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Where does distance matter? Distance to the closest maternity unit and risk of foetal and neonatal mortality in France

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Background: The number of maternity units has declined in France, raising concerns about the possible impact of increasing travel distances on perinatal health outcomes. We investigated impact of distance to closest maternity unit on perinatal mortality. **Methods:** Data from the French National Vital Statistics Registry were used to construct foetal and neonatal mortality rates over 2001–08 by distance from mother's municipality of residence and the closest municipality with a maternity unit. Data from French neonatal mortality certificates were used to compute neonatal death rates after out-of-hospital birth. Relative risks by distance were estimated, adjusting for individual and municipal-level characteristics. **Results:** Seven percent of births occurred to women residing at ≥ 30 km from a maternity unit and 1% at ≥ 45 km. Foetal and neonatal mortality rates were highest for women living at < 5 km from a maternity unit. For foetal mortality, rates increased at ≥ 45 km compared with 5–45 km. In adjusted models, long distance to a maternity unit had no impact on overall mortality but women living closer to a maternity unit had a higher risk of neonatal mortality. Neonatal deaths associated with out-of-hospital birth were rare but more frequent at longer distances. At the municipal-level, higher percentages of unemployment and foreign-born residents were associated with increased mortality. **Conclusion:** Overall mortality was not associated with living far from a maternity unit. Mortality was elevated in municipalities with social risk factors and located closest to a maternity unit, reflecting the location of maternity units in deprived areas with risk factors for poor outcome.

Introduction

The number of maternity units in France has declined steadily over the past 40 years.¹ Previously, we showed that this reduction in supply had on average no adverse effects on accessibility for most women in France, meaning no increased travel time to get to the maternity unit where they gave birth.² When faced with a reduction in the supply of maternity units, some women tended chiefly to choose proximity when deciding where to give birth.³ We also found that there is a small but growing number of women who live far from their closest maternity unit.² A separate study found that median travel times to the maternity unit where the birth had taken place remained constant over 2001–10 in France.⁴ But at the subnational scale, travel times had risen in certain rural, sparsely populated departments, while decreasing in others.

Distance to the closest maternity unit is an important consideration. Long effective or minimal distances to the closest maternity unit, may put both the mother and the child at higher risk of adverse health outcomes,^{5,6} including stillbirth and neonatal mortality.^{7,8} This also holds true in the case of accidental out-of-hospital births.^{9–12} In France, distance to the closest maternity unit was found to aggravate the risks of out-of-hospital birth.⁹ In the French rural region of Burgundy, increased travel times between 2000 and 2009 and adverse perinatal outcomes were positively associated: foetal heart rate abnormalities, meconium-stained amniotic fluid and out-of-hospital births.⁶

European countries have seen a decline in stillbirths, neonatal and infant mortality rates over the past 20 years, but the French situation has not improved since 2004.¹³ France was ranked 20th for infant mortality in 2009 when it had been 7th only 10 years earlier.¹⁴ In 2010, the infant mortality rate in France was 3.5 per 1000 live births, slightly lower than in England and Wales (3.8 per 1000) and Germany (3.7 per 1000), but higher than in Italy (3.4 per 1000) and Denmark (2.7 per 1000). France had the highest late stillbirth rate (28 weeks of gestational age), in Europe for 2010 at 4.3 per 1000.¹² Current research explores the separate and combined effects of social status and place of residence on perinatal health outcomes.^{7,14,15}

We investigate here the effect of the distance a woman must travel to give birth on stillbirth, neonatal mortality (deaths 0–28 days after birth) and neonatal mortality associated with out-of-hospital birth by measuring the impact of distance to the nearest maternity unit on mortality rates taking into account other individual and area-level socio-demographic risk factors.

Data and methods

Vital statistics registry data

We used the 2001–08 national data on births according to municipality of residence for mainland France. In 2010, there were 36 570 municipalities in mainland France. Annual statistics for births come

from birth certificates completed at the municipality where the birth occurred. These include information on vital status, type of pregnancy (singleton or multiple) and maternal age. We requested aggregate tables for live births and foetal deaths by type of pregnancy (singleton, multiple) and maternal age. Aggregate data on foetal deaths were only available between 2002 and 2005 because of a technical problem in 2006 with the death certificate and changes in legislation governing the registration of stillbirths in 2001–08.^{16,17} There were 26 860 stillbirths and 3 086 128 live births in 2002–05.

