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Regional differences in Dutch maternal mortality

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Objective To study regional differences in maternal mortality in the Netherlands.

Design Confidential inquiry into the causes of maternal mortality.

Setting Nationwide.

Population A total of 3 108 235 live births and 337 maternal deaths.

Methods Data analysis of all maternal deaths in the period 1993–2008.

Main outcome measure Maternal mortality.

Results The overall national maternal mortality ratio was 10.8 per 100 000 live births. In the 12 provinces of the Netherlands, the maternal mortality ratio ranged from 6.2 in Noord Brabant to 16.3 per 100 000 live births in Zeeland. In the four largest cities, maternal mortality varied from 9.3 in Amsterdam to 21.0 in Rotterdam. At a national level, the most frequent direct cause was pre-eclampsia. Increased risks for maternal mortality were found for women living in deprived neighbourhoods (RR 1.41), women from non-Western origin (RR 1.59), and women who were 35 years or older (RR 1.61).

Conclusion There are significant variations in maternal mortality ratios in the Netherlands between cities, provinces, and neighbourhoods. In addition, higher maternal mortality was observed in women of non-Western origin and in women who were 35 years of age or older.

Keywords Deprived neighbourhood, maternal mortality, non-Western origin, pre-eclampsia, regions, safe motherhood.

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Introduction

Maternal mortality is a principal indicator of maternal health, and a sensitive indicator for both social disparities and substandard care.[1] Among human development indicators, maternal mortality shows the most pertinent inequalities between resource-rich and resource-poor countries, but also between the rich and the poor within countries. The maternal mortality ratio (MMR) is commonly defined as the number of maternal deaths during a given period of time per 100 000 live births in the same period of time.[2] According to recent reports, the mean MMR is 6.3 in Europe,[3] 11.0 in the USA,[4,5] and 498.0 in Africa.[2]

Maternal health is influenced by many factors, including age, education, cultural norms, gender issues, obstetric care, and protective regulations from governments and employers.[6–8]

Recent studies showed poor outcomes in deprived neighbourhoods for perinatal health and mortality.[9–13] It has been suggested that this may also be the case for maternal morbidity.[12,13] Consequently, we investigated the influence of the place of residence on maternal mortality in the Netherlands during the period 1993–2008.

Methods

Maternal mortality

This study investigates cases of maternal deaths as registered in the database of the Dutch Maternal Mortality Committee (MMC) in the period 1993–2008. The cases are reported by obstetricians, midwives, and general practitioners, using standard forms.

The level of adherence to and compliance with this reporting system is high. In order to avoid any missing

cases, the database is cross-checked and complemented with data from Statistics Netherlands.

The MMC consists of eight obstetricians and one internist working in the field of maternal medicine. The Dutch Society of Obstetrics and Gynaecology is responsible for the appointment and supervision of the MMC.[6]

Maternal death is defined and classified according to the World Health Organization's International Classification of Diseases,[14] 10th revision (ICD-10). The MMR is defined as the number of direct and indirect maternal deaths per 100 000 live births up to 42 days after the termination of pregnancy.[6] Direct maternal death is the result of a complication of the pregnancy or delivery, or management thereof. Indirect maternal death is caused by pre-existing disease or morbidity that developed or deteriorated during pregnancy.[15] Late maternal death is defined as the sum of direct and indirect mortality, occurring between 42 and 365 days after pregnancy. Regions, cities, and deprived neighbourhoods in the Netherlands.

The Netherlands comprises 12 provinces (Figure 1) that represent legal administrative units sitting between municipalities and the national government. Regional differences in MMR were analysed according to province, the four largest cities (C4), and deprived neighbourhoods (DNs). Previous studies have used postal codes and have confirmed their utility in birth outcome research.[16–19] Likewise, our study was also based on postal-code areas.

In 2007, the Dutch government designated 40 neighbourhoods as DNs: 20 of these were in the four largest cities of the Netherlands and the remainder were scattered over 14 smaller cities across the country.[20] These neighbourhoods were characterised by high rates of unemployment, crime, insecurity, and poor housing. Designation as a DN was based on the number of these determinants associated with the geographical area.[21]

