

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

Mercedes Bonet, Béatrice Blondel, Babak Khoshnood

► **To cite this version:**

Mercedes Bonet, Béatrice Blondel, Babak Khoshnood. Evaluating regional differences in breast-feeding in French maternity units: a multi-level approach.: Regional differences in breastfeeding. Public Health Nutrition, Cambridge University Press (CUP), 2010, 13 (12), pp.1946-54. <10.1017/S136898001000159X>. <inserm-00585112>

HAL Id: inserm-00585112

<http://www.hal.inserm.fr/inserm-00585112>

Submitted on 11 Apr 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

1 **Evaluating regional differences in breastfeeding in French maternity units: a multilevel**
2 **approach**

3
4 Mercedes Bonet ¹, Béatrice Blondel ¹, Babak Khoshnood ¹

5 1) INSERM, UMR S953, U953- Epidemiological Research Unit on Perinatal Health and
6 Women's and Children's Health, Paris; UPMC Univ Paris 06, Paris, France.

7
8
9
10 Corresponding author: M. Bonet, INSERM-U953, 16 Avenue Paul Vaillant-Couturier, 94807
11 Villejuif Cedex, France. Tel +33 1 45 59 50 04. Fax: +33 1 45 59 50 89. E-mail:
12 mercedes.bonet-semenas@inserm.fr

13
14 Short title: Regional differences in breastfeeding

15 Key words: Breastfeeding, Regional variations, Social inequalities, Multilevel models

33 **Abstract**

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

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

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

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

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

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

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68 **Introduction**

69 Evidence on the short- and long-term beneficial effects of breastfeeding continue to increase^{1 2} and
70 exclusive breastfeeding is recommended for the first six months of life^{3 4}. However, breastfeeding
71 rates in maternity units vary strongly from country to country, and the level in France at the turn of
72 this century was particularly low (63%)⁵. National rates mask important regional differences, as
73 observed in the United Kingdom^{6 7}, Italy⁸, the United States^{9 10}, Australia¹¹, and France^{12 13}.

74
75 Understanding these geographic variations is essential for several reasons. First, public health
76 policies, including breastfeeding promotion policies, are conducted at the level of regions or states
77 within countries^{9 14}. Identification of geographic zones with particularly high or low breastfeeding
78 rates could thus facilitate the orientation of these policies.

79
80 Secondly, analysis of regional differences may contribute to better knowledge of the determinants
81 of breastfeeding. Many factors influence breastfeeding practice and interact at various levels.
82 Besides factors at the individual level, the contextual factors that characterise women's
83 environments also play an important role — factors such as family, social network, and
84 community^{15 16}.

85
86 Nonetheless, we know relatively little about the respective roles of individual and contextual
87 characteristics in breastfeeding and how these characteristics interact at different levels. To our
88 knowledge, few studies have examined geographic variations of breastfeeding rates within
89 countries, after adjusting for individual factors^{9 17}. Moreover, studies that have assessed the role of
90 contextual characteristics analysed them at the individual (e.g., for newborns) instead of group level
91 (e.g., geographic areas)^{9 18 19}.

92
93 Among the entire set of factors that influence breastfeeding practices, social and cultural factors
94 occupy a particularly important place. In high income countries, breastfeeding is more common
95 among women of higher social class, among immigrants^{6 15 20}, and metropolitan residents^{9 18}.
96 Moreover, the decision to breastfeed depends on the attitude of family and friends and on the
97 general opinion of the population about breastfeeding. Public beliefs about breastfeeding vary
98 according to the general population's economic and culture level^{21 22}. It is therefore important to
99 know the extent to which the social characteristics of women and of the general population may
100 explain some regional differences in breastfeeding.

101

102 Our objective was to investigate how regional variations in breastfeeding in maternity units might
103 be explained by differences in the distribution of individual maternal characteristics between
104 regions, and whether regional social characteristics were associated with breastfeeding,
105 independently of individual-level factors. We also used empirical Bayes residuals to identify
106 regions with extremely high or low breastfeeding rates, after adjustment for individual-level
107 characteristics. This analysis, which used multilevel models²³, was conducted with data from a
108 national representative sample of births in France in 2003.

