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ORIGINAL ARTICLE

Trends in maternal mortality in Switzerland among Swiss and foreign nationals, 1969–2006

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Abstract
Objectives To test whether maternal mortality was higher among immigrant women than Swiss women.
Methods All maternal deaths and live births in Switzerland from 1969 to 2006 from official vital statistics were considered. We calculated maternal mortality ratios (MMRs) in four time intervals (1969–1979, 1980–1989, 1990–1999, 2000–2006) for both Swiss and immigrant women overall, and for Italian, Spanish and Turkish women. We also computed the odds ratios and 95% confidence intervals of maternal mortality over the four time periods, considering maternal deaths as cases, and live births as controls.
Results From 1969 to 2006 there were 279 maternal deaths, 204 of Swiss women and 75 of immigrant women. Women's age, marital status and cause of death were similar in the two groups. For immigrant women, the crude odds ratio of a pregnancy ending with maternal death, not homogeneous across the four periods, was 4.38 (95% CI 1.88–10.55) in 2000–2006.
Conclusions Immigrant women have a higher risk of maternal mortality than Swiss women. A closer scrutiny of risk factors and quality of care is necessary to identify opportunities for prevention.

Keywords Maternal mortality · Immigration

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Introduction

Maternal death is defined by the current international classification (World Health Organization 1993) as "the death of a woman during pregnancy, childbirth, or within 42 days of the completion of the pregnancy, independently of the duration and the site of the pregnancy, due to any cause related to or aggravated by the pregnancy or related care, but not by accidental or incidental causes". Maternal mortality still represents a frequent event in developing countries, especially in African and Asian countries, although some progress has recently been recorded (Hogan et al. 2010). In developed countries it is an exceptional event, reflecting the general good health of the population, satisfactory access to medical care, and the quality of health care (Turner et al. 2002; Salanave et al. 1999). Although in Western Europe it varies from 2 to 12 per 100,000 live births (Euro-Peristat Project 2008), it is conceived as a sentinel health event, which should alert the entire health care system, worth investigating for the potential of ending maternal deaths, avoiding severe maternal morbidity and improving pregnancy outcome.

The conditions leading to maternal death are not only of medical nature, but also the result of a chain of events related to the social and economic conditions of the individual mother or the group to which she belongs in the society (Calderón et al. 2007). A number of studies in European countries have shown that immigrant women are at increased risk of maternal death (Stirbu et al. 2006; Ibison et al. 1996; Razum et al. 1999; Bragg 2008; Deneux-Tharaux et al. 2009). Possible explanations for the association between maternal mortality and being an immigrant were illegal residence, vulnerable social status, inadequate interpreter services, and inadequate quality of obstetric care (Bragg 2008; Deneux-Tharaux et al. 2009).

As other European countries, Switzerland has seen an important influx of labor immigrants since the end of World War II, with a peak in the 1970s, and more recently accepted asylum seekers and refugees. Currently, 22% of the resident population has a foreign nationality (Office fédéral de la Santé Publique 2008). Since 1996 health insurance is mandatory for all persons legally residing in Switzerland. Immigrants have similar entitlements as Swiss citizens to basic health care, both ambulatory and hospital. However, three aspects are of interest for our study: (1) interpreters are not routinely available in the health care system, and arrangements for translation are often unsatisfactory and perceived as the main barrier to antenatal care by migrant women (Bischoff and Hudelson 2010; Bollini et al. 2007); (2) due to low socio-economic status, immigrant women can afford complementary health insurance less frequently than Swiss women, and continuity between antenatal care and delivery is less often assured, since most private gynecologists who follow women through the antenatal period provide obstetric services only in private hospitals, not reimbursed by the basic health insurance scheme; and (3) irregular immigrants (those without a resident permit, also called undocumented migrants) are seldom insured, and although in many large towns arrangements are made to provide free care or care at low cost, most pregnant women with irregular status have delayed or inadequate access to antenatal services (Wolff et al. 2008).

As most European countries, Switzerland has a low maternal mortality, although no in-depth enquiry on maternal deaths is in place, and underreporting is estimated at 20% (Meili et al. 2003). Poorer pregnancy outcomes (perinatal mortality, infant mortality, and low birth weight) of immigrant women as compared to Swiss women have been reported (Lehmann et al. 1990; Degrate et al. 1999; Bollini and Wanner 2006), while no information on maternal mortality has been published. Our study aims at testing the hypothesis that maternal mortality is higher for women of foreign nationality than for Swiss women, using vital registration data on maternal deaths and live births by nationality from 1969 to 2006.

