Evaluating regional differences in breast-feeding in French maternity units: a multi-level approach.

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Abstract

Objectives: To study how individual and regional characteristics might explain regional variations in breastfeeding rates in maternity units and to identify outlier regions with very low or high breastfeeding rates.

Design: Individual characteristics (mother and infant) were collected during hospital stay. All newborns fed entirely or partly on breast milk were considered breastfed. Regional characteristics were extracted from census data. Statistical analysis included multilevel models and estimation of empirical Bayes residuals to identify outlier regions.

Setting: all births in all administrative regions in France in 2003.

Subjects: a national representative sample of 13 186 live births.

Results: Breastfeeding rates in maternity units varied from 43% to 80% across regions. Differences in the distribution of individual characteristics accounted for 55% of these variations. We identified two groups of regions with the lowest and the highest breastfeeding rates, after adjusting for individual-level characteristics. In addition to maternal occupation and nationality, the social characteristics of regions, particularly the population's educational level and the percentage of non-French residents, were significantly associated with breastfeeding rates.

Conclusions: Social characteristics at both the individual and regional levels influence breastfeeding rates in maternity units. Promotion policies should be directed at specific regions, groups within the community, and categories of mothers, to reduce the gaps and increase the overall breastfeeding rate.

Introduction

Evidence on the short- and long-term beneficial effects of breastfeeding continue to increase [1 2] and exclusive breastfeeding is recommended for the first six months of life [3 4]. However, breastfeeding rates in maternity units vary strongly from country to country, and the level in France at the turn of this century was particularly low (63%)[5]. National rates mask important regional differences, as observed in the United Kingdom[6 7], Italy[8], the United States[9 10], Australia[11], and France[12 13].

Understanding these geographic variations is essential for several reasons. First, public health policies, including breastfeeding promotion policies, are conducted at the level of regions or states within countries[9 14]. Identification of geographic zones with particularly high or low breastfeeding rates could thus facilitate the orientation of these policies.

Secondly, analysis of regional differences may contribute to better knowledge of the determinants of breastfeeding. Many factors influence breastfeeding practice and interact at various levels. Besides factors at the individual level, the contextual factors that characterise women's environments also play an important role — factors such as family, social network, and community[15 16].

Nonetheless, we know relatively little about the respective roles of individual and contextual characteristics in breastfeeding and how these characteristics interact at different levels. To our knowledge, few studies have examined geographic variations of breastfeeding rates within countries, after adjusting for individual factors[9 17]. Moreover, studies that have assessed the role of contextual characteristics analysed them at the individual (e.g., for newborns) instead of group level (e.g., geographic areas)[9 18 19].

Among the entire set of factors that influence breastfeeding practices, social and cultural factors occupy a particularly important place. In high income countries, breastfeeding is more common among women of higher social class, among immigrants[6 15 20], and metropolitan residents[9 18]. Moreover, the decision to breastfeed depends on the attitude of family and friends and on the general opinion of the population about breastfeeding. Public beliefs about breastfeeding vary according to the general population's economic and culture level[21 22]. It is therefore important to know the extent to which the social characteristics of women and of the general population may explain some regional differences in breastfeeding.

Our objective was to investigate how regional variations in breastfeeding in maternity units might be explained by differences in the distribution of individual maternal characteristics between regions, and whether regional social characteristics were associated with breastfeeding, independently of individual-level factors. We also used empirical Bayes residuals to identify regions with extremely high or low breastfeeding rates, after adjustment for individual-level characteristics. This analysis, which used multilevel models[23], was conducted with data from a national representative sample of births in France in 2003.

Materials and methods

Data

Individual-level data were obtained from the most recent French National Perinatal Survey conducted in 2003. The survey's design has been described in detail elsewhere[13]. It included all births in all administrative regions at or after 22 weeks of gestation or of newborns weighing at least 500 grams, during a one-week period. Two sources of information were used: 1- medical records, to obtain data on delivery and the infant's condition at birth and, 2- face-to-face interviews of women after childbirth, to obtain data about social and demographic characteristics and breastfeeding. Around 50% of mothers were interviewed within 48 hours of the birth and 38% on the third or fourth postpartum day. The information regarding infant feeding refers to the feeding method (only breast-fed, breast-fed and bottle-fed, or only bottle-fed) reported by the mother at the interview.