Neonatal mortality certificate data

We used 2001–08 data from the neonatal death certificate provided by the CepiDc (*Centre d'épidémiologie sur les causes médicales de décès*). Certificate includes medical causes of death as well as perinatal data: type of pregnancy (singleton vs. multiple) and maternal age and where the birth occurred (in-hospital, out-of-hospital).¹⁸ There were 14 860 neonatal deaths, 282 deaths after out-of-hospital births and 6 202 918 live births during the study period. There were high rates of missing data for type of pregnancy (9.7%) and maternal age (16.6%).

Definitions

Mortality measures

The stillbirth rate was defined as all foetal deaths starting ≥ 22 weeks of gestation or ≥ 500 grams per 1000 total births (stillbirths and live births). The neonatal mortality rate was defined as all deaths before 28 days of life per 1000 live births. Neonatal mortality after out-of-hospital birth was defined as neonatal deaths occurring after out-of-hospital birth per 100 000 live births. We developed this latter indicator because we hypothesized that risk of death occurring in these circumstances would increase with greater distance to the closest maternity unit. French birth and death certificates do not record whether a birth is initially planned at home or occurred accidentally; our analysis focused on deaths associated with out-of-hospital birth, whatever the reason. French maternity services do not include an option for home birth, although some midwives in the private sector offer this service. Out-of-hospital births occurring far from a maternity unit are highly unlikely to be planned home births: rapid transfer to a maternity unit in case of complications is a prerequisite for safe home birth.¹⁹ Because we were interested in the occurrence of neonatal deaths associated with out-of-hospital birth for the overall population of women giving birth, the denominator for this measure is total births.

Urban/rural

We used the INSEE (the French National Institute for Statistics and Economic Studies) ZAUER classification (*zonage en aires urbaines et aires d'emploi de l'espace rural*), which divides the French municipalities by increasing urbanization (rural, peri-urban or urban).²⁰

Municipal-level socio-economic characteristics

We selected three variables representing social, economic and demographic dimensions related to perinatal health: the unemployment rate (percentage of individuals 15–64 years self-declared as unemployed), percentage of single-parent households (households with a single-parent and one or more children with no children themselves) and percentage of foreign-born residents.^{21–23} These were available from the French 2006 census.²⁴ We grouped these variables into birth population quintiles going from the least (Q1) to the most (Q5) prevalent, i.e. the fifth quintile for unemployment grouped the 20% of births to women living in municipalities with the highest unemployment rates.

Distance measurements

We geocoded the location of each maternity unit and of the municipality of residence of each mother from the vital statistics data at the centre of the municipality.

We calculated the distances between the municipalities in kilometres according to major regional road networks provided by the French National Geography Institute (IGN Route120[®]) with the ArcGIS Network Analyst package (ArcGIS 9.3).

Analysis strategy

We described the association of stillbirth, neonatal mortality and deaths after out-of-hospital birth according to distance from the place of residence to the closest maternity unit, urban/rural status of the municipality, municipal-level socio-economic status (SES) variables and individual characteristics of the mother. We adjusted for these individual, area-level and spatial variables to determine relative risks for mortality and distance to the closest maternity unit and municipal-level SES variables.

A sensitivity analysis was conducted to investigate whether findings were similar by geographical configuration for regions where long distances to the closest unit were more common (i.e. regions where $>12\%$ of women lived ≥ 30 km from the closest maternity unit) vs. other regions. Results were similar and we selected not to present these models. Distance from the closest maternity unit and urbanization are highly collinear. We did not include urban/rural residence in our final multivariable models.

Statistical modelling

χ^2 tests were used to test the relationship between mortality measures and the selected risk factors. The association for each of these perinatal outcomes was estimated using generalized linear models with the log link function. Wald statistics were used to test the main effects of each variable. The descriptive and multivariable analyses were performed with Stata 12 (StataCorp LP).