109

110 **Materials and methods**

111

112 **Data**

113

114 Individual-level data were obtained from the most recent French National Perinatal Survey
115 conducted in 2003. The survey's design has been described in detail elsewhere¹³. It included all
116 births in all administrative regions at or after 22 weeks of gestation or of newborns weighing at least
117 500 grams, during a one-week period. Two sources of information were used: 1- medical records, to
118 obtain data on delivery and the infant's condition at birth and, 2- face-to-face interviews of women
119 after childbirth, to obtain data about social and demographic characteristics and breastfeeding.
120 Around 50% of mothers were interviewed within 48 hours of the birth and 38% on the third or
121 fourth postpartum day. The information regarding infant feeding refers to the feeding method (only
122 breast-fed, breast-fed and bottle-fed, or only bottle-fed) reported by the mother at the interview.

123

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

128

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

132

133 **Outcome and predictor variables**

134

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

137 At the individual level, we included variables identified in a previous analysis as related to
138 breastfeeding in our population²⁰. Social and demographic variables included maternal age, parity,
139 nationality, maternal occupation (current or last occupation), and partnership status (marital
140 status/living with a partner). Other variables were included in the models as potential confounders:
141 mode of delivery, characteristics of the infants (gestational age, birth weight, and multiple birth),
142 status of maternity units (university, other public, private hospital) and size (number of births per
143 year).

144

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

151

152 **Statistical analysis**

153

154 We estimated breastfeeding rates by region with corresponding 95% binomial exact confidence
155 intervals. We used a two-level hierarchical logistic regression model²³ with infants (level-1) nested
156 within regions (level-2). First, we estimated a random-intercept model, without any predictor
157 variables (model 1, “empty model”) to obtain the baseline regional-level variance ($\tau_{00}^{(1)}$). In a
158 second model (model 2), we included variables characterizing mothers, infants and maternity units.
159 Model 2 allowed us to estimate the residual regional variation after adjustment for individual-level
160 variables ($\tau_{00}^{(2)}$). We used the proportional change in the variance (PCV), defined as $PCV = (\tau_{00}^{(1)} -$
161 $\tau_{00}^{(2)} / \tau_{00}^{(1)}) \times 100$, to assess the extent to which regional differences may be explained by the
162 compositional factors (i.e., possible differences in the distribution of individual-level
163 characteristics) of the regions.

164

165 Next, we investigated whether regional variables were associated with breastfeeding independently
166 of individual-level factors. We included regional-level variables in four separate models (model 3a
167 to 3d), after adjustment for individual-level variables: percentage of urban population (model 3a),
168 percentage of residents with a university educational level (model 3b), average annual salary (model
169 3c), and percentage of non-French residents (model 3d). Additional analysis allowed us to
170 investigate the effect of the regional characteristics most strongly associated with breastfeeding
171 when put together in the same model (model 4). Cut-off points for regional variables were

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

175

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

184

185 Finally, we analyzed regional differences in breastfeeding using empirical Bayes residuals, in order
186 to identify outlier regions (those with unusually high or low breastfeeding rates). Empirical Bayes
187 residuals are defined by the deviation of the empirical Bayes estimates of a randomly varying level-
188 1 (individual level) coefficient from its predicted value based on the level-2 (regional level)
189 model⁽²⁰⁾. We computed empirical Bayes residuals based on a random-intercept model that included
190 only individual-level variables. Hence, these residuals reflect differences across regions after
191 adjustment for individual-level characteristics. Computation of the residuals for each region took
192 into account the number of infants in the region. As a result, the fewer the number of infants in a
193 region, the more the value of the regional residual shrinks towards the average breastfeeding rate
194 across regions. This is done so that small regions do not appear as outliers due purely to chance. We
195 compared ranking of regions for all breast-fed infants (only breast-fed and breast and bottle-fed
196 only breast-fed and for) and also for infants only breast-fed.

