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SOCIO-DEMOGRAPHIC DETERMINANTS OF PREGNANCY OUTCOMES AND INFANT GROWTH IN TRANSITIONAL RUSSIA

by

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ABSTRACT

There is a growing body of literature exploring social, demographic, and life-style factors in relation to pregnancy outcomes and infant growth patterns. However, only a few studies on the topic were conducted in transitional economies of Eastern Europe despite considerable political, economic, and social changes in these countries during the last 15 years. The changes in Russia have been even more profound, although no studies on the topic were performed there.

The purpose of the study was to estimate the effect of the socio-demographic and life-style factors on selected pregnancy outcomes and infant growth in transitional Russia. The specific aims were to describe social circumstances around pregnant women in an urban Russian setting and to study social determinants of foetal growth, preterm delivery, initiation and duration of breastfeeding as well as social variations in infant growth patterns.

The study was performed in Severodvinsk, a town in Northwest Russia. All 1559 pregnant women registered at prenatal care centres in 1999 were enrolled in a cohort and followed through delivery and their infants were then followed up during one year. Data about maternal social and demographic characteristics as well as the medical history were obtained from the medical records. In addition, a questionnaire on living conditions and life-style factors was completed at the first antenatal visit. Data on breastfeeding and infant growth are taken from the records at the paediatrics hospitals.

The study revealed considerable social variations in pregnancy outcomes. Clear gradients of birth weight and spontaneous preterm birth rates by maternal educational level were revealed. Maternal education was the most important social factor influencing birth weight, ponderal index and preterm birth rates even after adjustment for known or strongly suspected explanatory mechanisms. Poor housing conditions, perceived stress, and smoking were negatively associated with birth weight. Placental complications, stress, and a history of foetal death in previous pregnancies were associated with elevated risks for preterm delivery, while smoking, hypertension, and multigravidity were associated with reduced length of pregnancy in metric form.

The rates of breastfeeding in Severodvinsk were high. Only 1.3% of infants were never breastfed. Breastfeeding rates at 3, 6, and 12 months were 75.0%, 47.2%, and 18.4% respectively, which is substantially higher than previously reported from Russia. Maternal education, age, and marital status influenced the duration of breastfeeding thereby raising concern of inequalities in breastfeeding practices in Russia.

Prevalence rates of stunting, underweight, and wasting at 12 months of age were 1.1%, 1.1%, and 0.5% respectively – much lower than previously reported from Russia. Mean weight-for-length Z-scores considerably increased from birth to 12 months, while length-for-age Z-scores remained largely unchanged. However, social variations in linear growth indices tended to increase during the first year of life. Positive trends between linear growth and maternal age and education were observed.

In summary, this is the first community-based mother-and-child cohort study, which documents the importance of social determinants of pregnancy outcomes and infant health in transitional Russia. Social variations in pregnancy outcomes, breastfeeding rates, and infant growth patterns indicate existence of inequalities in maternal and child health that might further increase with age.

LIST OF PUBLICATIONS

I. Grjibovski AM, Bygren LO, Svartbo B. Socio-demographic determinants of poor infant outcome in north-west Russia. *Paediatr Perinat Epidemiol* 2002; 16: 255 – 262

II. Grjibovski AM, Bygren LO, Svartbo B, Magnus P. Social variations in fetal growth in a Russian setting: an analysis of medical records. *Ann Epidemiol* 2003; 13: 599 – 605

III. Grjibovski AM, Bygren LO, Svartbo B, Magnus P. Housing conditions, perceived stress, smoking and alcohol – determinants of foetal growth in Northwest Russia. *Acta Obstet Gynecol Scand* 2004; 83: 1159 – 1166

IV. Grjibovski AM, Bygren LO, Yngve A, Sjöström M. Large social disparities in spontaneous preterm births in transitional Russia. *Public Health* 2005; 119: 77 – 86

V. Grjibovski AM, Yngve A, Bygren LO, Sjöström M. Socio-demographic determinants of initiation and duration of breastfeeding in Northwest Russia. *Acta Paediatr* 2005, in press.

VI. Grjibovski AM, Bygren LO, Yngve A, Sjöström M. Social variations in infant growth performance in Severodvinsk, Northwest Russia: community-based cohort study. *Croat Med J* 2004; 45: 757 – 763

The papers will be referred to in the text by their Roman numerals.