The final study population consisted of 13 186 infants, after exclusion of infants born in French overseas districts (n=636), infants transferred to another ward or hospital (n=975), infants whose mother was hospitalized in an intensive care unit for more than 24 hours (n=26), and those with an unknown feeding status (n=393).

Regional-level data came from census data from 1999 and 2003. We distinguished 24 regions: 21 administrative regions and a further subdivision of Ile-de-France: Paris, Petite Couronne (Paris inner suburbs) and Grande Couronne (Paris outer suburbs).

Outcome and predictor variables

We analysed breastfeeding as a binary variable, considering that newborns were breastfed if they were fed entirely or partly breast milk at the time of interview.

At the individual level, we included variables identified in a previous analysis as related to breastfeeding in our population[20]. Social and demographic variables included maternal age, parity, nationality, maternal occupation (current or last occupation), and partnership status (marital status/living with a partner). Other variables were included in the models as potential confounders: mode of delivery, characteristics of the infants (gestational age, birth weight, and multiple birth), status of maternity units (university, other public, private hospital) and size (number of births per year).

Social context at the regional level was characterized by four indicators: the percentage of urban population (percentage of population in communes that include an area of at least 2000 inhabitants with no building further than 200 m away from its nearest neighbour), the percentage of residents with a university educational level (percentage of residents aged 15 years old or older with at least a three-year university degree), the average annual salary per employee (in euros), and the percentage of non-French residents.

Statistical analysis

We estimated breastfeeding rates by region with corresponding 95% binomial exact confidence intervals. We used a two-level hierarchical logistic regression model[23] with infants (level-1) nested within regions (level-2). First, we estimated a random-intercept model, without any predictor variables (model 1, "empty model") to obtain the baseline regional-level variance ($\tau_{00}^{(1)}$). In a second model (model 2), we included variables characterizing mothers, infants and maternity units. Model 2 allowed us to estimate the residual regional variation after adjustment for individual-level variables ($\tau_{00}^{(2)}$). We used the proportional change in the variance (PCV), defined as PCV= ($\tau_{00}^{(1)}$ - $\tau_{00}^{(2)}$ / $\tau_{00}^{(1)}$) x 100, to assess the extent to which regional differences may be explained by the compositional factors (i.e., possible differences in the distribution of individual-level characteristics) of the regions.

Next, we investigated whether regional variables were associated with breastfeeding independently of individual-level factors. We included regional-level variables in four separate models (model 3a to 3d), after adjustment for individual-level variables: percentage of urban population (model 3a), percentage of residents with a university educational level (model 3b), average annual salary (model 3c), and percentage of non-French residents (model 3d). Additional analysis allowed us to investigate the effect of the regional characteristics most strongly associated with breastfeeding when put together in the same model (model 4). Cut-off points for regional variables were

established at the 50th percentile and the reference category for each variable was equal or inferior to the 50th percentile of the distribution of each variable. Analyses using quartiles showed comparable results.

We also examined whether the effects of certain individual-level social characteristics differed across regions. We did so by estimating random-coefficient (random-intercept and random-slope) models to assess whether associations between breastfeeding and maternal nationality and occupation varied from one region to another. In addition, we tested whether the association between breastfeeding and maternal occupation varied according to the educational level of the population in each regions, and whether the association between breastfeeding and maternal nationality varied according to the percentage of non-French population in each region, by examining cross-level interactions.

Finally, we analyzed regional differences in breastfeeding using empirical Bayes residuals, in order to identify outlier regions (those with unusually high or low breastfeeding rates). Empirical Bayes residuals are defined by the deviation of the empirical Bayes estimates of a randomly varying level-1 (individual level) coefficient from its predicted value based on the level-2 (regional level) model[20]. We computed empirical Bayes residuals based on a random-intercept model that included only individual-level variables. Hence, these residuals reflect differences across regions after adjustment for individual-level characteristics. Computation of the residuals for each region took into account the number of infants in the region. As a result, the fewer the number of infants in a region, the more the value of the regional residual shrinks towards the average breastfeeding rate across regions. This is done so that small regions do not appear as outliers due purely to chance. We compared ranking of regions for all breast-fed infants (only breast-fed and breast and bottle-fed only breast-fed and for) and also for infants only breast-fed.