197

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

201

202

203

204

205

206

207 **Results**

208

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

212

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

216

217 Variations in breastfeeding rates across regions were statistically significant (model 1), with a
218 baseline regional variance of $\tau_{00}^{(1)} = 0.147$ ($p < .0001$) (Table 2). The inclusion of individual-level
219 variables (model 2) decreased the variance in breastfeeding rates across regions but residual
220 differences remained statistically significant ($\tau_{00}^{(2)} = 0.066$; $p < .0001$). The PCV was 55% ($PCV =$
221 $(0.147 - 0.066 / 0.147) \times 100 = 55\%$). Hence, about half of the regional variations in breastfeeding could
222 be explained by differences in the distributions of individual-level variables across regions. High
223 breastfeeding rates were found mainly among women who were primiparous, non-French, and from
224 higher status occupational groups. The measured characteristics of the infants and the maternity
225 units in our study also had little effect on breastfeeding practice and on regional variations (data
226 available on request)

227

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

233

234 Residual regional variance for model 2 (which included individual-level variables only) slightly
235 reduced with the introduction of the percentage of urban population ($\tau_{00}^{(3a)} = 0.050$). Variance for
236 model 2 was further reduced by 50% with the addition of regional educational level ($\tau_{00}^{(3b)} = 0.031$)
237 or the percentage of non-French population ($\tau_{00}^{(3d)} = 0.034$) (i.e., $PCV = (0.066 - 0.031 / 0.066) \times 100 =$
238 53%). Hence, individual and regional variables (educational level or percentage of non-French
239 population) together accounted for 79% of the regional variations in breastfeeding (i.e., $PCV =$
240 $(0.147 - 0.031 / 0.147) \times 100 = 79\%$).

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

247

248 Next, we included in the same model (model 4) the two regional variables most strongly associated
249 with breastfeeding — percentage of residents with a university educational level and percentage of
250 non-French population. Both variables remained significantly associated with breastfeeding.
251 Moreover, results from model 4 showed that together individual and regional variables accounted
252 for 90% of the regional variations in breastfeeding (i.e., $PCV = (0.147 - 0.015 / 0.147) \times 100 = 90\%$).

253

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

266

267 **Discussion**

268

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

275

276 We chose to analyze the geographic differences in breastfeeding at the regional level for several
277 reasons. Health policies in France are beginning to be implemented at the regional level, as stated in
278 the French Public Health Code²⁴. Following recommendations in the national nutrition program¹⁴,
279 since 2006, health professional networks and regional committees in charge of perinatal health are
280 including breastfeeding promotion in their objectives. Regional breastfeeding workshops for health
281 professionals are also organized. Analysis at the regional level is also important because regional
282 social and demographic characteristics vary substantially across French regions²⁵. Finally, national
283 statistics, such as census data, are available at the regional level.

284

285 However, our analysis at regional level had some limitations. The small number of regions (n=24)
286 in our sample limited the number of regional variables that could be introduced in the same
287 model²⁶. Moreover, we were not able to assess the impact of regional breastfeeding promotion
288 policies because data about these policies are not available systematically. Other multilevel studies
289 have shown that policies or legislation in favour of breastfeeding explained a part of the differences
290 between states in the US⁹ or between municipalities in Brazil²⁷. Nonetheless in France, the effect of
291 these policies in 2003 was probably slight, because programs promoting breastfeeding were
292 introduced only in the early 2000's.

293

294 French National Perinatal surveys provide information about a limited number of indicators and are
295 not designed to study specifically questions related to breastfeeding in detail. We were therefore
296 unable to use the complete definitions of breastfeeding using the WHO criteria²⁸. Furthermore, no
297 information was collected about practices in maternity wards or breastfeeding duration. The effects
298 of maternity unit practices within a given region are difficult to assess. However, only two out of
299 618 maternity units had received the Baby Friendly Hospital designation in France in 2003²⁹.

300

301 We identified regions with very high and very low breastfeeding rates using empirical Bayes
302 residuals²³. Identification of these regions can facilitate targeting policies to promote breastfeeding,
303 particularly in regions with very low breastfeeding rates. They may also be helpful in identifying
304 factors or programs that may favour breastfeeding in regions with high breastfeeding rates. The
305 multilevel approach used in our analysis and in particular the use of empirical Bayes residuals is
306 potentially applicable to a wide spectrum of evaluation studies, aimed at estimating the effects
307 associated with groups (e.g., regions, neighbourhoods, hospitals, or wards). These residuals have
308 distinct advantages because they take into account the hierarchical structure of data (group
309 membership) and produce relatively stable estimates even when the sample sizes per group are
310 modest²³.

