Stillbirths in south-western Siberia, Russia, 1963–1991

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Introduction

Though there are numerous studies on stillbirth (SB) rates in North America and Europe, little information is published in Russia and, particularly, in Siberia. Meanwhile, Siberia is a unique natural model for studying the biological effects of extreme climate because of its marked variability throughout the year. Thus, the magnitude of January-July mean temperature difference is about 40° C in western Siberia and reaches 50° C in some districts of its eastern part.

Stillbirths in human populations are commonly subjected to seasonality. The regular periodic fluctuations are due to climate under certain circumstances, operating either directly through extreme weather conditions, or indirectly through the influence on patterns of diseases in both expectant mother and/or unborn child. There are no data on sex difference in seasonal pattern of SBs in the available literature. Therefore, it was one of the purposes of the present study to verify the sex-specific patterns and to test a hypothesis of more pronounced seasonality in male fetal deaths taking into account the evidence of less resistance of male vs. female newborns and infants to challenging influences.

The present study was undertaken to examine linear and seasonal trends in SB rate in western Siberia and to verify possible differences between sexes, urban and rural populations, and the two periods 1963–1976 and 1977–1991.

Materials and Methods

Data

Data on live births and stillbirths by month, setting, and sex for the years 1963-1991 were obtained from the official vital register in the Novosibirsk Regional Committee of Statistics. The entire period was subdivided into two subperiods, the first 14 years (1963-1976) and the subsequent 15 years (1977-1991), to enable better judgment of trend changes. The population of the region (2,767,938 in 1988) was unevenly distributed, with the greatest concentration in the urban area (2,056,458) and especially in the Novosibirsk city (1,425,125). Rapid urbanization occurred during that time. Thus, the mean ratio between the size of urban and rural populations in the region is 2.11 over the period studied ranging between 1.55 in 1966 and 2.95 in 1991. People are mostly Russians.

A total of 1,220,932 singleton live births (815,238 urban, 405,694 rural) and 9631 stillbirths (7864 urban, 1767 rural) were included. Stillbirths in Russia were then defined as fetal deaths occurring at 28 or more weeks of gestation or if the weight of the fetus is 1000 g or more. During the period of observation the criteria for defining stillbirths did not change and the quality of birth registration was similar. The completeness of vital register in 1980s is considered to be close to 90%.

Climate

The climate in western Siberia is continental with wide variation between the distinct seasons. As for air temperature, for the weather station located near the city of Novosibirsk during the period 1951-1980, the average difference between monthly mean temperatures in

January (-18.8°C) and July (+19.0°C) was so far 37.8°C, with marked changes from March to May (difference, 20.4°C) and from September to November (19.3°C). Aside from subtle differences, seasonal weather trends in the whole West Siberian Lowland are rather similar to those in Novosibirsk region due to a uniform landscape.

Analysis

The number of live births occurring during the certain time interval was considered a population at risk for the given setting-sex group and interval. The monthly stillbirth rates were calculated per 1000 live births. The method and computer program, used here to detect seasonality, are those proposed by Jones et al. [1]. The method fits sine waves to the data with a fundamental period of one year. It also allows different lengths of time intervals, different sizes of populations at risk, and an arbitrary shape for the seasonal pattern by presenting the data as a Fourier series with up to three harmonics together with a possible linear trend.

Amplitudes of the observed SB rates are expressed as percentages of deviation from the mean. Seasonal patterns were compared between sexes and between urban and rural populations with each controlling for the other's effect. Mean SB rates and amplitudes were compared using the distribution-free Mann-Whitney test. Values are expressed as mean±SD.

Results

The month-to-month variations in observed SB rates do not follow any obvious pattern in both sexes and populations. Four points should be noted: (1) rates for males were greater than those for females; (2) urban rates were higher than rural ones for both sexes; (3) rates during the subperiod 1963-1976 were higher than those during the 1977-1991; (4) irregular yearly fluctuations could be observed over the entire period; the coincidence of curves within the populations is better than that between the populations.

1963–1976

For both urban male and female fetuses there are negative trends whereas in rural population the positive trends occur over the subperiod studied.

The analysis of observed SB rates revealed the mid-winter peak and summer trough for *male* fetuses. The seasonal variation was more notable for rural population for which the rates were 22.4% above the monthly mean in December as compared with 12.3% for urban population ($p<0.05$), and 25.3% below the mean in July for rural population compared with 14.7% for urban population ($p<0.01$).

Stillbirths for urban *females* exhibit two peaks through the year in April (excess above mean, 14.6%) and November (11.7%) and two troughs in July (deficit, 13.0%) and January (4.2%). For rural females, the periodicity was more pronounced.