CONTENTS

DEFINITIONS

Pregnancy outcome	A summary concept used in this thesis for various measures, such as birth weight, ponderal index, stillbirth, and perinatal mortality
Poor infant outcome	Any of the following outcomes: preterm birth, low birth weight, perinatal death, and Apgar score lower than 7 at the 1st minute
Preterm birth	Birth before the 37th completed week of gestation
Low birth weight	Birth weight less than 2500 grams
Ponderal Index	Birth weight in kg / (length in m)^3
Perinatal death	Stillbirth or death at 0 – 6 completed days of life
Stillbirth	Foetal death at 28 weeks of gestation or later
Infant death	Death within the first year of life
Nullipara	A woman with no previous births
Multipara	A woman with at least one previous birth
Z-score	A standard deviation score for comparison of the observed values with the reference population. Z-score = $(O - M_{ref})/SD_{ref}$, where O is observed value, M_{ref} is mean or median value of the reference population, and SD_{ref} is a standard deviation value of the reference population
Stunting	Height (length)-for-age Z-score below -2.0
Wasting	Weight-for-height Z-score below -2.0

LIST OF ABBREVIATIONS

OR	Odds Ratio
CI	Confidence Intervals
PIO	Poor Infant Outcome
ELSPAC	European Longitudinal Study on Pregnancy and Childhood
PI	Ponderal Index
LBW	Low Birth Weight
BFHI	Baby-Friendly Hospital Initiative
HDI	Human Development Index
GNP	Gross National Product
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

1. INTRODUCTION

The World Health Organization identified inequity in health as a prime obstacle to its "Health for All by the Year 2000" strategy (WHO, 1985). Vågerö (1994) suggested that reduction in inequalities could contribute to the improvement of a populations' health and serve as a tool in maintaining and improving human capital. Pregnancy outcomes are very sensitive to social circumstances around expectant mothers. Socio-economic variations in infant health indicators and key pregnancy outcomes, such as infant and perinatal mortality, low birth weight (LBW), intrauterine growth retardation, and preterm delivery have been found in both developed and developing countries (Kramer, 1987a; Kramer et al., 2000; Villar & Belizan, 1982). For example, almost a third of LBW infants (Spencer et al., 1999) and perinatal deaths (Bambang et al., 2000) are attributable to social inequalities in the UK. The differences in pregnancy outcomes exist not simply between rich and poor, but throughout the whole range of relative wealth in a population. The research on inequalities should focus on the documentation of inequalities, the investigation of the mechanisms that link social circumstances with adverse outcomes, and the evaluation of potential interventions (Logan, 2003). While several wealthy countries have completed the first phase and currently investigate the pathways and develop strategies to reduce social disparities in health, the levels of inequalities in health in general and in mother-and-child health in particular in most countries of the former Soviet Union remain largely undocumented.

1.1. PREGNANCY OUTCOMES

1.1.1. Birth weight

Birth weight is one of the most commonly studied pregnancy outcomes in epidemiological studies. It is precisely recorded in most countries, free to use, and available through vital statistics or medical records. On an individual level, birth weight is a strong predictor of both mortality and morbidity in infancy and reflects antenatal nutritional status and growth rates (Alberman, 1991). Moreover, it is considered to be an important measure of the health status of a population and to reflect socio-economic circumstances (Sterky & Mellander, 1978).

Most of the literature about birth weight determinants has focused on LBW (Lekea-Karanika et al., 1999; Rodriguez et al., 1995; Seidman et al., 1990), defined as birth weight below 2500 g and often seen as the clinically most important aspect of birth weight distribution. In industrialized countries most LBW babies are preterm, though the opposite is true in developing countries, where intrauterine growth retardation plays a major role (Villar & Belizan, 1982). Therefore, LBW does not seem to be an appropriate outcome for epidemiological studies in mother-and-child health, especially on recognition that the determinants of the duration of pregnancy differ from the determinants of foetal growth (Kramer, 1987a; Kramer, 1987b; Kramer et al., 2000).

Finally, birth weight is associated with a number of adult diseases. Growth restriction in the foetal period, clinically expressed as reduced birth weight, has been consistently shown to be a risk factor for coronary heart disease, type 2 diabetes and hypertension later in life (Barker, 1995; Barker, 2000; Godfrey & Barker, 2001; Holness et al., 2000; Lithell et al., 1996; Phillips et al., 1994). These epidemiological findings, known as the foetal origins hypothesis, suggest that diseases that present in adulthood may originate through foetal adaptations to inadequate nutrient supply in certain periods of antenatal development (Barker, 1998).