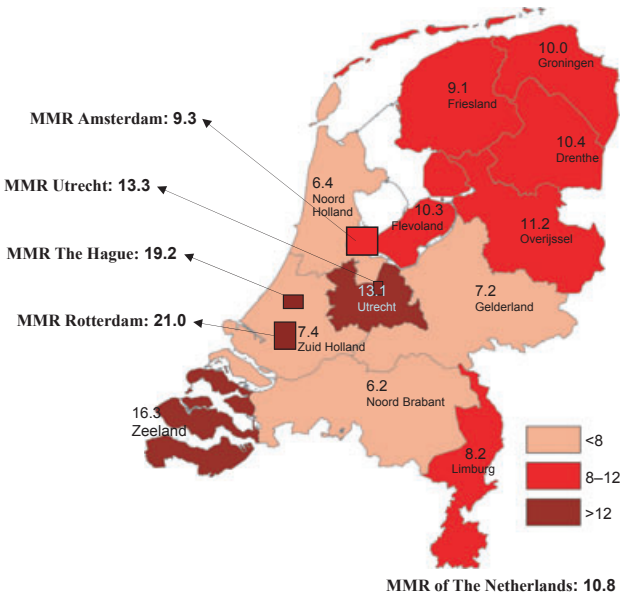

Figure 1. Maternal mortality ratio (MMR) in the provinces and four largest cities of the Netherlands.

Maternal characteristics

Maternal characteristics were categorised by age (<35 or ≥35 years), parity (0 and ≥1), and ethnicity. Ethnicity was defined by the care provider. In this study, we differentiated between Western (native Dutch and other Westerners) and non-Western (including different ethnic groups) women.

Statistical analysis

The frequency and relative risk (RR) of MMR were analysed according to region, cause of death, ethnicity, age, and parity. A chi-squared test was used for statistical analysis.

Results

In the study period of 1993–2008, a total of 3 108 235 live births and 337 maternal deaths were registered (MMR 10.8). Twenty percent of these cases occurred in the four largest cities (C4), whereas they account for 14% of births. When excluding the C4, the remaining MMR was 8.4. The difference between the MMR of the C4 (15.2) and the rest of the country is statistically significant ($P < 0.02$) (Table 1). No other significant differences in the MMR in Table 1 were observed.

The highest MMR was seen in Rotterdam (21.0) and The Hague (19.2) (Table 2). The MMRs in these two cities were significantly higher compared with the MMR in the Netherlands once the C4 are excluded, as shown in Table 1 ($P < 0.001$). No other significant differences in relation to the MMRs listed in Table 2 were found.

Figure 1 presents the MMRs for the 12 provinces. Notably, the highest MMR occurred in the province of Zeeland (16.3). Compared with the national MMR excluding the C4, the high MMR in Zeeland was significant ($P < 0.05$). The MMR for the remaining provinces varied from 6.2 to 13.1. None of these ratios differed significantly from the national MMR.

Pre-eclampsia/hypertension is the most frequent direct cause of death (Table 1). Its related MMR of 3.0 is higher compared with other European countries (Table 3). Pre-eclampsia/hypertension-related maternal mortality appeared to be higher in women living in deprived neighbourhoods and in non-Western women, compared with women living in non-deprived neighbourhoods and Western women, respectively (Table 4).

Twenty-nine of the deceased women lived in deprived neighbourhoods. Twenty-six (90%) of them resided in the C4 (Table 1). Table 2 shows their distribution in the C4:

Table 1. Characteristics of the four largest cities (C4) compared with the rest of the Netherlands (NL) in the period 1993–2008

Characteristics	NL total	C4		Rest of NL (=excl. C4)		Postal code unknown	
	n	*n*	% of NL total	*n*	% of NL total	*n*	% of NL total
Live births total*	3 108 235	434 870	14	2 673 359	86	NA	NA
Maternal mortality total	337	66	20	224	66	47	14
MMR	**10.8**	**15.2**		**8.4**		**NA**	
Pre-eclampsia/hypertension	92	18	20	62	67	12	13
Thromboembolism	56	9	16	39	70	8	14
Other direct cause	79	15	19	55	70	9	11
Indirect cause	110	24	22	68	62	18	16
Maternal mortality, non-Western	87	40	46	36	41	11	13
Maternal mortality, DN	29	26	90	3	10	NA	NA
Maternal mortality, age ≥ 35 years	99	22	22	62	63	15	15

NA, not applicable.
*Source: Statistics Netherlands (CBS), available online at: http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=37259ned&D1=1,27&D2=0&D3=0-16&D4=20,33-48&HDR=T&STB=G2,G1,G3&VW=T.