The estimating procedure rejected the null hypothesis of the absence of distinguished effects of sex and setting on the annual periodicity of SB rates. These effects are the real ones, the seasonal patterns in the four groups are different, and the regression coefficients are not equal. Comparing the differences between likelihood ratio tests (44.70 for the case when setting groups were pooled vs. 26.04 for the case of sex groups pooled) and values of significance for the null hypotheses invalidity ($p<0.0001$ for setting effect vs. $p<0.05$ for sex effect) one can assume the more marked effect of setting on SB seasonality compared with sex.

1977–1991

Likewise for the 1963–1976 subperiod, the seasonal pattern is again found more pronounced for rural population and for female SBs. Thus, through the year, the observed SB

rates were 15.1% above the monthly mean in December for urban males and 16.8% above in January for rural males ($p<0.1$). For females, the rates in February were 15.6% above the mean for urban population and 22.9% for rural one ($p<0.01$). The sex difference was significant for rural population only (22.9% for female vs. 16.8% for male deaths, $p<0.05$). The minimum rates in June-July were 7.8% below the mean for urban males and 22.2% for rural males ($p<0.01$), and 13.0% and 31.7% below the mean for urban and rural females, respectively ($p<0.001$).

The harmonic analysis allows to conclude that (1) the amplitude of seasonal variation is higher for rural population than for urban one; (2) the peaks of SB rate are in December for urban population and in February-March for rural population; (3) the negative linear trend over the time span considered is established for the male fetuses only. The likelihood ratio test showed that the hypothesis of the absence of differences between groups is quite reliable, and no statistical difference in seasonal patterns of SB rates between the four groups over the 1977–1991 subperiod is observed.

Discussion

This study has established the trends over time and differences in SB rates between sexes and settings. The reasons for the trends observed are presumably multifaceted, and so far no concrete explanation can be suggested for this result. However, it is necessary to note that the improving ante- and perinatal care in Siberia and the resulted decrease in proportion of infections, birth injuries, pregnancy complications, maternal hypertensive disorders among the causes of fetal deaths during the 1960–1990, especially in urban districts, undoubtedly played an important role.

A worldwide decrease over time in the influence of the seasons on the birth and mortality statistics is usually more remarkable in urban than in rural regions [2]. Regarding this difference, the amplitudes are found here to be slightly lower for urban population and maxima are reached somewhat earlier in the year. The similar setting-specific changes were stated in the comprehensive review of human reproductive statistics [3] and in the study of suicides [4]. It is evident from the present investigation that not only the conception and birth rhythms but also the stillbirth annual periodicity are setting-dependent. The decreasing amplitudes in vital statistics, morbidity and mortality annual rhythms have generally been attributed to deseasonalization of the populations [5,6] mainly due to industrialization and urbanization [7].

In the introduction, it is hypothesized a higher seasonality in male SBs basing on the assumptions that annual periodicity of the late fetal death is at least partly due to exogenous (climatic) causes, and that male fetuses are less resistant to these causes usually demonstrating the greater perinatal and infant mortality compared with females. It is surprising that, although the greater mean SB rates were observed for males in both populations, female fetuses exhibited the more pronounced seasonal pattern, whereas according to the known chronobiological evidence the higher absolute amplitude usually accompanies the greater mean value of the parameter. Furthermore, females show the bimodal seasonal pattern during the 1963–1976 subperiod.

The explanation of these phenomena is unclear, but one can assume that female fetuses and/or pregnant girl-bearing women are more sensitive to seasonally varying climatic factors e.g. the ambient temperature. Lerchl has found for Germany [8] that both the absolute temperature and - more markedly - the monthly temperature deviation from the annual mean prior to conception were positively correlated with the sex ratios at birth. Although the main determinants for the secondary sex ratio are known to be the conception-related factors (length of follicular phase [9,10] levels of gonadotropins and gonadal steroids [11]), the fetal loss rate in mammals was found to be sex-specific [9] and temperature-dependent [12]. In Novosibirsk

region, the weather is characterized by the sharp change from cold to heat in April and from heat to cold in October. One can speculate that the bimodal seasonal pattern of stillbirth rate for females with the peaks in April and October might be due to thermal stress caused by the sharp temperature deviation regardless of the opposite directions of changes in spring and autumn.

Melatonin 'mechanism' could also be involved into the control of late fetal death because of the known light- and season-related effects of the hormone on maternal reproductive system via gonadotropins and ovarian steroids [13].

The results of this study demonstrate the seasonal pattern of stillbirth rate in the south part of West Siberia. An involvement of several factors into the causality of stillbirths here could be tested in a desirable observational case-crossover study. This analysis performed on the population level allows to put forward some working hypotheses for such investigation. Individually, the data obtained can be useful in pregnancy planning by women who have had stillbirth(s) in their previous pregnancies.

References

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