Importantly, increased risks of adult diseases are not only associated with LBW but exist throughout the entire birth weight distribution. For example, the prevalence of impaired glucose tolerance and death rates from coronary heart disease fall progressively with increases in birth weight (Barker, 1995; Hales et al., 1991). These findings warrant studying birth weight distribution as a whole.

1.1.2. Ponderal index

Ponderal index (PI) is defined as weight in kilograms divided by length in meters raised to power of 3. It is an indicator of thinness of a newborn and is considered to reflect foetal adaptation to unfavorable conditions in mid-late pregnancy. Low PI at birth has been found to be associated with coronary heart disease (Forsen et al., 1997) and non-insulin dependent diabetes (Lithell et al., 1996) in a graded way through the whole distribution similarly to birth weight. For example, the prevalence of non-insulin dependent diabetes in Swedish men gradually increased from 3.5% among those whose PI at birth was 29.4 mg/m^3 or higher to 11.9% in those with PI below 24.2 kg/m^3 (Lithell et al., 1996).

1.1.3. Preterm birth

Most of the morbidity and mortality associated with small size at birth in industrialized countries is related to the duration of gestation, not the rate of growth in utero. In other words, it is preterm birth - not LBW per se - that is primary cause of the excess morbidity and mortality in the perinatal period and shortly thereafter (Rasmussen, 2001). Preterm birth is defined as birth before the 37^{th} completed week of gestation and is a major problem in developed countries accounting for approximately two thirds of neonatal deaths (Terzidou & Bennett, 2002). Notable reduction in early mortality has occurred during last decades in developed countries, but this has been mostly attributed to the improvements in obstetric and neonatal practices, rather than prevention of preterm deliveries. The fall in mortality has been reciprocated by an increase in morbidity and disability in survivors. Therefore, preterm birth can be a devastating event with long-term consequences for the offspring, associated with heavy psychological and economical impact on affected individuals, their families, health care system, and society. In Germany, for example, the overall costs related to preterm delivery exceed €1.0 Billion per year (Friese, 2003).

Preterm births constitute approximately 5-10% of all births (Haram et al., 2003). Moreover, this proportion tends to increase in many countries, which may partly be

explained by introduction of ultrasound techniques to estimate gestational age and by the increase in the number of multiple pregnancies.

The rates of preterm delivery vary considerably between the countries, although some of these variations are due to different inclusion criteria. For example, in 2000, the reported proportions of preterm births were 3.3% in Denmark and 7.5% in Norway, but these differences were attributed mainly to the differences in registration procedures: stillbirths between 22 and 37 weeks' gestation and multiple births were included in Norway, but excluded in Denmark (Haram et al., 2003). In the Soviet Union, any birth before the 28th completed week of gestation was considered an abortion unless the infant survived the first 7 days. This practice is still present in Russia resulting in underestimation of preterm birth rates and complicating international comparisons.

1.2. INFANT GROWTH

Infancy is the period of postnatal life when growth rates and nutritional demands are highest (Baxter-Jones et al., 1999). Even small changes in nutritional or health status are reflected by changes in infant growth pattern. Impaired growth in this period is associated with increased risk of morbidity and mortality (WHO, 1995). Delayed consequences of growth failure in infancy may include lasting deficits in growth (Boddy et al., 2000), poor cognitive development (Corbett & Drewett, 2004), cardiovascular diseases (Robinson & Barker, 2002), and reduced work capacity (Spurr et al., 1977). On the other hand, excessive weight gain during infancy is associated with increased risks of obesity in childhood (Stettler et al., 2002) and in young adulthood (Stettler et al., 2003).

Anthropometric characteristics are the main criteria used to assess the adequacy of infant growth (WHO, 1995). The most often used parameters are length-for-age, weight-for-age, and weight-for-length. Low length-for-age (stunting) reflects a failure to reach linear growth potential as a result of long-term cumulative inadequacies of nutrition and general health. Low weight-for-length (wasting) is often associated with acute malnutrition and/or severe illness. Low weight-for-age reflects both previous indicators. In addition to evaluating the health and nutritional status, growth assessment of infants and children provides good indirect measurement of the social well being in a population. This is particularly relevant for transitional economies due to problems with measuring actual income or consumption in these countries (Micklewright & Ismail, 2001).