Descriptive analysis was performed using STATA 9 software (StataCorp LP, College Station, TX, USA). Multilevel analysis was performed using Hierarchical Linear and Nonlinear Modeling (HLM version 6) software (Scientific Software International, Inc., Lincolnwood, IL, USA).

Results

Figure 1 shows breastfeeding rates across regions in France. They were higher in Ile de France, Rhône-Alpes, Provence-Alpes-Côte d'Azur, and Alsace (from 67% to 80%) and lower in Auvergne, Pays-de-la-Loire, and Picardie (from 42% to 51%).

Breastfeeding rates also varied according to regional characteristics (Table 1). They were higher in regions with a high percentage of urban population, of residents with a university educational level, and of non-French residents, and in regions with a high average salary.

Variations in breastfeeding rates across regions were statistically significant (model 1), with a baseline regional variance of $\tau_{00}^{(1)}$= 0.147 (p<.0001) (Table 2). The inclusion of individual-level variables (model 2) decreased the variance in breastfeeding rates across regions but residual differences remained statistically significant ($\tau_{00}^{(2)}$= 0.066; p<.0001). The PCV was 55% (PCV= (0.147-0.066/0.147)x100= 55%). Hence, about half of the regional variations in breastfeeding could be explained by differences in the distributions of individual-level variables across regions. High breastfeeding rates were found mainly among women who were primiparous, non-French, and from higher status occupational groups. The measured characteristics of the infants and the maternity units in our study also had little effect on breastfeeding practice and on regional variations (data available on request)

Next, we introduced one regional variable at a time into four different models (model 3a to 3d) (Table 2). After taking into account individual-level variables, including maternal education and nationality, regions with a high percentage of urban population, of people with university education, or of non-French residents still had higher breastfeeding rates. The association between breastfeeding and average salary was not significant.

Residual regional variance for model 2 (which included individual-level variables only) slightly reduced with the introduction of the percentage of urban population ($\tau_{00}^{(3a)}$= 0.050). Variance for model 2 was further reduced by 50% with the addition of regional educational level ($\tau_{00}^{(3b)}$= 0.031) or the percentage of non-French population ($\tau_{00}^{(3d)}$= 0.034) (i.e., PCV= (0.066-0.031/0.066)x100= 53%). Hence, individual and regional variables (educational level or percentage of non-French population) together accounted for 79% of the regional variations in breastfeeding (i.e., PCV= (0.147-0.031/0.147)x100= 79%).

We used random-coefficient models to examine whether the effects of certain individual-level social variables differed across regions. Results from these models did not show significant regional differences in the effects associated with maternal occupation or nationality. In addition, we did not find significant interactions between the effects of factors at the regional and individual levels: maternal occupation and regional educational level ($p \geq 0.2$ for almost all occupational groups) and maternal nationality and regional non-French population ($p = 0.08$).

Next, we included in the same model (model 4) the two regional variables most strongly associated with breastfeeding — percentage of residents with a university educational level and percentage of non-French population. Both variables remained significantly associated with breastfeeding. Moreover, results from model 4 showed that together individual and regional variables accounted for 90% of the regional variations in breastfeeding (i.e., PCV= (0.147-0.015/0.147)x100= 90%).

Finally, empirical Bayes residuals were used to rank regions according to their breastfeeding rates, after taking into account individual-level characteristics (Figure 2). Formally, the empirical Bayes residuals represent regional differences in the adjusted log-odds of breastfeeding in maternity units after taking into account individual-level characteristics in different regions. Therefore these residuals reflect indirectly adjusted regional differences in breastfeeding rates. We identified a group of regions with the lowest (Picardie, Pays-de-la-Loire, Auvergne and Nord-Pas-de-Calais) and another with the highest breastfeeding rates (Provence-Alpes-Côte d'Azur, Paris, Petite Couronne and Rhône-Alpes). In general, confidence intervals for the empirical Bayes residuals were relatively wide. However, those for regions with the lowest breastfeeding rates did not overlap with those with the highest breastfeeding rates. In a model comparing infants only breast-fed and infants only bottle-fed, ranking of regions for only breast-fed infants did not differ from ranking of regions for all breast-fed infants.