Results

Stillbirths were 8.7 per 1000 deaths during 2002–05, neonatal deaths were 2.4 per 1000 live births during 2001–08 and deaths after out-of-hospital birth were 4.5 per 100 000 live births during 2001–08 as shown in Table 1. Stillbirth rates were higher when distance between the mother's residence and the maternity unit was closest (<5 km) and farthest (≥ 45 km): 9.4 and 8.9 per 1000 total births, respectively. Neonatal deaths were higher when residence was nearest to a maternity unit, but not at longer distances. Deaths after out-of-hospital birth increased sharply when residence was ≥ 45 km to the closest maternity unit. Both stillbirth and neonatal deaths were more frequent in urban and rural areas and lower in peri-urban areas. Out-of-hospital death rates were higher in rural areas.

Table 2 shows that rates were higher for stillbirth, neonatal and out-of-hospital deaths in multiple vs. singleton births—three times for stillbirths (24.4 per 1000 vs. 8.2 per 1000) and almost eight times for neonatal deaths (13.6 per 1000 vs. 1.8 per 1000)—and roughly four times for out-of-hospital deaths. Women ≥ 35 and <25 were at higher risk of stillbirth and neonatal mortality. For municipal-level SES characteristics, stillbirth and neonatal death rates increased significantly with increasing quintiles of unemployment, percentage of foreign-born residents and percentage of single-parent households.

Table 3 presents individual and municipal-level risk factors according to measures of geographic accessibility and urban/rural residence. Women in urban areas were more likely to live in municipalities with a high proportion of single-parent households

Table 1 Stillbirths, neonatal deaths and neonatal deaths after out-of-hospital birth by distance to the closest maternity unit and urban/rural residence

	Total births 2002–05 N	Stillbirth rate per 1000	Live births 2001–08 N	Neonatal mortality rate per 1000	Neonatal deaths after out-of-hospital birth per 100 000
Total	3 086 128	8.7	6 202 918	2.4	4.5
Distance to closest maternity unit (km)					
<5	1 404 665	9.4	2 808 068	2.7	4.1
5–14	811 775	8.2	1 626 885	2.1	4.0
15–29	648 495	8.0	1 316 329	2.2	5.5
30–44	186 537	8.0	381 288	2.1	6.0
45+	34 367	8.9	69 787	2.2	10.0
Urban/rural					
Urban	1 975 555	9.1	3 957 579	2.5	4.1
Peri-urban	639 600	7.8	1 294 550	2.0	3.9
Rural	470 973	8.2	950 789	2.2	7.3

Table 2 Stillbirths, neonatal deaths and neonatal deaths after out-of-hospital birth by individual and municipal-level socio-economic characteristics

	Total births 2002–05 N	Stillbirth rate per 1000	Live births 2001–08 N	Neonatal mortality rate per 1000	Neonatal deaths after out-of-hospital birth per 100 000
Individual characteristics					
Type of pregnancy					
Singleton	2 988 169	8.2	6 009 255	1.8	3.7
Multiple	97 959	24.4	193 663	13.6	20.7
Maternal age (years)					
<25	494 689	9.6	977 596	2.4	6.2
25–29	979 913	7.6	1 989 674	1.8	3.3
30–34	1 028 407	7.7	2 027 394	1.8	3.1
35–39	469 975	10.4	975 090	2.1	3.5
≥40	113 144	16.2	233 164	2.9	3.4
Municipal-level characteristics					
Unemployment rate (quintiles)					
<7.5	616 369	7.6	1 241 626	2.0	4.2
7.5–9.7	616 855	8.2	1 239 604	2.2	4.1
9.8–12.4	621 008	8.4	1 249 150	2.4	4.2
12.5–15.3	614 270	9.3	1 232 139	2.6	4.2
>15.3	617 625	10.0	1 240 399	2.8	6.0
% single-parent households (quintiles)					
<8.9	614 335	7.7	1 241 086	2.0	4.1
8.9–12.9	616 962	7.9	1 240 639	2.1	4.5
13.0–15.9	618 009	8.7	1 241 420	2.4	4.8
16.0–18.6	633 336	9.1	1 269 233	2.6	4.0
>18.6	603 485	10.2	1 210 540	2.8	5.4
% foreign-born residents (quintiles)					
<2.5	615 764	8.0	1 240 750	2.1	6.1
2.5–5.6	619 957	8.3	1 246 447	2.2	5.2
5.7–9.4	625 416	8.6	1 255 871	2.3	3.6
9.5–15.4	606 203	9.1	1 219 282	2.4	3.8
>15.4	618 787	10.6	1 240 568	3.0	4.0