Although children have similar growth potential in infancy and early childhood, there is a wide variation in infant growth characteristics between and within countries (WHO, 1997). A substantial part of this variation can be attributed to socio-economic determinants (Habicht et al., 1974). Thus, studying social variations in early child growth is of increased public health concern in populations with high or increasing levels of social inequalities.

Breastfed infants grow differently from bottle fed infants. This necessitates collection of data on feeding mode while studying infant growth patterns. For infants, besides

nutritional benefits, breastfeeding reduces the risk of infectious and atopic diseases, improves visual activity and psychomotor development, and possibly reduces the risk of adiposity in childhood (Heinig & Dewey, 1996a; Oddy, 2002). For mothers, beneficial effects of breastfeeding range from contraceptive effect and reducing the risk of post partum haemorrhage to diminishing the risk of breast cancer, ovarian cancer, and osteoporosis later in life (Heinig & Dewey, 1996b). Moreover, the promotion of breastfeeding among low-income populations is a cost-effective strategy for mothers and for society (Montgomery & Splett, 1997). Success of breastfeeding may be attributed to numerous factors, which can be summarized in five large groups: socio-demographic attributes, psychosocial factors, health care/biomedical factors, community attributes, and public policy (Yngve & Sjöström, 2001).

1.3. SOCIO-DEMOGRAPHIC AND LIFESTYLE DETERMINANTS OF PREGNANCY OUTCOMES AND INFANT GROWTH

There have been a number of studies exploring socio-economic, demographic and common life factors and their influence on various pregnancy outcomes, breastfeeding practices, and infant health. Socio-economic disparities in pregnancy outcomes have been found in many countries, even in those where poverty hardly exists, differences between rich and poor are relatively small and access to prenatal care is universal (Kramer et al., 2000). Socio-economic status is a complex construct generally used to define social inequality, usually measured by income, occupation, and educational attainment (Liberatos et al., 1988). Socio-economic status has been used in many epidemiological studies in relation to pregnancy outcome. In studies of the American population, social and class factors were shown to be more predictive of LBW than medical factors alone for women without serious chronic health problems (Longo et al., 1999).

Rates of adverse pregnancy outcomes generally rise with increasing socio-economic disadvantage. The rise is not necessarily linear; it is often steepest at the lower end of the social scale (Liberatos et al., 1988). Significant associations have been found between socio-economic status and birth weight (Arntzen et al., 1994; Koupilova et al., 1998a; Koupilova et al., 1998b; Koupilova et al., 2000; Vågerö et al., 1999), PI (Vågerö et al., 1999) LBW (Dickute et al., 2004; Hemminki et al., 1990; Hirve & Ganatra, 1994; Lekea-Karanika et al., 1999; Nair et al., 2000; Rodriguez et al., 1995), preterm birth (Koupilova et al., 2000; Parker et al., 1994), and duration of gestation (Olsen et al., 1995; Petridou et al., 1996; Parker et al., 1994) But these findings contradict the results from some other studies (Magnus et al., 1984; Morrison et al., 1989; Tuntiseranee et al., 1999). The contradictions might be at least partly explained by the use of different definitions of socio-economic status in different areas and by adjustments for different mediating factors. Breastfeeding initiation rates, duration of breastfeeding, and infant growth patterns are also influenced by parental socio-economic circumstances (Frongillo et al., 1997; Rogers et al., 1997; Yngve & Sjöström, 2001).

There is a large body of evidence showing an independent effect of maternal education on preterm birth (Koupilova et al., 1998b; Olsen et al., 1995; Parker et al., 1994) intrauterine growth retardation (Kalinka et al., 1996; Parker et al., 1994; Raum et al., 2001), birth weight (Arntzen et al., 1994; Koupilova et al., 1998a; Koupilova et al., 1998b; Koupilova et al., 2000; Nordström & Cnattingius, 1996), length of gestation (Petridou et al., 1996), and LBW (Brzezinski & Szamotulska, 1993; Dickute et al., 2004; Mondal, 2000; Parker et al., 1994; Rodriguez et al., 1995). When parental education was examined jointly, it was found that the mothers' educational level had the greatest impact on birth weight (Arntzen et al., 1994). It is assumed that education can be considered as a proxy for health related behaviors, economic status, nutrition and living standards. However, biological pathways through which education may influence pregnancy outcomes are not completely understood and have to be further explored.

