than half of them were housewives or unemployed. One mother in 10 could not speak French properly (table 1).

Across the entire sample, close to 7% of the infants had separated parents or were living with only one of their parents (table 1).

Between 2006 and 2009, 34% of infants were exposed to smoking every day if the parents were separated as against 21.6% when the parents were together ($p < 0.001$). Over the period 2010–2012, 22.5% of infants were exposed to smoking if their parents were separated as against 10.7% when the parents were together (table 2). Taking into account the entire sample size between 2006 and 2012, regardless of the family structure, 1% and 8% of infants' vaccinations were not in order for hexavalent and pneumococcal disease, respectively. Regarding vaccination against rotavirus, a total absence of vaccine doses against rotavirus was, conversely, significantly associated with parental separation, with an OR of 1.5 (95% CI 1.3 to 1.7). The same trend was found for the risk of incomplete vaccination, with an OR of 1.2 (95% CI 1.0 to 1.3).

Table 1 Description of study population

Baseline variable	Per cent	New categories*	Per cent
Gender n=78 720			
Male	50.6	–	–
Female	49.4		
Birth weight n=78 924 (g)		n=78 388	
<1000	0.2		
1000–1499	0.5		
1500–1999	1.2		
2000–2499	5.0	<2500	6.9
2500–2999	20.7	≥2500	93.1
3000–3499	40.7		
3500–3999	25.5		
4000–4499	5.6		
≥4500	0.6		
Mother's age at childbirth n=77 979		n=77 979	
9–15	0.1		
16–17	0.9	<17	1.0
18–24	21.7	18/24	21.7
25–30	39.8	25/30	39.8
31–37	30.7	31/37	30.7
38–44	6.6	≥38	6.8
45–53	0.2		
Mother's level of education n=79 701		n=65 482	
Incomplete primary education/no schooling	2.6		
Complete primary education/incomplete lower secondary education	5.0	<Lower secondary education	9.3
Complete lower secondary education	14.7	Complete lower secondary education	17.9
Complete upper secondary education	28.0	Complete upper secondary education	34.1
Complete higher education/academic or not	31.8	Higher education	38.7
Unknown	17.9		
Mother's occupation n=79 701		n=76 450	
Unemployment/housewife	45.3		
Part-time occupation	17.9	Unemployment/housewife	47.3
Early retirement/invalidity/work incapacity	1.5	Early retirement/work incapacity/invalidity	1.6
Professional break/parental leave or full-time equivalent	2.7	Student	1.6
Student	1.6	Full-time or part-time occupation/professional break/parental leave	49.5
Full-time occupation	26.9		
Unknown	4.1		
Mother's French language level n=79 701		n=77 698	
None	3.6		
Basic	6.7	None	3.7
Proficient	87.2	Basic	6.8
Unknown	2.5	Proficient	89.5
Family structure n=79 701		n=78 008	
Separated parents	5.1		
Sees only one parent	1.5		
Children's home/home/foster home	0.3	Separated parents/sees only one parent (n=5143)	6.6
Grandparents, uncles/aunts, others	0.6	Parents together (n=72 865)	93.4
Parents together	91.4		
Unknown	1.2		

*Without unknown data.

Thus overall, non-adherence to the vaccination schedule against rotavirus (absent, incomplete, unknown) was significantly associated with separation, with an OR of 1.2 (95% CI 1.1 to 1.4). In our sample, 25% of infants did

not receive exclusive maternal breast feeding. Nutrition also appeared to be less optimal when the parents were separated: a higher percentage of infants had not received exclusive breast feeding, with an OR of 1.8 (95%