and foreign-born residents (fifth quintile of these indicators), than women in peri-urban or rural regions. Women in urban areas were also more often older, as were those living closest (<5 km) to a maternity unit. Risk factors for adverse outcomes—more older mothers, unemployment and foreign-born residents—were also higher for women living at ≥45 km from their closest maternity unit compared with those at ≥30 or ≥15 km.

Table 4 shows crude (cRR) and adjusted (aRR) risk ratios for mortality rates according to distance to closest maternity unit and municipal-level socio-demographic characteristics. Risk ratios (RR) are adjusted for all variables as well as for individual risk factors (maternal age and multiplicity). Higher levels of unemployment (>15.3%) and foreign-born residents (>15.4%) in a municipality

were independently associated with an increased risk of stillbirth and neonatal deaths. Living far (≥30 km) from the closest maternity unit was no longer associated with increased stillbirth death rates after adjustment. Distance to the closest maternity unit of ≥45 km was associated with deaths after out-of-hospital birth.

Discussion

We sought to determine whether distance to the nearest maternity unit is a risk factor for both stillbirth and neonatal mortality. We found that although there is increased risk for stillbirth at the closest and farthest distances, this association did not hold after accounting for individual-level demographic and area-level SES characteristics.

Table 3 Demographic and socio-economic characteristics associated with distance to closest maternity unit and urban/rural residence

	Maternal age (years)		Multiple births	Unemployment Rate Q5	Single-parent household Q5	Foreign-born population Q5
	<25	35+				
Distance to closest maternity unit (km %)						
<5	17.5	20.2	3.1	31.0	37.1	36.6
5–14	14.1	19.8	3.2	13.3	9.8	7.7
15–29	14.3	18.1	3.1	8.2	2.1	2.5
30–44	15.5	17.5	3.1	9.7	2.1	5.1
45+	15.6	19.2	3.0	14.2	4.3	8.6
Urban/rural (%)						
Urban	16.8	20.2	3.1	27.3	30.0	28.7
Peri-urban	11.9	19.1	3.3	2.9	2.6	2.6
Rural	16.7	17.1	3.0	12.8	2.0	4.3

Q5 = fifth quintile.

Table 4 Relative risk of stillbirths, neonatal mortality and neonatal deaths after out-of-hospital birth by distance to the closest maternity unit and SES context defined by municipality

	Stillbirth		Neonatal mortality		Neonatal deaths after out-of-hospital birth	
	cRR	aRR	cRR	aRR	cRR	aRR
Distance to closest maternity unit (km)						
<5	1	1	1	1	1	1
5–15	0.87 ^a	0.99	0.79 ^a	0.91 ^a	0.98	1.10
15–30	0.85 ^a	1.01	0.81 ^a	0.94	1.34	1.58 ^a
30–45	0.85 ^a	1.00	0.77 ^a	0.90 ^a	1.47	1.51
45+	0.95	1.08	0.80 ^a	0.96	2.45 ^a	3.68 ^a
Wald test	<0.01	0.51	<0.01	<0.01	<0.01	<0.01
Unemployment rate (quintiles)						
<7.5	1	1	1	1	1	1
7.5–9.7	1.08 ^a	1.03	1.13 ^a	1.09 ^a	0.98	1.11
9.8–12.4	1.11 ^a	1.03	1.19 ^a	1.07	1.01	1.21
12.5–15.3	1.22 ^a	1.10 ^a	1.32 ^a	1.14	1.01	1.18
>15.3	1.32 ^a	1.15 ^a	1.43 ^a	1.20 ^a	1.42	1.53
Wald test	<0.01	<0.01	<0.01	<0.01	<0.01	0.59
% single-parent household (quintiles)						
<8.9	1	1	1	1	1	1
8.9–12.9	1.03	0.99	1.05	1.00	1.10	1.30
13.0–15.9	1.13 ^a	1.03	1.16 ^a	1.01	1.16	1.65
16.0–18.6	1.18 ^a	1.04	1.30 ^a	1.06	0.98	1.51
>18.6	1.32 ^a	1.08 ^a	1.41 ^a	1.05	1.31	1.94
Wald test	<0.01	0.04	<0.01	0.44	<0.01	0.32
% foreign-born residents (quintiles)						
<2.5	1	1	1	1	1	1
2.5–5.6	1.04 ^a	1.01	1.02	0.95	0.85	0.64 ^a
5.7–9.4	1.08 ^a	1.01	1.08 ^a	0.94	0.58 ^a	0.33 ^a
9.5–15.4	1.14 ^a	1.04	1.15 ^a	0.99	0.62 ^a	0.50 ^a
>15.4	1.33 ^a	1.17 ^a	1.41 ^a	1.16 ^a	0.66 ^a	0.53 ^a
Wald test	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