Maternal education was positively associated with duration of breastfeeding in developed countries (Dulon et al., 2001; Lande et al., 2003; Rogers et al., 1997) and in transitional economies (Berovic, 2003; Hoyer & Pokorn, 1998). Negative associations were observed in the Philippines (Abada et al., 2001) and no relationship between maternal education and breastfeeding practices were found in Saudi Arabia (Shawky & Abalkhail, 2003). Prevalence of stunting and underweight in infancy is higher in babies born to mothers with lower education in developing countries (Marins & Almeida, 2002, Shah et al., 2003). No association between education and weight in infancy was recently found in the Netherlands, suggesting that in countries with developed social welfare systems and free health care system, maternal social factors may have little influence on infant growth (Bulk-Bunschoten et al., 2002).

Marital status is another established determinant of pregnancy outcome. Marriage has for a long time been one of the central institutions in most societies. Risks related to marital status are becoming of increasing concern as out of wedlock births are becoming more and more common in Europe. Socio-demographic characteristics of unmarried mothers are often different from those of married mothers (Arntzen et al., 1996a). Marital status was found to be a significant individual predictor for both preterm and term LBW infants in Spain (Rodriguez et al., 1995). Single women had significantly shorter duration of pregnancy in Greece (Petridou et al., 1996). Intrauterine growth retardation was associated with marital status in Poland (Kalinka et al., 1996). Babies of unmarried mothers were significantly lighter in Czech Republic (Koupilova et al., 1998b) and Estonia (Koupilova et al., 2000). The relative importance of the marital status for pregnancy outcomes depends on cultural acceptance of single mothers into the society. In the Nordic countries, for example, unmarried mothers are no longer a marginalized group. In a Swedish study, marital status was not associated with birth weight after adjustment for maternal smoking (Vågerö et al., 1999). Being single is not a risk factor for shorter duration of breastfeeding in Norway (Lande et al., 2003), but it is in Germany (Dulon et al., 2001) and Slovenia (Hoyer & Pokorn, 1998), countries where out-of-wedlock births are less prevalent than in Scandinavia.

Little is known at present about the mechanisms by which marital status functions as a risk factor for various pregnancy outcomes. Cramer (1987) suggested that it was probably only a proxy for other factors. It seems as if being unmarried in some way

constitutes resource deficit (Arntzen, 1996b). In countries where maternal benefits are low, the single mothers may start working and quit breastfeeding earlier than their married counterparts supported by their husbands, for example.

Maternal (Olsen et al., 1995, Sanjose et al., 1991) and paternal (Rodriguez et al., 1995) occupation has been significantly associated with preterm birth in some studies, but not in the others (Morrison et al., 1989; Tuntiseranee et al., 1999). Babies who had unemployed fathers were lighter at birth and had poorer growth in infancy than those of employed fathers in Scotland (Cole et al., 1983). Maternal unemployment was significantly associated with preterm birth in Poland (Hanke et al., 2001) and with the risk of delivering a LBW baby in Lithuania (Dickute et al., 2004). It has been suggested that maternal rather than paternal factors were the major determinants of LBW and preterm birth (Basso et al., 1999).

Income has been found to be an important determinant of intrauterine growth retardation and preterm delivery in the United States and Canada (Parker et al., 1994; Wilkins et al., 1991). Mothers with low income were more likely to deliver LBW babies in Lithuania (Dickute et al., 2004). Correlations between family income and birth weight were found in Thailand (Tuntiseranee et al., 1999) and Norway (Arntzen et al., 1994), but not in Australia (Morrison et al., 1989). However, estimation of actual family income in countries in transition is problematic; therefore, other measures of social well-being should be used (Micklewright & Ismail, 2001).

Despite the fact that there is little doubt of the negative effect of relative social deprivation on adverse pregnancy outcomes, the determinants of gestational duration and preterm birth are different from the determinants of foetal growth. Cigarette smoking, low weight gain, low pre-pregnancy BMI, primiparity, hypertension, short stature, congenital anomalies, non-white race, and alcohol/drug abuse are the most important aetiological determinants of growth restriction in industrialized societies (Kramer, 1987b; Kramer et al., 2000). Genitourinary infections, multiple birth, prior preterm delivery, placental complications, incompetent cervix, low pre-pregnancy BMI, cigarette smoking, heavy work, and cocaine are the determinants of preterm delivery in developed countries, although a large proportion of preterm births remains unexplained and occurs in low risk groups (Kramer, 1987b; Kramer et al., 2000).