Table 2 Parental behaviours with infants aged 7–11 months

Variables describing the factors that influence the infant's health	Total	Parents together	Separated parents	p Value
Daily smoking in the house (2006–2009)	(n=38 783)	(n=36 063)	(n=2720)	<0.001
Yes (%)	22.4	21.6	34.0	
Crude OR (95% CI)		1	1.9 (1.7 to 2.0)	
Smoking in the house (2010–2012)	(n=30 549)	(n=28 665)	(n=1884)	<0.001
Yes (%)	11.5	10.7	22.5	
Crude OR (95% CI)		1	2.4 (2.2 to 2.7)	
Non-compliance with the hexavalent vaccine	(n=78 008)	(n=72 865)	(n=5143)	0.1
Yes (%)	0.9	0.8	1.1	
Crude OR (95% CI)		1	1.2 (0.9 to 1.7)	
Non-compliance with the pneumococcal vaccine (2007–2012)	(n=68 606)	(n=64 148)	(n=4458)	0.871
Yes (%)	7.6	7.6	7.7	
Crude OR (95% CI)		1	1.0 (0.9 to 1.1)	
Rotavirus (2007–2012)	(n=68 606)	(n=64 148)	(n=4458)	<0.001
Complete (%)	8.8	8.9	7.4	
Incomplete (%)	72.2	69.8	72.4	
Missing or unknown (%)	19.0	18.7	22.9	
Crude OR ¹ (95% CI)		1	1.2 (1.0 to 1.3)	
Crude OR ² (95% CI)		1	1.5 (1.3 to 1.7)	
Non-compliance with vaccination				
Yes (%)	91.2	91.1	92.6	
Crude OR (95% CI)		1	1.2 (1.1 to 1.4)	
Exclusive breast feeding	(n=74 931)	(n=69 960)	(n=4971)	
Ever breast fed (%)	25.5	24.6	36.5	
Crude OR (95% CI)		1	1.8 (1.6 to 1.9)	<0.001
Breast feeding duration in months	(n=55 530)	(n=52 387)	(n=3143)	
Less than 3 months (%)	50.7	50.2	58.8	<0.001
Crude OR (95% CI)	(n=28 163)	(n=265 569)	(n=1594)	
		1	1.4 (1.3 to 1.5)	
Less than 6 months (%)	87.4	87.3	88.5	<0.04
Crude OR (95% CI)	(n=48 516)	(n=45 770)	(n=2746)	
		1	1.1 (1.0 to 1.2)	

OR¹: incomplete; OR²: missing or unknown.

CI 1.6 to 1.9). The duration of exclusive breast feeding was also significantly shorter when there was separation ($p<0.001$; median duration 10 vs 13 weeks; [figure 1](#)). This

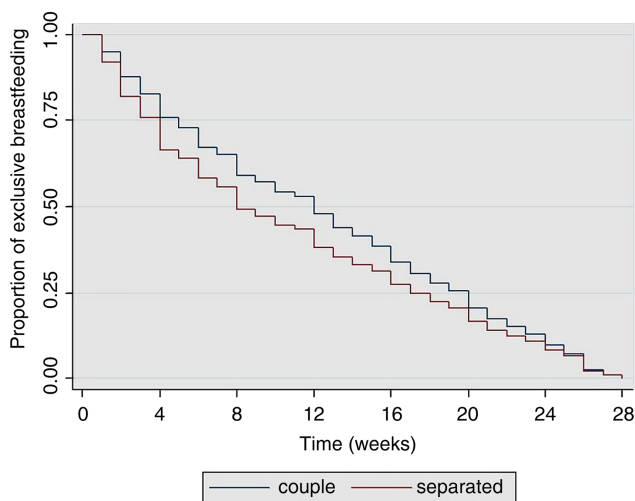


Figure 1 Duration of exclusive breast feeding: couple versus separated (log-rank test: $p<0.001$).

trend was also observed in the analysis of the duration of exclusive breast feeding of less than 3 or less than 6 months, with ORs (95% CI) of 1.4 (1.3 to 1.5) and 1.1 (1.0 to 1.2), respectively.

After adjusting for the other socioeconomic and cultural factors, it was observed that parental separation remained significantly associated with all the variables potentially affecting the health of infants that were taken into account in this study. The adjusted ORs were generally lower than the crude ORs. For example, when considering tobacco exposure in the house between 2010 and 2012, the adjusted OR was 1.5 (95% CI 1.3 to 1.7). For total absence of exclusive breast feeding between 2006 and 2012, the adjusted OR was 1.3 (95% CI 1.2 to 1.4; [table 3](#)).