311 Despite their advantages, empirical Bayes residuals have limitations as group-level indicators²³.
312 There is possible bias due to unmeasured individual-level confounders and/or model
313 misspecifications. This is a general limitation of all multivariable regression models, including
314 multilevel models and empirical Bayes residual estimations. Another important consideration
315 relates to the potential problem of a statistical self-fulfilling prophecy. This can come about as the
316 result of shrinkage of the estimates for empirical Bayes residuals towards the average value in the
317 population for small groups (small regions). Hence, to the extent that data are unreliable for small
318 groups, the group effects are made to conform more to expectations. Consequently, it becomes
319 more difficult to identify small regions that represent outliers. This could be the case for Corse, the
320 smallest region in our sample, which had the second lowest breastfeeding rate in our sample but
321 was not identified as a low outlier region by the empirical Bayes residuals.

322

323 Our results showed a strong association between breastfeeding and maternal occupation and
324 nationality. These associations were comparable to those identified in a previous analysis that did
325 not take regional variations into account²⁰. In addition, using random coefficients from multilevel
326 models, we showed that associations between breastfeeding and maternal characteristics did not
327 differ across regions or according to regional social context. These results suggest that maternal
328 characteristics play an important and stable role in breastfeeding, independently of the context
329 where the mothers live.

330

331 The high proportion of women with maternal characteristics most favourable to breastfeeding in the
332 regions with high breastfeeding rates¹³ explains nearly half the regional variations in breastfeeding
333 in France. This is the case in Paris and in its immediate suburbs, where the many women with high-
334 status jobs (e.g., managers, professionals, or technicians) or born in foreign countries appear to
335 contribute to the very high breastfeeding rates in these regions compared to other French regions. In
336 the United States, 25-30% of the variation in maternal breastfeeding between states also appears to
337 be explained by maternal characteristics⁹.

338

339 We observed that at the regional level both a highly educated population and a substantial foreign
340 population have a positive influence on breastfeeding. Our results are consistent with those of a
341 recent study in the US³⁰ that showed that women living in an area that is a high-risk environment
342 for newborns (based on the indicators of the Right Start for America's Newborns program) were
343 less likely to breastfeed. On the other hand, we found no relation between breastfeeding and mean
344 income. In some studies that used only individual-level data, breastfeeding was found to increase
345 with maternal education^{10 17} or poverty level^{10 18}. However, when the effects of education and

346 poverty level were assessed simultaneously, breastfeeding remained associated with maternal
347 education but not with poverty level¹⁸.

348

349 Our results at the regional level suggest that education and culture play a more important role than
350 standard of living. The influence of the social and culture background on breastfeeding may be
351 related to public knowledge of breastfeeding benefits, beliefs and attitudes, and breastfeeding
352 practices in the general population^{15 19 21 22 31 32}. For example, populations of foreign origin are very
353 favourable to breastfeeding for cultural reasons¹⁹. Similarly, more highly educated people are more
354 receptive to health messages and might be more supportive of health-related behaviour, including
355 breastfeeding^{21 22 31 32}.

356

357 In this way, a high proportion of foreign residents may produce through different mechanisms an
358 environment that is culturally supportive of breastfeeding, independent of the mother's nationality.
359 Regions with a high proportion of foreigners today have long been regions with high immigration
360 rates. The role of foreign cultures may remain strong in these regions, including for mothers born in
361 France. That is, the preference for breastfeeding seems to continue from immigrant mothers to first
362 and second-generation mothers³³. In regions with a high foreign population, there may be many
363 French women of the first or second generation — in families, among healthcare professionals, and
364 in childbirth preparation or breastfeeding support groups — very favourable to breastfeeding. For
365 example, in areas with high immigrant rate, the partners of native-born French women may more
366 often be either foreign or from an immigrant family, and they may incite their partners to breastfeed
367 more frequently¹⁹.

368

369 The socio-cultural context may also have an important impact on health professional practices in
370 maternity units³⁴ and explain regional disparities. It has been shown that health professionals'
371 knowledge, experiences and beliefs influence attitudes and behaviours on breastfeeding support and
372 promotion^{35 36}. However, we do not know how health professionals' support in maternity units
373 varied between regions at the time of the survey. In any case, maternity units are part of, and are
374 influenced by the general socio-cultural context, which is an important determinant of breastfeeding
375 promotion policies. For example, breastfeeding promotion practices could be more easily adopted in
376 maternity units within regions with a highly educated population.