The magnitude of the effects of social factors on pregnancy outcomes varies between areas. Many studies performed in developed countries conclude that social characteristics have little or no effect on pregnancy outcomes after maternal anthropometry and smoking are controlled for (Brooke et al., 1989; Morrison et al., 1989; Nordström & Cnattingius, 1996). Generally, the role of social determinants on pregnancy outcomes (Vågerö et al., 1999) and infant growth (Bulk-Bunschoten et al., 2002) has been diminishing during the twentieth century in Western countries, paralleling the improvements in general social conditions.

On the contrary, in countries of the former Communist block, these factors have become of great importance due to major societal changes accompanying the transition from socialism and planned economy to democracy and market economy. Only a few studies on the topic have been performed in these countries in spite of the unique

situation there. The existing materials from the Czech Republic (Koupilova et al., 1998a; Koupilova et al., 1998b) Estonia (Koupilova et al., 2000), Lithuania (Dickute et al., 2004), and Poland (Brzezinski & Szamotulska, 1993; Kalinka et al., 1996) show large and/or increasing social variations in pregnancy outcomes. Moreover, these variations persist even after controlling for some biologic factors, including smoking (Koupilova et al., 2000). An exception is a study from Ukraine, which concluded that the social problems associated with transition did not alter the risk of preterm delivery after classical risk factors were present (Monaghan et al., 2001).

Generally, the observed social variations in pregnancy outcomes are more pronounced in countries of Eastern and Central Europe than in Western Europe and this can not be simply explained by different distribution of biologic and life style factors.

Maternal age and parity are both demographic and social indicators and moreover, their effects are often combined in relation to pregnancy outcomes. Most of the studies have shown an inverse U-shaped distribution of birth weight in relation to maternal age. The heaviest babies are born to mothers in the middle age group, while the lightest are born to mothers at the extremes of age distribution. Recent study from Finland, however, indicates that generally, infant outcomes of teenage mothers are similar to those of middle age group if controlled for the social factors and parity (Hemminki & Gissler, 1996). Young motherhood seems to be a social rather than a medical problem and youthfulness itself is not associated with adverse pregnancy outcomes (Milaat & du Florey, 1992), whereas for older mothers this is a medical rather than social issue (Hemminki et al., 1996). A constellation of socio-demographic factors predicts pregnancy outcomes better than maternal age alone (Seidman et al., 1990).

Firstborn infants have lower birth weight (Cogswell & Yip, 1995). Many studies have shown that birth weight increases from the first to the third child, but decreases afterwards. Adjustments for gestational age, age and parity were found to influence birth weight by affecting foetal growth rather than duraiton of pregnancy (MacLeod & Kiely, 1998). Some studies found null-parity as a risk factor for spontaneous abortions, and preterm births (Cnattingius et al., 1993). Older primiparas have more complications during pregnancy and labor and the outcomes are generally worse.

In relation to breastfeeding, maternal age is positively associated with duration of breastfeeding in most developed settings (Berovic, 2003; Dulon et al., 2001; Hoyer & Pokorn, 1998; Rogers et al., 1997) whereas no association was found in some developing countries (Abada et al., 2001; Shawky & Abalkhail, 2003). Previous infant feeding experience is an important predictor of breastfeeding duration in both developed and developing countries (Victora et al., 1992; White et al., 1990; Yngve & Sjöström, 2001). While a positive association between parity and duration of breastfeeding was observed in Norway (Lande et al., 2003), Slovenia (Hoyer & Pokorn, 1998) and in North America (Bourgoin et al., 1997; Piper & Parks, 1996), the opposite findings were reported in the UK (White et al., 1990) and in the Philippines (Abada et al., 2001). In Jamaica and Peru older women were less likely to breastfeed their infants, but breastfed for longer than young women (Rogers et al., 1997).