The lack of higher education and work and the mother's young age (under 25) were also associated with smoking tobacco around the infant. Conversely, when mothers were of foreign descent, it seemed to have a protective influence with regard to tobacco smoking in the home of the infant ([table 3](#)). Besides parental separation, the categories that posed a risk of non-adherence

Table 3 Parental behaviours with infants aged 7–11 months: adjusted ORs

Variable	Dailysmoking in the house (2006–2009) OR (95% CI)	Smoking in the house (2010–2012) OR (95% CI)	Vaccination incomplete vs complete rotavirus OR (95% CI)	Vaccination missing/ unknown vs complete rotavirus OR (95% CI)	Vaccination missing/ unknown/ incomplete versus complete rotavirus OR (95% CI)	Ever breast fed OR (95% CI)	Breast feeding during less than 3 months OR (95% CI)	Breast feeding during less than 6 months OR (95% CI)
Family structure								
Parents together	1	1	1	1	1	1	1	1
Parents separated	1.3 (1.2 to 1.5)	1.5 (1.3 to 1.7)	1.2 (1.0 to 1.3)	1.3 (1.1 to 1.5)	1.2 (1.1 to 1.4)	1.3 (1.2 to 1.4)	1.3 (1.1 to 1.4)	1.2 (1.1 to 1.4)
p Value	<0.001	<0.001	0.01	<0.001	<0.001	<0.001	<0.001	0.001
Mother's level of education								
Higher education	1	1		1		1	1	1
Upper secondary education	2.3 (2.1 to 2.5)	2.6 (2.2 to 2.9)		1.0 (0.9 to 1.1)		1.9 (1.8 to 2.0)	1.5 (1.4 to 1.6)	1.2 (1.1 to 1.3)
Lower secondary education	4.3 (3.9 to 4.7)	5.3 (4.6 to 6.1)		1.0 (0.9 to 1.2)		3.0 (2.8 to 3.2)	1.9 (1.8 to 2.0)	1.3 (1.2 to 1.4)
<Lower secondary education	5.3 (4.7 to 5.9)	6.2 (5.2 to 7.2)		1.2 (1.1 to 1.4)		3.2 (2.9 to 3.5)	1.6 (1.5 to 1.8)	1.1 (0.9 to 1.2)
p Value	<0.001	<0.001		0.1		<0.001	<0.001	<0.001
Mother's occupation								
Professional occupation/break	1	1	1	1	1	1	1	1
Unemployment/ housewife	1.5 (1.4 to 1.6)	1.6 (1.5 to 1.8)	1.2 (1.0 to 1.2)	1.4 (1.3 to 1.6)	1.2 (1.1 to 1.3)	1.0 (0.9 to 1.1)	0.5 (0.5 to 0.6)	0.3 (0.3 to 0.4)
Early retirement/ incapacity/invalidity	1.6 (1.3 to 2.0)	2.4 (1.8 to 3.1)	1.2 (1.1 to 1.4)	1.4 (1.1 to 1.8)	1.1 (0.9 to 1.3)	1.2 (1.1 to 1.4)	0.9 (0.8 to 1.1)	0.4 (0.3 to 0.5)
Student	0.9 (0.7 to 1.2)	0.9 (0.7 to 1.2)	0.3 (0.2 to 0.4)	0.5 (0.4 to 0.7)	0.9 (0.7 to 1.2)	0.7 (0.6 to 0.8)	0.6 (0.5 to 0.7)	0.5 (0.4 to 0.6)
p Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mother's age at childbirth (years)								
<17	2.1 (1.6 to 2.7)	2.7 (1.9 to 3.6)		1.6 (1.1 to 2.4)	1.4 (1.0 to 1.9)	1.8 (1.5 to 2.1)	2.8 (2.1 to 3.6)	2.3 (1.5 to 3.7)
18/24	1.4 (1.3 to 1.5)	1.4 (1.3 to 1.6)		1.0 (0.9 to -1.1)	1.0 (0.9 to 1.1)	1.1 (1.0 to 1.2)	1.5 (1.4 to 1.6)	1.4 (1.3 to 1.5)
25/30	1	1		1	1	1	1	1
31/37	0.9 (0.9 to 1.0)	0.9 (0.8 to 1.1)		1.1 (1.0 to 1.2)	1.1 (0.9 to 1.2)	1.1 (1.0 to 1.2)	0.8 (0.4 to 0.9)	0.8 (0.7 to 0.9)
38 and more	1.1 (0.9 to 1.2)	0.9 (0.8 to 1.1)		1.1 (1.0 to 1.3)	1.1 (0.9 to 1.2)	1.2 (1.1 to 1.3)	0.8 (0.7 to 0.9)	0.7 (0.6 to 0.8)
p Value	<0.001	<0.001		<0.001	0.1	<0.001	<0.001	<0.001
Mother's French language level								
Proficient	1	1	1	1	1	1	1	1
Basic	0.5 (0.4 to 0.6)	0.4 (0.3 to 0.5)	1.6 (1.4 to 1.9)	2.8 (2.3 to 3.4)	1.9 (1.6 to 2.2)	0.3 (0.3 to 0.4)	0.5 (0.5 to 0.6)	0.6 (0.5 to 0.7)
None	0.6 (0.5 to 0.7)	0.6 (0.5 to 0.8)	1.4 (1.1 to 1.6)	1.8 (1.4 to 2.3)	1.5 (1.3 to 1.8)	0.3 (0.2 to 0.4)	0.5 (0.4 to 0.5)	0.7 (0.6 to 0.8)
p Value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Continued