Methods

The Federal Office of Statistics provided from the vital registration system anonymous data on maternal deaths occurring in Switzerland between 1969 and 2006, including both women with Swiss and foreign nationality. In Switzerland "ius sanguinis" applies: access to Swiss citizenship is narrow, and several proposals to widen it have been rejected over the years. The naturalization rate of foreign citizens, between 1 and 2% of foreign residents per year, is among the lowest in Europe. Naturalization is based on a three-tiered decision system (communal, canton and federal), at it requires at least 12 years of residence in the country (Wanner et al. 2002). Accordingly, having a foreign nationality is used as a proxy for immigrant status, either first or second generation (Office fédéral de la Statistique 2004). Maternal deaths were deaths where the cause of death codes was identified as complications of pregnancy, childbirth, and the puerperium in the International Classification of the Diseases (ICD). Causes of death were coded according to ICD, 8th revision for deaths occurring until 1994 (World Health Organization 1969), and 10th revision for the period 1995–2006 (World Health Organization 1993), while ICD-9 was never adopted. All deaths of women residing in Switzerland during that period were registered, including deaths occurring among irregular migrants (only tourists were excluded). Information included year of death, age of the woman, marital status, nationality, and cause of death. Because of differences in ICD classifications, we grouped the causes of maternal death in nine broad categories: obstetric embolism (ICD-8 code 673 and ICD-10 codes O88.1 and O88.2), eclampsia and pre-eclampsia (ICD-8 code 637 and ICD-10 codes O14–O15), hemorrhage (ICD-8 codes 632, 651, 652, 653 and ICD-10 codes O44.1, O46.0, O67.8, O67.9, O72.1, O72.2), abortion (ICD-8 codes 640–645, no ICD-10 codes recorded), ectopic pregnancy (ICD-8 code 631 and ICD-10 code O00.9), puerperal phlebothrombosis (ICD-8 code 671 and ICD-10 code O87.1), uterine rupture (ICD-8 code 659 and ICD-10 codes O71.0 and O71.1), sepsis and other infections (ICD-8 codes 635, 670 and ICD-10 code O85, O41.1), and miscellanea.

The number of live births between 1969 and 2006 by nationality was derived from the BEVNAT database, registering all births of residents in Switzerland according to mother nationality. It is worth noting that from 1969 to 1986 some nationalities such as Portuguese and Yugoslav, at that time exclusively labor migrants to Switzerland, were lumped together in the category "Other nationalities", and individually registered since 1987. In 1992, after the conflict in former Yugoslavia, the category "Yugoslav" was split into Yugoslav, Bosnia–Herzegovina, Kosovo, and Macedonia, groups which described the new political organization and included refugees and asylum seekers from this region. The list of all foreign countries of origin with at least one maternal death from 1969 to 2006 is shown in Appendix.

Since maternal mortality was subject to fluctuations, and a change in countries of origin of immigrants occurred over the almost 40 years considered, we calculated maternal mortality ratios (MMRs, number of maternal deaths per 100,000 live births) for four distinct periods of approximately 10 years each (1969–1979, 1980–1989, 1990–1999,

2000–2006), both for Swiss and foreign women, all nationalities included. Among the latter, we also calculated MMR for Italians, Spanish and Turkish, the three largest national groups in Switzerland for whom single registration of nationality was available throughout the whole period.

In order to study the difference between the maternal mortality of foreign and Swiss women over the four time periods considered, we used a case–control approach. For rare events, odds ratios are a good approximation of the risk ratio (Schlesselman and Stolley 1982). We considered maternal deaths as cases, and live births occurring in the same time interval as controls. This analysis approximates live births to pregnancies not ending with the death of the mother, which is slightly inappropriate because twin births are not excluded. However, since twin births represented 2.5% of all births, and were homogeneously distributed among different nationalities (Bollini and Wanner 2006), the results were not affected in an appreciable way. We calculated the odds of maternal mortality separately for the four periods, both for Swiss and foreign women, together with their 95% confidence intervals (95% CI). A Mantel–Haenszel test of homogeneity was performed to assess the homogeneity of the estimates across the four periods. Statistical analysis was performed using the statistical package STATA, 9th version (STATA Corporation 2005).

Results

From 1969 to 2006 there were 2,942,399 live births, of which 632,066 (21%) to women of foreign nationality. Two hundred and seventy-nine maternal deaths were registered, of which 75 (27%) of women of foreign nationality. Among the latter, Italian, Spanish and Turkish nationality accounted for more than 60% of the deaths of foreign mothers (30, 11 and 6, respectively), throughout the whole period. Deaths of women from Bosnia–Herzegovina, Macedonia, African and Asian countries, most of whom came to Switzerland to seek asylum (http://www.bfm.admin.ch/bfm/fr/home/dokumentation/zahlen_und_fakten/asylstatistik/jahresstatistiken.html), were recorded since the mid 1990s until 2006.