377

378 Regional variations in breastfeeding may also stem from the breastfeeding practices of the
379 preceding generation. The regional differences in 2003 are very similar to those observed in 1972¹²,
380 with breastfeeding rates higher in the east and Ile-de-France (Paris and its suburbs) than in the west.

381 The literature shows that women who were themselves breastfed breastfeed more often¹⁵.
382 Grandmothers transmit not only their own feeding practices and beliefs, but also their confidence
383 that breastfeeding is the normal way to feed an infant if they had breastfed their own children³⁷.
384 Women who give birth in regions where there was a high breastfeeding rate in the past may
385 therefore have received greater support for breastfeeding from their parents, family and friends.

386

387 **Conclusion**

388

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

398

399

400

401

402

403

404

405

406

407

408

409

410

411

412

413

414

415

417 **References**

- 418 1. Ip S, Chung M, Raman G, Chew P, Magula N, DeVine D, et al. Breastfeeding and Maternal and
 419 Infant Health Outcomes in Developed Countries. Evidence Report/Technology Assessment
 420 No. 153 (Prepared by Tufts-New England Medical Center Evidence-based Practice Center,
 421 under Contract No. 290-02-0022). Rockville, MD: Agency for Healthcare Research and
 422 Quality. , April 2007.
- 423 2. WHO. Evidence on the long-term effects of breastfeeding : systematic review and meta-analyses.
 424 Geneva:2007.
- 425 3. Infant and young child nutrition. 58° World health assembly. Resolution 58.32. Geneva:2005.
- 426 4. Agence Nationale d' Accréditation et d' Evaluation en Santé. [Breast feeding: implementation and
 427 continuation through the first six months of life. Recommendations (May 2002)]. *Gynecol*
 428 *Obstet Fertil* 2003;31(5):481-90.
- 429 5. Zeitlin J, Mohangoo A. EURO-PERISTAT Project with SCPE EUROCAT EURONEOSTAT.
 430 European Perinatal Health Report, 2008.
 431 <http://www.euoperistat.com/publications/european-perinatal-health-report.shtml> (accessed
 432 December 2008).
- 433 6. Hamlyn B, Brooker S, Oleinikova K, Wands S. *Infant Feeding 2000*. London, UK: The
 434 Stationery Office, 2002.
- 435 7. Bolling K, Grant C, Hamlyn B, Thornton A. Infant Feeding Survey 2005. London: The
 436 Information Centre Part of the Government Statistical Service 2007.
- 437 8. Giovannini M, Banderali G, Radaelli G, Carmine V, Riva E, Agostoni C. Monitoring
 438 breastfeeding rates in Italy: national surveys 1995 and 1999. *Acta Paediatr* 2003;92(3):357-
 439 63.
- 440 9. Singh GK, Kogan MD, Dee DL. Nativity/immigrant status, race/ethnicity, and socioeconomic
 441 determinants of breastfeeding initiation and duration in the United States, 2003. *Pediatrics*
 442 2007;119 Suppl 1:S38-46.
- 443 10. Li R, Darling N, Maurice E, Barker L, Grummer-Strawn LM. Breastfeeding rates in the United
 444 States by characteristics of the child, mother, or family: the 2002 National Immunization
 445 Survey. *Pediatrics* 2005;115(1):e31-7.
- 446 11. Donath S, Amir L. Rates of breastfeeding in Australia by State and socio-economic status:
 447 evidence from the 1995 National Health Survey. *J Paediatr Child Health* 2000;36(2):164-8.
- 448 12. Rumeau-Rouquette C, Crost M, Breart G, du Mazaubrun C. [Evolution of breast-feeding in
 449 France from 1972 to 1976 (author's transl)]. *Arch Fr Pediatr* 1980;37(5):331-5. [in French]
- 450 13. Blondel B, Supernant K, du Mazaubrun C, Bréart G. Enquête nationale périnatale 2003 :
 451 situation en 2003 et évolution depuis 1998. Paris, France, 2005.
 452 <http://www.sante.gouv.fr/htm/dossiers/perinat03/sommaire.htm>. (accessed December
 453 2008). [in French]
- 454 14. Hercberg S. Éléments de bilan du PNNS (2001-2005) et propositions de nouvelles stratégies
 455 pour le PNNS2 (2006-2008). Pour une grande mobilisation nationale de tous les acteurs
 456 pour la promotion de la nutrition en France. Paris: Ministère de la Santé et des Solidarités,
 457 2006:282. [in French]
- 458 15. Yngve A, Sjostrom M. Breastfeeding determinants and a suggested framework for action in
 459 Europe. *Public Health Nutr* 2001;4(2B):729-39.
- 460 16. Bentley ME, Dee DL, Jensen JL. Breastfeeding among low income, African-American women:
 461 power, beliefs and decision making. *J Nutr* 2003;133(1):305S-309S.
- 462 17. Ahluwalia IB, Morrow B, Hsia J, Grummer-Strawn LM. Who is breast-feeding? Recent trends
 463 from the pregnancy risk assessment and monitoring system. *J Pediatr* 2003;142(5):486-91.
- 464 18. Dubois L, Girard M. Social inequalities in infant feeding during the first year of life. The
 465 Longitudinal Study of Child Development in Quebec (LSCDQ 1998-2002). *Public Health*
 466 *Nutr* 2003;6(8):773-83.