Table 3 Continued

Variable	Dailysmoking in the house (2006–2009) OR (95% CI)	Smoking in the house (2010–2012) OR (95% CI)	Vaccination incomplete vs complete rotavirus OR (95% CI)	Vaccination missing/unknown vs complete rotavirus OR (95% CI)	Vaccination missing/unknown/incomplete versus complete rotavirus OR (95% CI)	Ever breast fed OR (95% CI)	Breast feeding during less than 3 months OR (95% CI)	Breast feeding during less than 6 months OR (95% CI)
Birth weight (g)						1	1	1
≥2500						2.2 (2.0 to 2.3)	1.5 (1.4 to 1.5)	1.4 (1.2 to 1.6)
<2500						<0.001	<0.001	<0.001
p Value								
Gender								
Male						1	1	1
Female						1.1 (1.0 to 1.2)	1.1 (1.0 to 1.2)	1.1 (1.0 to 1.2)
p Value						<0.001	<0.001	0.007

to the vaccination schedule were generally the mothers' lack of work, their low level of education, their very young age and their poor knowledge of French (table 3). Besides separation, the categories that posed a risk of suboptimal nutrition were mothers' young age, their lack of education, low birth weight of the infant or when the infant was a girl. However, when mothers did not speak French fluently and did not work, infants benefited from exclusive breast feeding of longer duration (table 3).

DISCUSSION

Our results considered the extrinsic factors that influence the health of infants. Thus, after adjusting for social, economic and cultural factors as well as for the age of mothers at childbirth and certain characteristics of the infants, when parents were separated, we observed a significant increase in the presence of harmful factors for the health of infants compared with situations in which the parental couple remained together.

Comparison with other studies

Smoking in the infants' environment. The short-term risks for infants that are linked with smoking tobacco in their environment are well documented, with an increase in respiratory infections, symptoms of allergy and sudden death, among others.^{16–19} The report on childhood in Belgium "Portrait de l'enfance en Belgique" was published in 2004⁶ and showed that parents were more often smokers and/or depressive when separated. In the focus-group study in 2006, the family doctors observed distress among separated parents, a corollary of this being high-risk behaviour (including smoking).¹⁰ Indeed, arguments confirm the link between difficulties in life (among which the separation of couples is cited) and the use of tobacco, among other things.^{20 21} Our adjusted results showing a greater risk of tobacco smoking in the environment of infants when the parents are separated therefore appear to be consistent with those that are to be found in the literature, which also gives us a possible explanation: the separation leads to ill-being in the adults in question. The lower risk for infants of being exposed to tobacco smoking when the mother speaks little or no French may be explained by the fact that the majority of women of non-Belgian descent come from cultures in which it is rarer for women to smoke tobacco.²²

Vaccination schedule. As part of the ONE's preventive consultations, the hexavalent and pneumococcal injections are performed free of charge and automatically. This explains their excellent distribution among infants. The percentage of infants vaccinated was 99% for the hexavalent vaccine and 92% for the pneumococcal vaccine. This difference in percentage can be explained for the pneumococcal vaccine by its more recent introduction into the schedule (2007) and by the time it took for the vaccine to come into use across all the vaccination