Discussion

Breastfeeding rates varied widely between regions and about half of the regional variations could be explained by differences in the distribution of maternal characteristics across regions. Estimates of empirical Bayes residuals in multilevel models suggested that there were regions with high breastfeeding rates and regions with low breastfeeding rates, independent of individual-level characteristics. In addition, at the regional level, a high percentage of urban population, of people with university education or of non-French population had a positive effect on breastfeeding.

We chose to analyze the geographic differences in breastfeeding at the regional level for several reasons. Health policies in France are beginning to be implemented at the regional level, as stated in the French Public Health Code[24]. Following recommendations in the national nutrition program[14], since 2006, health professional networks and regional committees in charge of perinatal health are including breastfeeding promotion in their objectives. Regional breastfeeding workshops for health professionals are also organized. Analysis at the regional level is also important because regional social and demographic characteristics vary substantially across French regions[25]. Finally, national statistics, such as census data, are available at the regional level.

However, our analysis at regional level had some limitations. The small number of regions (n=24) in our sample limited the number of regional variables that could be introduced in the same model[26]. Moreover, we were not able to assess the impact of regional breastfeeding promotion policies because data about these policies are not available systematically. Other multilevel studies have shown that policies or legislation in favour of breastfeeding explained a part of the differences between states in the US[9] or between municipalities in Brazil[27]. Nonetheless in France, the effect of these policies in 2003 was probably slight, because programs promoting breastfeeding were introduced only in the early 2000's.

French National Perinatal surveys provide information about a limited number of indicators and are not designed to study specifically questions related to breastfeeding in detail. We were therefore unable to use the complete definitions of breastfeeding using the WHO criteria[28]. Furthermore, no information was collected about practices in maternity wards or breastfeeding duration. The effects of maternity unit practices within a given region are difficult to assess. However, only two out of 618 maternity units had received the Baby Friendly Hospital designation in France in 2003[29].

We identified regions with very high and very low breastfeeding rates using empirical Bayes residuals[23]. Identification of these regions can facilitate targeting policies to promote breastfeeding, particularly in regions with very low breastfeeding rates. They may also be helpful in identifying factors or programs that may favour breastfeeding in regions with high breastfeeding rates. The multilevel approach used in our analysis and in particular the use of empirical Bayes residuals is potentially applicable to a wide spectrum of evaluation studies, aimed at estimating the effects associated with groups (e.g., regions, neighbourhoods, hospitals, or wards). These residuals have distinct advantages because they take into account the hierarchical structure of data (group membership) and produce relatively stable estimates even when the sample sizes per group are modest[23].

Despite their advantages, empirical Bayes residuals have limitations as group-level indicators[23]. There is possible bias due to unmeasured individual-level confounders and/or model misspecifications. This is a general limitation of all multivariable regression models, including multilevel models and empirical Bayes residual estimations. Another important consideration relates to the potential problem of a statistical self-fulfilling prophecy. This can come about as the result of shrinkage of the estimates for empirical Bayes residuals towards the average value in the population for small groups (small regions). Hence, to the extent that data are unreliable for small groups, the group effects are made to conform more to expectations. Consequently, it becomes more difficult to identify small regions that represent outliers. This could be the case for Corse, the smallest region in our sample, which had the second lowest breastfeeding rate in our sample but was not identified as a low outlier region by the empirical Bayes residuals.

Our results showed a strong association between breastfeeding and maternal occupation and nationality. These associations were comparable to those identified in a previous analysis that did not take regional variations into account[20]. In addition, using random coefficients from multilevel models, we showed that associations between breastfeeding and maternal characteristics did not differ across regions or according to regional social context. These results suggest that maternal characteristics play an important and stable role in breastfeeding, independently of the context where the mothers live.

The high proportion of women with maternal characteristics most favourable to breastfeeding in the regions with high breastfeeding rates[13] explains nearly half the regional variations in breastfeeding in France. This is the case in Paris and in its immediate suburbs, where the many women with high-status jobs (e.g., managers, professionals, or technicians) or born in foreign countries appear to contribute to the very high breastfeeding rates in these regions compared to other French regions. In the United States, 25-30% of the variation in maternal breastfeeding between states also appears to be explained by maternal characteristics[9].