aRR on distance to closest maternity unit, unemployment rate, % single-parent household, % foreign-born population, maternal age and multiplicity.

a: Confidence interval does not include 1.

Living far from a maternity unit no longer constituted a significant risk factor. For the rare deaths associated with out-of-hospital birth, however, longer distance did matter. Higher unemployment rates and larger percentages of foreign-born population in a municipality appeared as significant risk factors for both stillbirth and neonatal mortality. Paradoxically, women living closest to a maternity unit appeared to be at higher risk for neonatal mortality after adjusting for SES factors.

Our study is limited by the different periods for the measures of mortality we used and the missing data for individual characteristics. Stillbirths were measured during a shorter time period than neonatal

mortality, to keep consistency in the data because of the change in their definition for registration. This did not affect the overall analysis because of the large number of deaths included. Data were missing on individual characteristics for the mother's age and type of pregnancy (singleton vs. multiple) in the neonatal death certificate, partly due to its recent introduction. The reporting of these items is progressively improving¹⁸; there is no reason to believe that there is an association between distance and this missing information. Also, we cannot distinguish between medical terminations of pregnancy and spontaneous foetal deaths. Medical terminations are planned and thus probably less related to

distance than spontaneous foetal deaths, which may attenuate the association between distance and mortality. Finally, because French birth certificates do not record whether a birth is initially planned at home or occurred accidentally, we do not know that all deaths occurred after accidental out-of-hospital birth. Planned home deliveries are not offered as a part of standard maternity care in France, and these are rare: the overall rate of out-of-hospital births was estimated at 4.3 per 1000 births in 2005–06.⁹ Planned home births far from a maternity unit are dangerous, given the need to allow for rapid transfer to a maternity unit in case of unexpected complications, and midwives would be highly unlikely to accept these risks.¹⁹

A strength of this research is that it was carried out on mainland France as a whole. This means that we had a large enough sample to study a putative public health impact of living far away from a maternity unit and mortality. However, studies carried out on specific regions or smaller geographic configurations (e.g. isolated areas) might yield different results, as we have already noted for Burgundy.⁶

There was no association between living far from a maternity unit and both measures of mortality, once SES characteristics were accounted for. However, longer distances did have an impact on the risk of death after out-of-hospital birth. This mortality has different mechanisms underlying its occurrence⁹ and implies that physical distance can have negative implications in some personal and/or geographic settings. Because of the multiple mechanisms leading to foetal and neonatal death, our analyses using overall mortality as a principal outcome may lack the specificity to test for real differences related to distance. Deaths attributable to long travel distances are probably fewer than those due to causes (e.g. lethal congenital anomalies) less affected by distance. We were unable to develop cause-specific measures of mortality (e.g. associated with asphyxia or preterm births after spontaneous labour), which might be more associated with distance—data from the neonatal death certificate do not contain sufficient detail. This is an area to develop in future research. Including other outcomes, such as measures of morbidity, may also make it possible to explore this question in more depth.