- 467 19. Griffiths LJ, Tate AR, Dezateux C. The contribution of parental and community ethnicity to
468 breastfeeding practices: evidence from the Millennium Cohort Study. *Int J Epidemiol*
469 2005;34(6):1378-86.
- 470 20. Bonet M, Kaminski M, Blondel B. Differential trends in breastfeeding according to maternal
471 and hospital characteristics: results from the French National Perinatal Surveys. *Acta*
472 *Paediatr* 2007.
- 473 21. Li R, Ogden C, Ballew C, Gillespie C, Grummer-Strawn L. Prevalence of exclusive
474 breastfeeding among US infants: the Third National Health and Nutrition Examination
475 Survey (Phase II, 1991-1994). *Am J Public Health* 2002;92(7):1107-10.
- 476 22. Li R, Hsia J, Fridinger F, Hussain A, Benton-Davis S, Grummer-Strawn L. Public beliefs about
477 breastfeeding policies in various settings. *J Am Diet Assoc* 2004;104(7):1162-8.
- 478 23. Raudenbush SW, Bryk AS. *Hierarchical linear models : Applications and Data Analysis*
479 *Methods*. CA: Sage Publications, 2002.
- 480 24. JORF. Loi n°2004-806 du 9 août 2004 relative à la politique de santé publique. Journal Officiel
481 de la République Française, 2004;185: 14277
- 482 25. Institut National de la Statistique et des Études Économiques (Insee). *La France et ses régions,*
483 *édition 2002-2003*. Paris, France: INSEE, 2002.
- 484 26. Diez-Roux AV. Multilevel analysis in public health research. *Annu Rev Public Health*
485 2000;21:171-92.
- 486 27. Venancio SI, Monteiro CA. Individual and contextual determinants of exclusive breast-feeding
487 in Sao Paulo, Brazil: a multilevel analysis. *Public Health Nutr* 2006;9(1):40-6.
- 488 28. WHO. *Indicators for assessing infant and young child feeding practices. Part 1, Definitions.*
489 *Conclusions of a consensus meeting held 6-8 November 2007 in Washington, DC, USA,*
490 2008.
- 491 29. Cattaneo A, Yngve A, Koletzko B, Guzman LR. Protection, promotion and support of breast-
492 feeding in Europe: current situation. *Public Health Nutr* 2005;8(1):39-46.
- 493 30. Forste R, Hoffmann JP. Are US Mothers Meeting the Healthy People 2010 Breastfeeding
494 Targets for Initiation, Duration, and Exclusivity? The 2003 and 2004 National Immunization
495 Surveys. *J Hum Lact* 2008;24(3):278-88.
- 496 31. McIntyre E, Hiller JE, Turnbull D. Community attitudes to infant feeding. *Breastfeed Rev*
497 2001;9(3):27-33.
- 498 32. Humphreys AS, Thompson NJ, Miner KR. Intention to breastfeed in low-income pregnant
499 women: the role of social support and previous experience. *Birth* 1998;25(3):169-74.
- 500 33. Hawkins SS, Lamb K, Cole TJ, Law C. Influence of moving to the UK on maternal health
501 behaviours: prospective cohort study. *Bmj* 2008;336(7652):1052-5.
- 502 34. Hofvander Y. Breastfeeding and the Baby Friendly Hospitals Initiative (BFHI): organization,
503 response and outcome in Sweden and other countries. *Acta Paediatr* 2005;94(8):1012-6.
- 504 35. Furber CM, Thomson AM. Breaking the rules' in baby-feeding practice in the UK: deviance and
505 good practice? *Midwifery* 2006;22(4) 365-76.
- 506 36. Patton CB, Beaman M, Csar N, Lewinski C. Nurses' attitudes and behaviors that promote
507 breastfeeding. *J Hum Lact* 1996;12(2):111-5.
- 508 37. Grassley J, Eschiti V. Grandmother breastfeeding support: what do mothers need and want?
509 *Birth* 2008;35(4):329-35.
- 510
511