We observed that at the regional level both a highly educated population and a substantial foreign population have a positive influence on breastfeeding. Our results are consistent with those of a recent study in the US[30] that showed that women living in an area that is a high-risk environment for newborns (based on the indicators of the Right Start for America's Newborns program) were less likely to breastfeed. On the other hand, we found no relation between breastfeeding and mean income. In some studies that used only individual-level data, breastfeeding was found to increase with maternal education [10 17] or poverty level[10 18]. However, when the effects of education and

poverty level were assessed simultaneously, breastfeeding remained associated with maternal education but not with poverty level[18].

Our results at the regional level suggest that education and culture play a more important role than standard of living. The influence of the social and culture background on breastfeeding may be related to public knowledge of breastfeeding benefits, beliefs and attitudes, and breastfeeding practices in the general population[15 19 21 22 31 32]. For example, populations of foreign origin are very favourable to breastfeeding for cultural reasons[19]. Similarly, more highly educated people are more receptive to health messages and might be more supportive of health-related behaviour, including breastfeeding[21 22 31 32].

In this way, a high proportion of foreign residents may produce through different mechanisms an environment that is culturally supportive of breastfeeding, independent of the mother's nationality. Regions with a high proportion of foreigners today have long been regions with high immigration rates. The role of foreign cultures may remain strong in these regions, including for mothers born in France. That is, the preference for breastfeeding seems to continue from immigrant mothers to first and second-generation mothers[33]. In regions with a high foreign population, there may be many French women of the first or second generation — in families, among healthcare professionals, and in childbirth preparation or breastfeeding support groups — very favourable to breastfeeding. For example, in areas with high immigrant rate, the partners of native-born French women may more often be either foreign or from an immigrant family, and they may incite their partners to breastfeed more frequently[19].

The socio-cultural context may also have an important impact on health professional practices in maternity units[34] and explain regional disparities. It has been shown that health professionals' knowledge, experiences and beliefs influence attitudes and behaviours on breastfeeding support and promotion[35 36]. However, we do not know how health professionals' support in maternity units varied between regions at the time of the survey. In any case, maternity units are part of, and are influenced by the general socio-cultural context, which is an important determinant of breastfeeding promotion policies. For example, breastfeeding promotion practices could be more easily adopted in maternity units within regions with a highly educated population.

Regional variations in breastfeeding may also stem from the breastfeeding practices of the preceding generation. The regional differences in 2003 are very similar to those observed in 1972[12], with breastfeeding rates higher in the east and Ile-de-France (Paris and its suburbs) than in the west.

The literature shows that women who were themselves breastfed breastfeed more often[15]. Grandmothers transmit not only their own feeding practices and beliefs, but also their confidence that breastfeeding is the normal way to feed an infant if they had breastfed their own children[37]. Women who give birth in regions where there was a high breastfeeding rate in the past may therefore have received greater support for breastfeeding from their parents, family and friends.

Conclusion

Our study shows that a multilevel analysis including estimations of empirical Bayes residuals can identify regions with particularly high or low breastfeeding rates. This can in turn be helpful in targeting regional policies to promote breastfeeding, especially in regions with low breastfeeding rates. Our results suggest that strategies to be developed must also include, in all the regions, differentiated activities adapted to particular social groups, to improve the attitude of the general population towards breastfeeding, to help mothers in their feeding choices for their newborns and to support health professionals in and outside maternity units in implementing breastfeeding promotion activities. Breastfeeding promotion policies at these different levels might contribute both to decreasing individual and regional differences and to increasing national breastfeeding rates.