Table 1 shows a few characteristics of maternal deaths for Swiss and foreign women as available in the vital registration system. The average age at death was around 30 years, similar for Swiss and foreign women. The age distribution between the two groups was similar ($p = 0.5$), while the proportion of married women was higher for foreign mothers, although not significantly so ($p = 0.21$). The most common causes of death were eclampsia and pre-eclampsia, obstetric embolism and hemorrhage, similar for both Swiss and foreign women. However, no death from ectopic pregnancy was recorded for foreign women.

Table 1 Characteristics of women and cause of death by nationality, Switzerland 1969–2006

	Swiss women No. (%)[a]	Foreign women No. (%)	Overall No. (%)
Age at death (years)			
Mean (±SD)	30.0 (±6.1)	30.2 (±6.1)	30.0 (±6.11)
Categories of age			
<25 years	42 (21)	12 (16)	54 (19)
25–34 years	115 (56)	48 (64)	163 (58)
35–43 years	47 (23)	15 (20)	62 (22)
Marital status			
Married	173 (85)	69 (92)	242 (87)
Cause of death			
Eclampsia and pre-eclampsia	24 (12)	14 (19)	38 (14)
Obstetric embolism	25 (12)	10 (13)	35 (12)
Hemorrhage	25 (12)	9 (12)	34 (12)
Abortion	16 (8)	9 (12)	25 (9)
Ectopic pregnancy	14 (7)	0	14 (5)
Puerperal phlebothrombosis	10 (5)	3 (4)	13 (5)
Uterine rupture	10 (5)	3 (4)	13 (5)
Sepsis and other infections	10 (5)	2 (3)	12 (4)
Miscellanea	70 (34)	25 (33)	89 (32)
Total	204 (100)	75 (100)	279 (100)

SD Standard deviation

[a] Percentages are by column

One-third of the causes of death were included in the category "miscellanea", which mostly comprised unspecific codes such as delivery with other complications (ICD-8 661) (33 cases, 26 of Swiss women), other complications in the puerperium (ICD-8 677) (seven cases, four of Swiss women), and prolonged delivery for other reasons (ICD-8 657) (four cases of Swiss women). Table 2 shows the number of maternal deaths and MMR, overall and for selected nationalities. For Swiss women MMR sharply decreased from 19.2 per 100,000 live births in the period 1969–1979 to 5.8 in the period 1980–1989, and more slowly thereafter, down to 2.9 in 2000–2006. For foreign women MMR was 15.0 in the period 1969–1979, decreased by a half in 1980–1989, remained to the same level in 1990–1999, and increased again in 2000–2006 to 12.7, approximately four times higher than MMR of Swiss women. Italian, Spanish and Turkish women were the largest groups of foreigners for which registration was available since 1969. MMR for Italian and Spanish women showed a decrease since the period 1969–1979, increasing in 2000–2006, while for Turkish women it remained above 20 per 100,000 live births in the 1969–1979 and

Table 2 Number of maternal deaths, live births and maternal mortality ratio (MMR, number of deaths by 100,000 live births) in Switzerland, 1969–2006, by nationality

	1969–1979 No. of maternal deaths/No. of live births and MMR	1980–1989 No. of maternal deaths/No. of live births and MMR	1990–1999 No. of maternal deaths/No. of live births and MMR	2000–2006 No. of maternal deaths/No. of live births and MMR	Total number of maternal deaths, 1969–2006
Total	167/926,619 (18.0)	46/739,968 (6.1)	40/779,842 (5.1)	26/495,970 (5.2)	279
Swiss	129/673,622 (19.2)	37/635,297 (5.8)	27/623,153 (4.3)	11/378,261 (2.9)	204
Foreigners	38/252,997 (15.0)	9/104,671 (8.6)	13/156,689 (8.3)	15/117,709 (12.7)	75
Italian	19/147,338 (12.9)	5/42,424 (11.8)	2/33,716 (6.0)	4/15,820 (25.3)	30
Spanish	7/32,485 (21.5)	2/15,324 (13.1)	1/11,091 (9.0)	1/4,297 (23.3)	11
Turkish	2/8,261 (24.2)	0/15,055	4/18,029 (22.2)	0/9,120	6

MMR Maternal mortality ratio

Table 3 Crude odds ratios and confidence interval for maternal mortality of foreign versus Swiss women, by period of observation. Switzerland, 1969–2006

	Odds ratios	95% Confidence interval	
1969–1979	0.78	0.53	1.13
1980–1989	1.48	0.63	3.11
1990–1999	1.91	0.91	3.84
2000–2006	4.38	1.88	10.55

1990–1999, the only two periods where maternal deaths of Turkish women occurred.