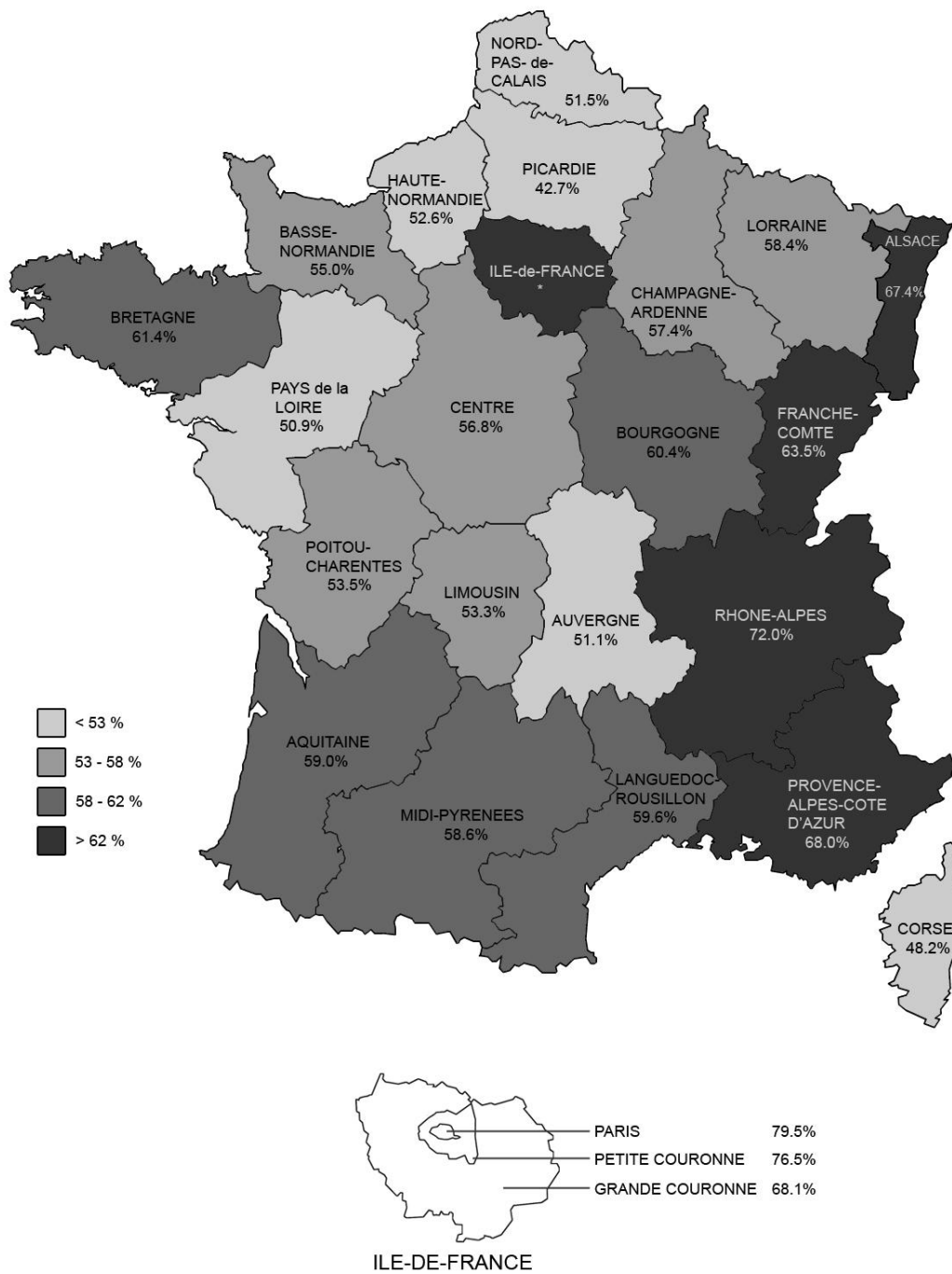
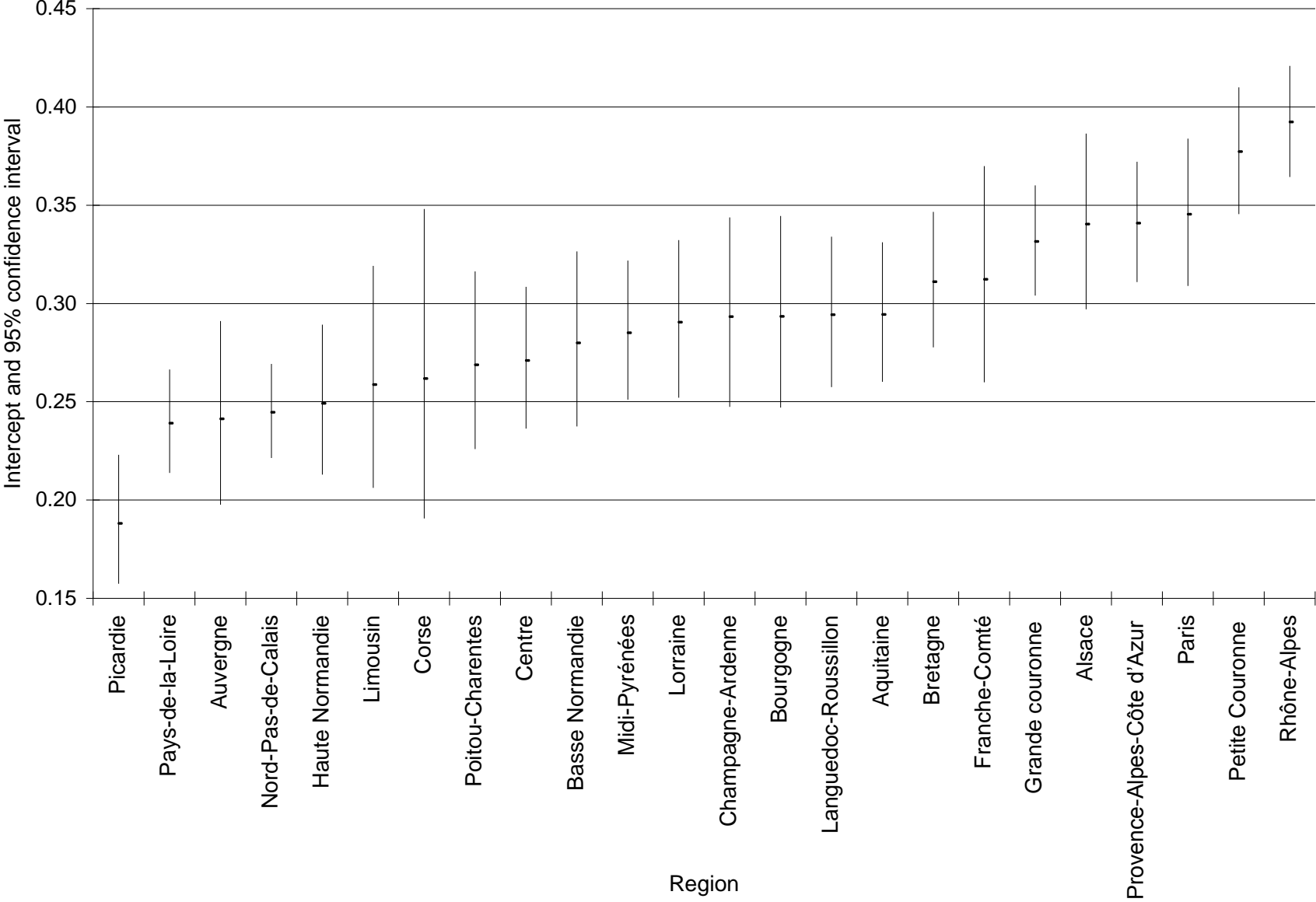


FIGURE 1 — Breastfeeding rates in maternity units in France in 2003 (n)

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= $(T_{00}^{(1)} - T_{00}^{(2)} / T_{00}^{(1)}) \times 100$.