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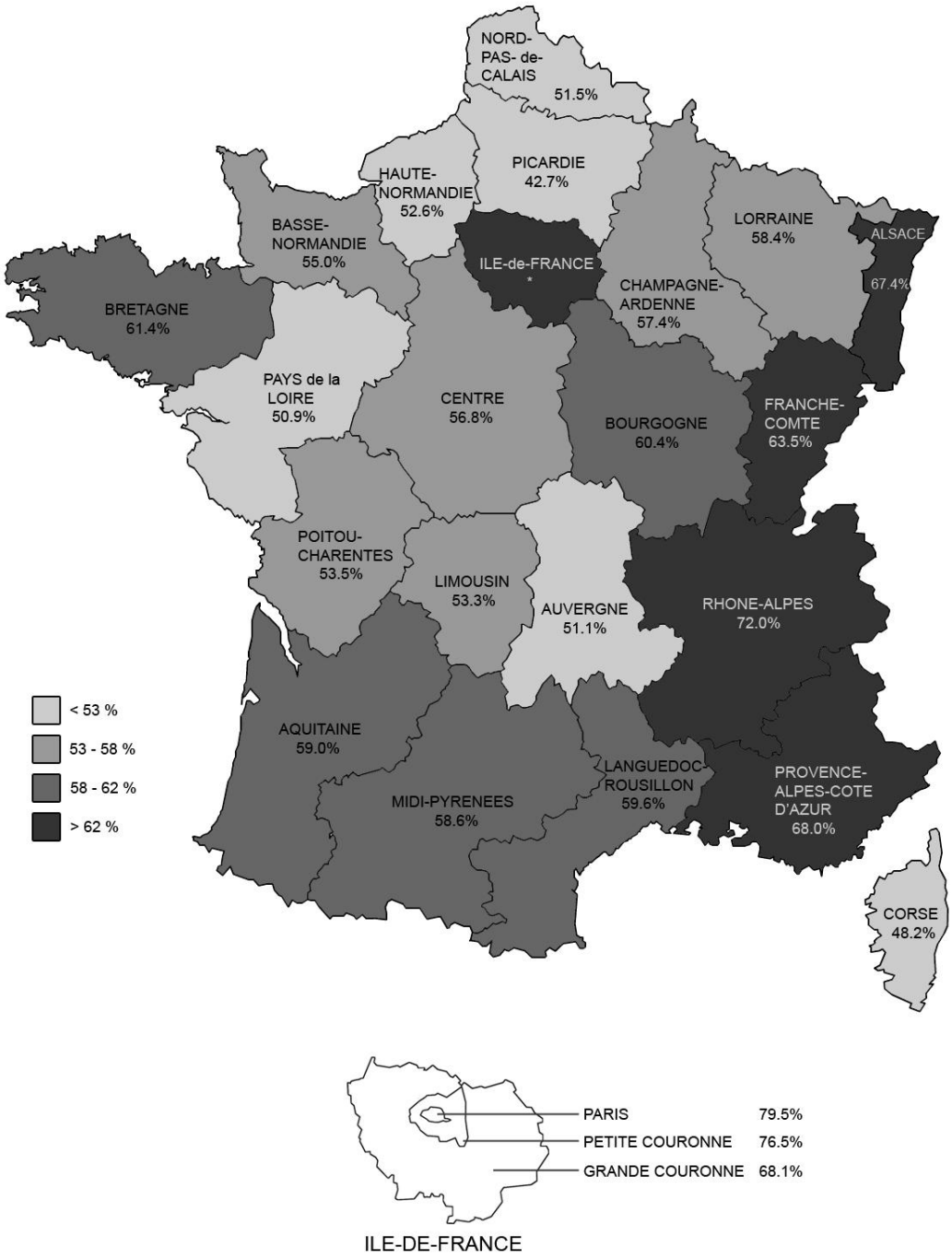
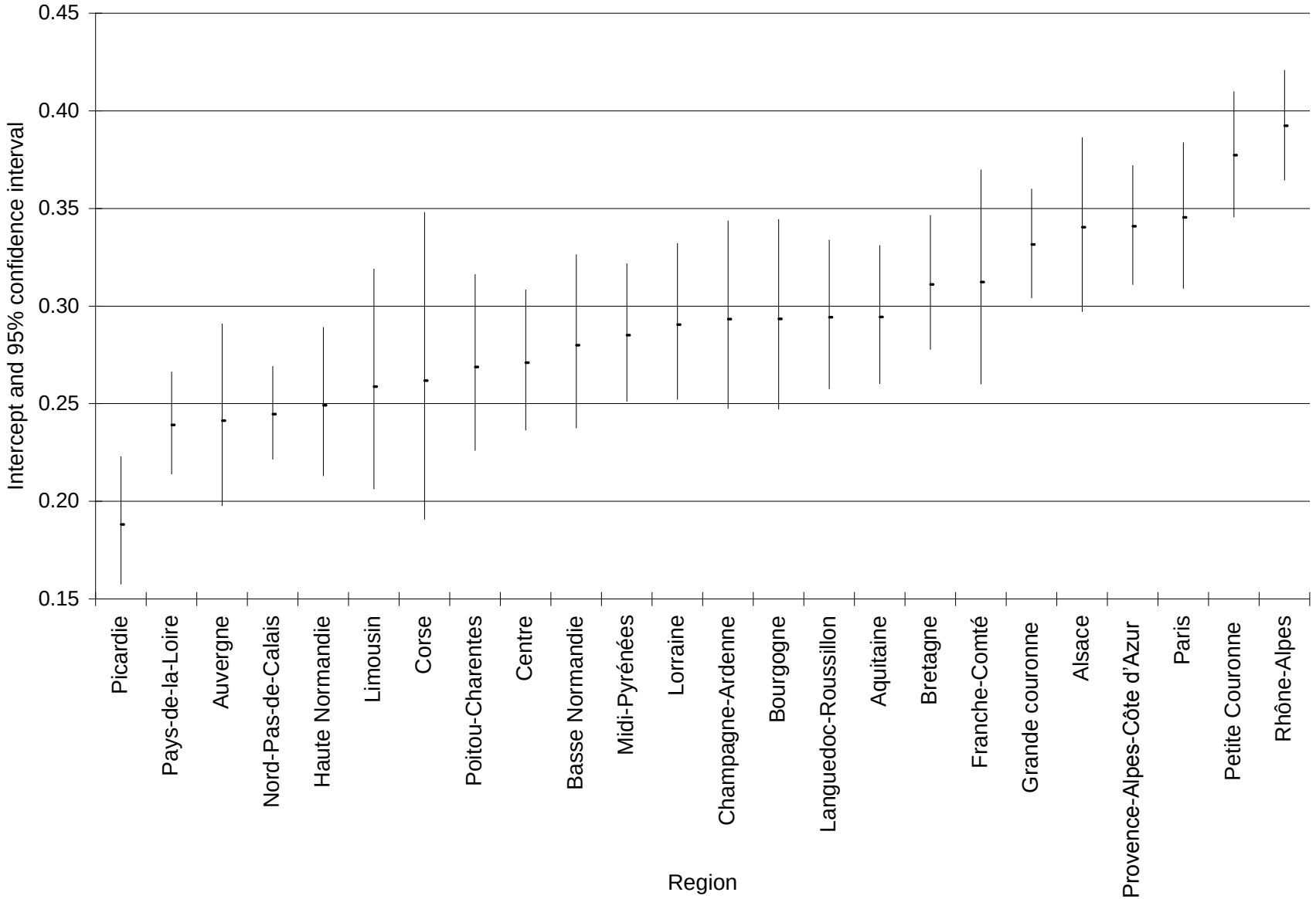