Overall, the crude odds ratio of maternal mortality of foreign women as compared to Swiss women was 1.34 (95% CI 1.02–1.76). However, the risk was not homogeneous over the four periods considered (Mantel–Haenszel test of homogeneity $p = 0.0004$). In fact the risk of maternal mortality, lower for foreign women than for Swiss women in the period 1969–1979, significantly increased to 4.38 (95% CI 1.88–10.55) in 2000–2006 (Table 3).

Discussion

The results of our study confirm that in Switzerland, as in other European countries, maternal mortality is higher for foreign nationals than for Swiss women. In the period 1969–1979, foreign women showed a lower MMR than Swiss women. This finding could be explained by a "healthy migrant effect", immigrant women being supposedly healthier than those in the countries of origin, or by underreporting of maternal deaths of immigrant women. The healthy migrant effect seems the least plausible explanation, since the advantage of foreign women disappeared in the following time periods. Instead, underreporting could be caused by the fact that up to the end of the 1960s, family reunification of foreign workers was not easily granted, and many spouses irregularly resided in Switzerland. It is likely that, when a maternal death occurred, in order to avoid sanctions families preferred to declare that the woman was just visiting, so that the death was not registered in the vital registration system. The legislation on family reunification was eased since the early 1970s with the introduction of a new migration policy based on long-term rather than short-term resident permit, thus probably ending underreporting. Over the years, the overall decline in MMR occurred mostly among Swiss women, while the evolution was less favorable for foreign women. After the year 2000, women of foreign nationality experienced a risk of death for a pregnancy-related condition four times higher than Swiss women.

Over the time interval considered, maternal mortality showed important variations in some causes of death (e.g., death due to abortion disappeared at the beginning of the 1980s, due to increased access to safe and legal pregnancy termination), and the improvement of clinical management of deliveries at risk (e.g., use of anti-thrombotic prophylaxis). The main causes of maternal mortality were similar for Swiss and foreign women, although a higher albeit non-significant proportion of hypertensive disorders was registered for the latter. A higher risk of dying from hypertensive disorders was reported in France (Philibert et al. 2009), and in Germany (Razum et al. 1999). Furthermore, it is worth noting that ectopic pregnancy was never registered as cause of death in foreign women, although we would have expected a similar incidence in both Swiss and foreign nationals. Since foreign women across Europe have delayed prenatal care, due to language problems and unsatisfactory organization of health services (Delvaux et al. 2001), it is likely that the pregnancy status of foreign women was not known at the moment of death, and the cause of death was wrongly ascribed to a non-maternal code. We do not know whether other systematic instances of misclassification occurred.

Among Spanish and Italian women, traditional labor migrants to Switzerland, several deaths occurred throughout the whole period considered. Three deaths (out of a total of six) of women of Turkish nationality occurred in 1999. We do not know whether these deaths occurred in

labor migrants or in women seeking asylum, nevertheless this cluster raises important concerns. Since the mid 1990s, deaths of women from Bosnia–Herzegovina, Africa, and Asia occurred. Although from vital statistics we cannot distinguish between labor migrants and persons coming to Switzerland to seek asylum, we may speculate that most of these women belonged to the latter category. The influx of asylum seekers, often with a traumatic past, could partly account for the worsening of MMR of foreign women in 2000–2006. However, the MMR of Italian and Spanish women, who came to Switzerland only as labor migrants, showed the same pattern, even if very few events were recorded. It is worth noting that the same nationalities showed other negative outcomes beside maternal mortality. Turkish women had higher rates of stillbirths, perinatal, neonatal, and infant mortality as compared to Swiss women, while Italian and Spanish women had higher rates of stillbirth and neonatal mortality. African women and women from Sri Lanka also showed quite negative perinatal outcomes as compared to Swiss women, such as a higher proportion of low birth weight and very low birth weight babies (Bollini and Wanner 2006). These data would support the view that maternal mortality is associated with other negative pregnancy outcomes.