It is possible that long distances trigger a specific set of behaviours among health providers to mitigate the possible negative consequences of living far from a maternity unit,²⁵ such as early hospitalization or planned birth for some women. In the Burgundy study, hospitalizations during pregnancy and inductions were more frequent for women living at greater distances.⁶ Some national health systems have tried to deal with long distances to maternity units, for instance by providing ‘maternity waiting homes’ in Finland and Sweden for women who live in isolated areas.^{26,27} There is no policy in France regarding management of pregnancies for women living far from a maternity unit. However, the magnitude of problems linked to distance differs across countries. What constitutes ‘far’ in France may be less extreme elsewhere: a study in Canada defined living >150 km from a maternity unit as ‘far’ and <50 km as ‘close’.²⁸ The effect of distance may also be attenuated by choices made by pregnant women themselves.³ In France, women are free to choose where to give birth: there are no reference maternity units, at least for low-risk pregnancies.

While long distances did not affect mortality, shorter distances were associated with higher risks of neonatal mortality. Women who live close to a maternity unit were principally situated in urban areas. Maternities located in urban areas may be larger and potentially better equipped than those located in rural or peri-urban areas and so may care for women with obstetric pathology referred from smaller maternities. These maternity units may have poorer outcomes than those located in rural areas. However, our study was population-based, and not facility-based. Adverse events occurring

to women living in rural areas—even if they were cared for in an urban tertiary centre—were attributed to their place of residence.

Our results could be explained by some characteristics of urban areas, higher levels of unemployment, foreign-born residents and single-parent households, all known risk factors for higher perinatal mortality. The RR for both stillbirth [RR = 1.32; 95% CI (1.21–1.48)] and neonatal mortality [RR = 1.38; 95% CI (1.19–1.60)] were significantly higher for municipalities in the fifth quintile of both unemployment rate and percentage of foreign-born residents, vs. those in the first quintile. These risk factors seem to have a compounded effect in urban areas, as has been observed in the Netherlands.^{29,30} After adjusting for these factors, women living close to a maternity unit appeared to be a higher risk group for neonatal mortality.

The association between short distances to the closest maternity unit and higher neonatal mortality seemingly contradicts the intuitive notion that proximity to a health service has a positive impact on health, the predominant line of thinking in French health planning and government policy. French law imposes territorial ‘equality’ in access to health services, as far as possible. These results conflict with two dominant paradigms in health care planning, namely: that geographic concentration of health services equates with a better level of health care delivery/better quality of care; that distance from health care services penalizes accessibility to health care.³¹

However, it may be that our measures of SES, which are area-level proxy measures, do not adequately adjust for levels of social risk and that populations living closest to maternity unit cumulate multiple risk factors.³² Alternatively, maternity units could be purposefully situated in neighbourhoods with greatest need. When supply is targeted or adapted to population risk factors, location itself can become endogenous variable.³³ Another possible explanation could be that the larger maternity units in France have to find sufficiently large spaces and reasonably priced real estate, often found at the periphery of urban areas.

Where does distance matter? For stillbirth and neonatal mortality, physical distance did not explain the variation in mortality on the national scale. A more subtle ‘social’ distance appears at play: social obstacles impeding effective access to health care in urban areas. Our results call for a more specific appraisal of the social and economic dimensions of those areas situated close to a maternity unit (<5 km). Poor health linked to different dimensions of deprivation is poorly understood at small scale. Negotiating health accessibility is an ‘adaptive’ process that needs large social capital,^{34,35} maybe unavailable for recent immigrants, or problems with poor transport infrastructure, for instance. These may be exacerbated when the gap between richest and poorest is large.^{36,37}

Conclusions

Further research should target these high-risk urban areas, characterized by higher levels of risk factors associated with stillbirths and neonatal mortality, with a view to better understanding underlying causal mechanisms. Social and spatial accessibility should also be explicitly and separately addressed in public health planning.^{38,39}

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Key points

- Maternity closures in France have led to an increase in travel distances for some pregnant women, especially those in more remote rural areas.
- After adjustment for individual demographic characteristics and area-based socio-economic characteristics, living far from a maternity unit was not associated with higher neonatal or foetal mortality.
- Deaths associated with out-of-hospital birth were more frequent with longer distances to the closest maternity unit, but these were rare.
- Area-based socio-economic measures (unemployment, single-parent households and percent foreign residents) were significant determinants of mortality.
- After adjustment, women closest to a maternity unit were at higher risk of poor outcome, raising questions about other risk factors in these predominantly urban environments.

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