FIGURE 1 — Breastfeeding rates in maternity units in France in 2003 (n)
Alsace (399); Aquitaine (571); Auvergne (239); Basse Normandie (309); Bourgogne (278); Bretagne (624); Centre (488); Champagne-Ardenne (279); Corse (54); Franche-Comté (222); Haute Normandie (403); Ile-de- France : Petite Couronne(1145), Paris (781), Grand Couronne (1094); Languedoc Roussillon (478); Limousin (150); Lorraine (425); Midi-Pyrénées (539); Nord-Pas-de-Calais (995); Pays-de-la-Loire (802); Picardie (354); Poitou-Charentes (284); Provence-Alpes-Côte d'Azur (965); Rhône-Alpes (1308).

FIGURE 2 — Regional variations in breastfeeding in maternity units ***: Empirical Bayes residuals**



*adjusted for individual-level variables (see model 2)

TABLE 1 — Breastfeeding rates in maternity units according to regional characteristics

Regional characteristics (quartiles)*	% breastfeeding†
Percentage of urban population	
<58.6	54.0
58.6-66.2	56.5
66.3-75.1	63.0
≥75.2	67.6
Percentage of residents with a university educational level	
<13.6	53.1
13.6-14.6	53.1
14.6-17.9	61.4
≥18	71.2
Average annual salary in euros	
<14 926	57.2
14 926-15 405	59.8
15 406-15 995	55.6
≥15 996	70.9
Percentage of non-French residents	
<3.1	54.6
3.1-3.9	53.7
4.0-6.4	62.2
≥6.5	72.7

***Quartiles refer to the distribution of regional variables; †p<.0001 for all variables.

TABLE 2 — Breastfeeding in maternity units in 2003 according to maternal and regional characteristics: results of the multilevel analysis

	Model 1 ("empty model")	Model 2 * (individual-level variables)		Model 3 *,† (individual and regional-level variables)		p cross–level interaction	Model 4 *,‡ (individual and regional-level variables)	
		aOR	95%CI	aOR	95%CI		aOR	95%CI
Fixed effects								
Maternal age								
<25 years		1.0		1.0			1.0	
25-34		1.1	1.0-1.3	1.1	1.0-1.3		1.1	1.0-1.3
≥ 35		1.1	1.0-1.3	1.1	1.0-1.3		1.1	1.0-1.3
Parity								
1		1.8	1.6-1.9	1.8	1.6-1.9		1.8	1.6-1.9
2-3		1.0		1.0			1.0	
≥4		1.2	1.0-1.4	1.2	1.0-1.4		1.2	1.0-1.4
Nationality								
French		1.0		1.0			1.0	
Other		4.6	3.9-5.5	4.6	3.8-5.4	0.08	4.5	3.8-5.4
Partnership status								
Married		1.2	1.0-1.4	1.2	1.0-1.4		1.2	1.0-1.4
Cohabitation		1.0	0.8-1.2	1.0	0.8-1.2		1.0	0.8-1.2
Single		1.0		1.0			1.0	
Maternal occupation								
Professional		3.8	3.1-4.7	3.8	3.1-4.7	0.2	3.8	3.1-4.7
Intermediate		2.8	2.4-3.4	2.8	2.4-3.4	0.03	2.8	2.4-3.4
Administrative, public service		1.7	1.5-2.0	1.7	1.5-2.0	0.2	1.7	1.5-2.0
Shopkeeper, shop assistant		1.3	1.1-1.5	1.3	1.1-1.5	>.5	1.2	1.1-1.5
Farmers, small business owners		1.2	0.9-1.6	1.2	0.9-1.6	0.3	1.2	0.9-1.6
Service worker		1.2	1.0-1.5	1.2	1.0-1.5	0.4	1.2	1.0-1.5
Manual worker		1.0		1.0			1.0	
None		1.3	1.1-1.5	1.3	1.1-1.5	>.5	1.3	1.1-1.5
Regional characteristics (model)§								
Percentage of urban population (3a)				1.3	1.1-1.6			
Percentage of residents with a university educational level (3b)				1.5	1.2-1.7		1.3	1.1-1.6
Average annual salary in euros (3c)				1.1	0.9-1.4			
Percentage of non-French residents (3d)				1.4	1.2-1.7		1.2	1.1-1.5
Random effects								
Variance between regions‖	$T_{00}^{(1)}$=0.147	$T_{00}^{(2)}$=0.066		$T_{00}^{(3a)}$=0.050; $T_{00}^{(3b)}$=0.031 $T_{00}^{(3c)}$=0.067; $T_{00}^{(3d)}$=0.034			$T_{00}^{(4)}$=0.015	
Proportional change in the variance % ¶	Ref.	55		3a=66; 3b=79 3c=54; 3d=78			90	

*Models 2 to 4 were adjusted for all individual-level variables in table and mode of delivery, gestational age, birth weight, multiple birth size and status of the maternity unit; †included regional variables in 4 different models (models 3a to 3d); ‡included regional variables at the same time in the model; §regional variables were cutoff at 50th percentile. Reference group ≤ 50th percentile; ‖p<.0001; ¶PCV= ($T_{00}^{(1)}$ - $T_{00}^{(2)}$ / $T_{00}^{(1)}$) x 100.