Other European countries have investigated the relationship between maternal mortality and immigrant status. In The Netherlands, a study explored the association between the level of mortality from 'avoidable' causes and ethnic origin, and identified social factors that contribute to this association. Migrant women experienced a higher risk of death from maternity-related conditions as compared to Dutch women (Relative Risk = 3.37) (Stirbu et al. 2006). A case–control study in Belgium investigated the associations between biomedical, social and health care factors and the occurrence of severe pre-eclampsia, eclampsia or HELLP syndrome (Hemolytic anemia, Elevated Liver enzymes and Low Platelet count), all conditions potentially associated with maternal mortality. The study showed that social disadvantage and illegal residence or asylum request were strongly associated with the outcome in univariate analysis (Haelterman et al. 2003). In the UK, an analysis of death registrations, 1970–1985, showed that the risk of dying in pregnancy, childbirth or during the puerperium, adjusted for age and year of death, was higher in immigrants as compared to women born in England and Wales. Women born in West Africa and the Caribbean were at very elevated risk of maternal death, women from Southern Asia, Europe and the USSR at moderate risk. The pattern of increased risk did not appear to be explicable by the parity or social class distribution of immigrants as far as data were available (Ibison et al. 1996). A more recent report on the 2003–2005 UK Confidential Enquiry into Maternal and Child Health confirmed that maternal mortality was six times higher for black African women and four times higher for black Caribbean women than for white women (Confidential Enquiry into Maternal and Child Health 2007), mirroring the particular disadvantage of these groups in British society (Nazroo 1997). Among factors which may have led to maternal mortality there were unsatisfactory arrangements for interpretation, lack of awareness of female genital mutilation, late booking or poor attendance to antenatal care, domestic violence, and levying charges on pregnant women who were not classified as ordinarily residents in the UK, such as refused asylum seekers, trafficked women and undocumented migrants (Bragg 2008). In France, the higher maternal mortality of immigrant women was partly explained by the poorer quality of care they received (Deneux-Tharaux et al. 2009). Similar problems of substandard care were also reported in The Netherlands (Van Roosmalen et al. 2002).

A limitation of our study is the small number of deaths occurring in some communities, making it impossible to analyze them separately and to understand specific characteristics leading to maternal death. A second limitation is that we did not have access to death certificates or hospital case records, so accurate identification of the causes of maternal deaths by differentiating the extent to which they are due to direct or indirect obstetric causes, or to accidental or incidental events, was not always possible. Another study conducted in Switzerland which investigated maternal deaths from 1985 to 1995, examined the corresponding clinical records and autopsy reports, and re-classified deaths as direct ($n = 45$), indirect ($n = 9$), late ($n = 0$) and pregnancy-related ($n = 18$) (Meili et al. 2003). The high proportion of cases that could not be classified indicated that further teaching was necessary to complete death certificates.

The third limitation of our study is that maternal deaths were coded with ICD-8 until 1994, and with ICD-10 thereafter. This case in not unique in Europe, where also Denmark never adopted ICD-9 (Larsen et al. 2005). Changes in coding systems are inevitable over a period of almost 40 years, but the issue here is whether a change of classification influenced the coding. For instance, a study from the United States found that the change from ICD-8 to ICD-9 in 1979 resulted in a 10% increase in maternal deaths (Hoyert 2007). We do not know what influence the switch from ICD-8 to ICD-10 had on the coding of maternal deaths in Switzerland, although the distribution of main codes before and after 1994 remained the same with both classifications (with the exception of death due to abortion).

In summary, pregnancy outcomes in Switzerland showed a disadvantage for immigrant communities, and diversity among them (Lehmann et al. 1990; Degrate et al. 1999; Bollini and Wanner 2006). Maternal mortality adds an important piece of information. Still, the mechanism(s)

behind such event remain elusive. In Switzerland no systematic investigation of maternal deaths is carried out, so the conditions which have led to it and the potential for prevention are unknown, both for Swiss and foreign women. This situation should be promptly addressed, especially in light of the worrisome recent increase of maternal deaths among foreign women. Furthermore, for the latter, access to early antenatal care should be improved, irrespective of legal status, and routine interpreter services throughout the health care system should be provided.

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Conflict of interest The authors declare that they have no competing interests.

Appendix

List of countries of origin with at least one maternal death and number of maternal deaths, Switzerland 1969–2006.

Country	No. of maternal deaths
Austria	1
Bosnia–Herzegovina	1
China	1
Congo–Kinshasa	1
France	4
Germany	1
Guinea–Bissau	1
Italy	30
Macedonia	1
Malaysia	1
Portugal	3
South Africa	1
Spain	11
Sri Lanka	1
Thailand	1
Turkey	6
United Kingdom	1
Yougoslavia	1

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