centres—that is, from 2008 onwards. In Belgium, immunisation against rotavirus has been recommended since 2007, but, as explained in the Methods section, besides the fact that this vaccine was not totally free, parents had to buy it themselves in a pharmacy. In our population, the infants of separated parents were less often vaccinated against rotavirus, an effect that persisted after adjustment had been made for sociocultural environment. We cannot entirely exclude that this significant result may be accounted for by income differences depending on the family situation. However, one hypothesis could be that separated parents are less available for carrying out certain tasks for their children because they do not have the time or because of multiple worries or even ill-being. There is little analysis in the literature of the link between family structure and vaccination cover. Thus, a systematic review published in 2008 attempted to identify the predictive factors of non-adherence to the vaccination schedule in Western countries. Though it listed difficulties of a social, cultural and financial nature as well as the level of education, the level of knowledge of vaccines, the age of the mother, the type of health insurance and so on, no reference was made to the family environment.²³ On the other hand, a Flemish study of 14-year-old adolescents showed a significant association between the lack of proper vaccination (MMR, hepatitis B, meningitis C) and social, cultural, financial and educational determinants, but also single parent families following a divorce.²⁴ An American study of a sample of more than 20 000 infants aged 19–35 months showed by means of univariate and bivariate analyses that the maternal characteristics that were the most associated with incomplete vaccination, besides the known sociocultural determinants, were large families, widowhood and parental separation.²⁵ If differing behaviour with regard to vaccination was indeed confirmed in parental separation, infants' risk of infection could also be different, as some prospective studies have already observed.⁸ Indeed, it should be remembered that in a qualitative study in 2006, Belgian family doctors were disappointed to observe both a higher frequency of infection in infants and a difficulty in obtaining compliance with the vaccination schedule following parental separation.¹⁰ In our sample, the other risk factors for non-compliance with the vaccination schedule against rotavirus were consistent with what is to be found in the literature—namely, a lack of education, the very young age of mothers, as well as when French is not their first language.

Exclusive breast feeding. Parental separation—after adjustment had been made for sociocultural environment, the age of the mother and certain characteristics of the infant such as birth weight and sex—was significantly associated with less-than-optimal nutrition. That is, the infant was not exclusively breast fed as often or for as long as the infants of non-separated couples. Besides the importance of the socioeconomic conditions and level of education of the mother, several literature reviews have reported that decision-taking with regard to

breast feeding as well as its duration were influenced by marital status and the presence of the infant's father.^{26 27} An Australian study has described results that are consistent with ours. This cohort study of nearly 2500 women showed that, after adjusting for socioeconomic and biomedical factors, the OR of stopping breast feeding at 4 months or less after childbirth as compared with more than 4 months was around 1.3 (95% CI 1.1 to 1.7) when the mother had experienced a stressful event during pregnancy, in particular separation of the parental couple.²⁸ The results linking environmental factors other than family structure and infant nutrition can be summarised as follows: in the most comfortable families, and when mothers are educated, the infant is breast fed longer. However, an exception should be noted: the infants of mothers of non-Belgian descent are more often given the recommended nutrition despite lower income and a lower level of maternal education, as has been reported by other European authors.²⁹ Furthermore, when the infant's birth weight was low, there is a greater risk of no breast feeding, as has been regularly described in the literature.^{30 31} Finally, in our sample, girls seemed to have been breast fed for a significantly shorter duration. The majority of authors have not found³² or have not looked for this association. However, the link with the infant's sex is sometimes documented,³³ mainly in Africa.

Strengths and limitations of this study

Regarding the main independent variable, namely the family environment, we found that 6.6% of the infants lived under parental separation by adding the 'parents separated' and 'infant only sees one parent' categories together. This percentage seems low given national statistics,⁷ but it is not negligible when one considers that the average age of mothers in Belgium at separation is around 44,³⁴ whereas the average age of the mothers in our sample was 29. The very young age of the infants is a factor that must be taken into account as well. As regards our results, caution should be exercised owing to the methods employed. The cross-sectional nature of our study results in uncertainty with regard to time: Theoretically, we do not know the direction of causality between the variables, and we have no idea of the length of time the infants were exposed to parental separation, nor whether their parents were separated or not when they were born. Only the implementation of longitudinal studies with sufficiently large sample sizes of children followed up since conception could provide us with insights about the mechanisms underlying our study results. One of the strong points of our study is the size of the sample, which was nearly 80 000 participants (20% of the population of that age in the French Community).³⁵ We noted some dissimilarities in comparison with the general population. For instance, we found a difference between the sexes that was 1.4% lower than that normally observed for this age group (1.2% vs 2.6% at 1 year of age).³⁶ Similarly, very small birth weights (≤ 1999 g), when taken together, represented 1.9% in this