Table 2. Comparison of the causes of maternal mortality and MMRs in the four largest cities in the Netherlands

Characteristics	Amsterdam		Rotterdam		The Hague		Utrecht	
	n	% of C4	*n*	% of C4	*n*	% of C4	*N*	% of C4
Live births total*	162 245	37	118 845	27	93 821	22	59 959	14
Maternal mortality total	15	23	25	38	18	27	8	12
MMR	9.3		21.0		19.2		13.3	
Pre-eclampsia/hypertension	2	11	9	50	6	33	1	6
Thromboembolism	1	11	3	33	3	33	2	22
Other direct cause	4	27	4	27	4	27	3	20
Indirect cause	8	33	9	38	5	21	2	8
Maternal mortality, non-Western	8	20	16	40	13	33	3	8
Maternal mortality, DN	5	19	12	46	7	27	2	8
Maternal mortality, age ≥ 35 year	7	32	7	32	6	27	2	9

*Source: Statistics Netherlands (CBS), available online at: http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=37259ned&D1=1,27&D2=0&D3=0-16&D4=20,33-48&HDR=T&STB=G2,G1,G3&VW=T.

almost half of them (46%) lived in the city of Rotterdam. The MMR for the DN group was 15.6 compared with 10.5 in the non-DN group (Table 3). The mean of the MMRs in the DN groups were 18.2 in the C4 and 6.8 in the rest of the Netherlands, respectively. Eighty-seven (26%) of the women who died were of non-Western origin (Table 1). The total maternal mortality was significantly higher in non-Western women compared with Western women (Table 4). Ninety-nine (29%) deceased women were 35 years or older (Table 1). The total maternal mortality in those women was higher compared with younger women (Table 4). Indirect causes of maternal death were also more frequent amongst the older women. Table 5 shows that total maternal mortality as well as maternal mortality caused by pre-eclampsia/hypertension was significantly increased in Rotterdam and the Hague, when compared with the rest of the Netherlands, excluding the C4.

Discussion

Despite the fact that the Netherlands is one of the 20 most prosperous countries in the world,[22] with a free and universally accessible prenatal care system, the maternal mortality ratio has increased in the last two decades.[6] In this study, we analysed regional differences in maternal mortality in the C4, the 12 provinces, and in 40 DNs. Our

Table 3. A comparison of direct, indirect and total MMR between the Netherlands and a selection of European countries

Causes of death	The Netherlands 1993–2008			UK 1994–2008[42]	Denmark 2002–2006[43]	Bavaria, Germany 1995–2000[44]	France 2001–2006[45]
	Non-DN	DN	Total				
All maternal deaths	10.5	15.6	10.8	12.4	11.0	9.9	9.6
Direct deaths	7.1	10.7	7.3	5.5	5.4	4.0	6.9
Pre-eclampsia/hypertension	2.6	8.6	3.0	0.8	0.5	1.2	1.0
Thromboembolism	1.9	0.5	1.8	1.6	2.6	1.2	1.0
Other direct causes	2.6	1.6	2.5	NA	2.3	1.5	5.0
Indirect deaths	3.5	4.8	3.5	6.9	5.6	5.9	2.7
Cardiovascular	1.8	2.7	1.9	2.0	2.1	2.2	0.6
Neurological	0.8	2.1	0.8	1.8	0.5	0.9	1.0
Psychiatric	0.3	0	0.3	0.7	0.6	0.9	NA
Infectious	0.2	0	0.2	NA	0.4	NA	NA
Endocrine, metabolic, and immune disease	0.1	0	0.1	NA	NA	NA	0.2
Malignant	0.1	0	0.1	0.3	0.4	0.6	0.2
Other indirect	0.2	0	0.2	2.1	1.6	1.2	0.7

NA, not applicable.

Table 4. Relative risk of maternal mortality by age, nulliparity, deprived neighbourhood (DN) and non-Western ethnicity

	Age ≥ 35 years (vs <35 years)				Nulliparity (vs multiparity)				Deprived neighbourhood (vs non-DN)				Non-Western (vs Western)			
	n	RR	(95% CI)	*P*	*n*	RR	(95% CI)	*P*	*n*	RR	(95% CI)	*P*	*n*	RR	(95% CI)	*P*
Total deaths	99	1.61	1.28–2.01	<0.001	172	0.97	0.80–1.16	NS	29	1.41	0.97–2.06	NS	87	1.59	1.26–2.02	<0.001
Pre-eclampsia/hypertension	23	1.37	0.87–2.16	NS	52	1.07	0.76–1.50	NS	16	2.85	1.68–4.85	<0.001	31	2.08	1.38–3.12	<0.001
Thromboembolism	18	1.76	1.03–2.99	<0.01	25	0.84	0.53–1.35	NS	1	0.29	0.04–2.11	NS	11	1.21	0.64–2.31	NS
Other direct causes	22	1.52	0.95–2.44	NS	39	0.93	0.64–1.37	NS	3	0.62	0.20–1.97	NS	23	1.80	1.13–2.86	<0.01
Indirect causes	36	1.79	1.23–2.61	<0.001	56	0.96	0.70–1.33	NS	9	1.34	0.68–2.65	NS	22	1.23	0.78–1.95	NS

NS, not significant.
P is calculated using the chi-squared test.