study, as compared with 2.3% on a national level.³⁷ A possible explanation is that boys and infants with a very low birth weight have higher morbidity, and it may be that they are more often followed up in a specialised medical setting than in preventive consultation at the ONE. We cannot exclude the possibility that the socioeconomic circumstances mentioned may also explain these differences. Indeed, in our sample, nearly 32% of the women held a higher education level, as against 25% generally in Belgium.³⁸ However, all the general population levels were represented in our sample size (though to different extent), which must be stressed, as our study aimed to draw comparisons between exposed (parents separated) and non-exposed participants (parents living together). The observation that our studied population appeared to be better off than the general population reinforces our hypothesis that there appears a link between family structure (parents living together or not) and parental behaviour that is independent of social status. We can therefore defend the concept that this bias reinforces our conclusions. Although our study results were adjusted for several essential socioeconomic indicators, it is worth noting that we have omitted to include parameters pertaining to the father's situation. This was purposely done in order to avoid losing too many observations. We have also omitted to include any variable concerning family income specifying the number and type of salaries per family, instead of income levels. In spite of these limitations, what also confirms our interpretation is that this study was undertaken in response to a 'clinical impression on the ground' of first-line doctors, which was later documented in a focus-group study¹⁰ in general practitioners and which is at the root of our current research topic. What is more, we have seen that the Western, and in particular European, literature has reported studies (including prospective studies) whose results support this idea of the negative impact of parental separation on the quality of the environment of infants. Two other salient points arising from this study were: (1) we focused on a specific age group that had scarcely been studied beforehand regarding the association between family structure and factors influencing health; (2) the full data were collected by paediatric healthcare professionals. We believe that these results are noteworthy, and for us this confirms the usefulness of conducting both research into other age groups and prospective studies.

Conclusions and implications for general practitioners

Our study confirms the need for primary and secondary preventive action that aims at the families of young children with regard to driving smoking out of homes, complying with vaccination schedules and obtaining optimal nutrition, and in particular for the poorest families, in which the adult members are less informed about their health and their children's health. In this regard, the proactivity of family doctors remains essential, because almost all the families in this country have an appointed family doctor whom 90% of adults and 70% of children see at

least once a year (four times a year on average). We also know that the more families experience socioeconomic difficulties, the more they go to see their doctor.³⁹ What these results reveal is that parental behaviours are significantly less adequate when parents are separated. Even though this study does not give any explanation about the reasons for these observations (parents and children chronically stressed? parental psychopathology? more restrictive schedules? relationship issues within blended families? etc), it makes us step back from the idea that the development of the children of separated parents is less than optimal only because of a financially more precarious environment. It seems worthwhile when dealing with families who have an infant or infants aged under 12 months to recommend that family doctors make it standard practice to enquire about family composition. In the event of parental separation and regardless of socioeconomic situation, the family doctor can then be even more attentive with regard to the infant's health (smoking in their environment, vaccinations, nutrition). Moreover, research could be started into whether there is a need to inform young couples who wish to start a family about the impact of the family environment on the infant's health—without lecturing or preconceptions on the doctor's part. Finally, in Belgium, it is already advised that every time family doctors have contact with a pregnant woman or a family with a young child or children they enquire about the quality of the partners' relationship.^{40 41} Our results confirm the validity of this approach, which makes it possible to support couples who are often in difficulty during pregnancy and in the months that follow childbirth. It can be presumed that if the recommendations proposed are properly understood—that is, applied in a kind and understanding manner and people are not stigmatised—then the benefits, however small, will in all cases outweigh the resulting risks. This merits investigation within the profession at any rate.

Contributors NK made the research question; contributed to the conception and design of the work; analyzed and interpreted the data; and wrote the article. MD-W contributed to the conception and design of the work, analysis and interpretation of data for the work; drafting the work and revising it critically for important intellectual content. MS contributed to the conception of the work. MR contributed to the conception and design of the work. MD-W, MS and MR approved the final version to be published; agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. MS and MR revised the work critically for important intellectual content.

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Competing interests Lead author and coauthors earn their living as clinicians and member of the academic staff of the Faculty of Medicine (Université Libre de Bruxelles).

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24 January 2012 under the following reference: P2012/026 (See attached document 'Kacelenenbogen *et al* Ethics approval of research.jpg' supplementary figure 1). The study data came from a database that was anonymised; the ethics committee deemed that it was impossible and not necessary to obtain the informed consent from participants or their representative.

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Data sharing statement Extra data can be accessed via the Dryad data repository at <http://datadryad.org/> with the doi: 10.5061/dryad.q71gs.

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