Table 5. Relative risk of maternal mortality in the four largest cities compared with the rest of the Netherlands

	Amsterdam				Rotterdam				The Hague				Utrecht			
	n	RR	(95% CI)	*P*	*n*	RR	(95% CI)	*P*	*n*	RR	(95% CI)	*P*	*n*	RR	(95% CI)	*P*
Total deaths	15	1.10	0.65–1.86	NS	25	2.51	1.66–3.80	<0.001	18	2.29	1.42–3.70	<0.001	8	1.59	0.79–3.22	NS
Pre-eclampsia/hypertension	2	0.53	0.13–2.17	NS	9	3.27	1.62–6.57	<0.001	6	2.76	1.19–6.37	<0.01	1	0.72	0.10–5.19	NS

NS, not significant.
P is calculated using the chi-squared test.

study showed large regional differences. The C4 show a higher MMR compared with the rest of the Netherlands. For Rotterdam and the Hague, the differences were highly significant. This could be because urbanisation is associated with an increase in environmental health risks, risk behaviour, stress, and low socio-economic status.[12,23–25]

Of the 12 provinces, Zeeland showed the highest MMR, which is significantly different from the rest of the

Netherlands. Possible reasons for this poor outcome can be derived from Statistics Netherlands:[26] the frequency of hypertension in Zeeland is the highest in the country; there are fewer hospitals for the area and the travel times are long, which have been shown to be important risk factors;[6,19] and socio-economic status and lifestyle in the region are below the average standards. In addition, self-score questionnaires demonstrate that the inhabitants of Zeeland rate their health condition as the lowest in the country.

The high MMRs in DNs could be explained by an accumulation of heterogeneous risk factors present within these neighbourhoods,[9,19,20] for example a lack of health insurance, low income, poor education, irregular consultation, and stress.[27–30]

The MMR of non-Western women is also high, and this excess risk has been reported in several European studies.[31–33] The common denominator is low socio-economic status. However, in the Netherlands 75% of non-Western pregnant women do not live in deprived neighbourhoods.[34] A lack of proficiency in Dutch and therefore an inability to access adequate antenatal care is a more plausible explanation. This can result in late antenatal care,[35] insufficient understanding of warning symptoms,[6,36] inadequate diagnosis, and poor compliance with the advice of the midwife or doctor.[36–38]

In this study, women aged 35 years or older were also at increased risk of maternal mortality, probably because of a deterioration of pre-existing disease. A growing number of women aged ≥35 years embark on a pregnancy, despite pre-existing medical problems.

The maternal mortality ratio (MMR) related to pre-eclampsia/hypertension in the Netherlands is higher than in other European countries (Table 3). Substandard care, both in community and hospital care, has previously been shown to be involved.[36]

In 2005, the Dutch Society of Obstetrics and Gynaecology (DSOG) implemented the revised *Guideline Hypertensive Disease in Pregnancy*.[39,40] Since 2005, a total of eight regional audits were organised to evaluate adherence to these guidelines and compliance with its protocols. It appeared that common practice was inadequate. Consequently, the DSOG strongly advised an improvement and adherence to the guidelines in general and hospital practices. In addition, adequate prophylaxis of eclamptic seizures should be enhanced.[41] In general, well-organised programmes for education and information should be initiated, particularly for women with a low socio-economic status and of non-Western origin.

In conclusion, marked differences in maternal mortality are observed between cities, provinces and neighbourhoods in The Netherlands. Furthermore, higher maternal mortality was observed in women of non-Western origin and for women aged ≥35 years. This should be taken into account in current discussions on the quality of obstetric care.

Disclosure of interests

The authors declare that they have no competing interests.

Contribution to authorship

JPdG co-developed the core idea and the study design, conducted the analyses, interpretated the results and wrote the article. JMS co-developed the core idea, participated in the study design, collected the primary data for analysis and participated in the interpretations of the results and revision of the draft version of the article. JP conducted the analyses, interpreted the results and revised the draft version of the article. JvR co-developed the core idea and participated in the interpretations of the results and in the revision of the draft version of the article. GJB co-developed the core idea, developed the study design and the data analysis, participated in the interpretation of results and wrote the article. EAPS developed the core idea and participated in the study design, analyses and interpretation of the results, and wrote the article. All authors approved the final version of the article.

Details of ethics approval

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