Several studies demonstrated an increased risk of preterm delivery and intrauterine growth restriction in women with low pre-pregnancy weight (Brown et al., 2002; Cogswell & Yip, 1995; Edwards et al., 1979; Kramer, 1987a; Kramer et al., 1999; Kramer et al., 2000). Birth weight increases with increasing maternal size (Robinson et al., 2000). Low maternal weight for height is associated with lower birth weight, but foetal weight doesn't increase further when maternal weight-for-height is more than 120% of ideal body weight (Gardosi et al., 1992). Short maternal stature is also associated with reduced foetal growth, but at the same time it has been demonstrated that offspring of short mothers have reduced risk of late foetal death (Cnattingius et al., 1998). Low pre-pregnancy body mass index was shown to be associated not only with increased risk of LBW but also with poor infant survival (Cogswell & Yip, 1995). Mongelli (1996) suggests that there is only one factor, namely, cigarette smoking, which has an effect on birth weight independent of maternal anthropometric parameters. Maternal pre-pregnancy weight serves as an important determinant of placental size and foetal capillary surface area, which plays an important role for nutrient supply to the foetus (Stevens-Simon et al., 1995). Current evidence suggests that maternal height, weight and body composition relate to the metabolic capacity of the mother and determines her ability to support protein synthesis, which is closely related to the foetal growth and development (Jackson, 2000). Maternal obesity is negatively associated with initiation and duration of breastfeeding (Li et al., 2003) that can be at least partly explained by the findings that overweight and obese women had a lower prolactin response to suckling (Rasmussen & Kjolhede, 2004).

Interest in studying the effects of smoking during pregnancy began in 1957 when Simpson reported a significantly lower birth weight for infants born to mothers who smoked than to those who did not (Simpson, 1957). Smoking is widely recognized now as the most important factor associated with intrauterine growth retardation leading to 150 – 200 g reduction in birth weight (Stein & Kline, 1983) with strong evidence of a dose-response relationship (Meyer et al., 1976). The risk of delivering a LBW baby is twice as high among smokers (Floyd et al., 1993; Sexton & Hebel, 1984). It has been estimated that maternal smoking reduces birth weight by 10-15 g for each cigarette smoked per day (Anderson et al., 1984). In relation to preterm delivery, the role of smoking is less important, contributing to a small aetiologic fraction (Kramer et al., 2000). Smoking is more prevalent among the socially disadvantaged in developed countries (Lumley et al., 1985). Women who smoke are less likely to start breastfeeding and if they start, they stop breastfeeding earlier (Rogers et al., 1997). However, it was suggested that this association is largely due to smokers' lower motivation to breastfeed rather than a physiological effect of smoking on their milk supply (Donath et al., 2004).

The prevalence of smoking is increasing in countries of Central and Eastern Europe. It is known that the number of cigarettes smoked per day before pregnancy recognition is the best predicting factor for smoking cessation during pregnancy (Bolumar et al., 1994). The public health importance of smoking depends upon its prevalence during pregnancy and differs considerably between settings. In Nordic countries, smoking has become less prevalent among pregnant women (Eriksson et al., 1996) while the opposite trend may be expected for Russia.

Alcohol appears to be one of the most teratogenic legal substances, particularly if combined with smoking (Cushner, 1993, Streissguth, 1983). Large doses of alcohol during pregnancy can result in foetal alcohol syndrome and antenatal death. A decrease in mean birth weight was observed among babies born to the women who drank one glass of wine every day during pregnancy (Wright, 1984). Lundsberg et al. (1997) found that light wine drinking had a protective effect on growth retardation in the early pregnancy. An inverted "J-shaped" function between drinking during pregnancy and birth weight has been shown in other studies (Abel & Hannigan, 1995). Binge drinking, defined as heavy drinking during a short time, was found to increase the risk for LBW, small-for-gestational-age infants and other adverse pregnancy outcomes (Kaminski et al., 1978; Sulaiman et al., 1988). One should be careful when making conclusions about alcohol and pregnancy outcome because neurodevelopment of the foetus can be affected even when the size at birth is within normal range. Associations between alcohol use and probability of initiation of breastfeeding are similar to that of smoking.

Both alcohol and nicotine enter breastmilk to some extent and can produce adverse effect on the production, volume, composition and ejection of breastmilk, as well as direct negative effects on the infant (Liston, 1998).

1.4. EVIDENCE FROM RUSSIA

Socio-demographic determinants of pregnancy outcomes have become of major importance during the time of transition as was shown in the studies performed in Central and Eastern Europe. However, no studies have been conducted to estimate socially determined variability in pregnancy outcomes and infant health in transitional Russia, although social and economic changes there have been even more profound after the collapse of the Soviet Union in 1991 than in the countries of Central and Eastern Europe.

The information in international peer-reviewed journals on maternal and child health in Russia is scarce. However, an evaluation of Russian medical documentation in relation to reproductive health data performed jointly by Norwegian, Canadian and Russian researchers confirmed its sufficient quality for epidemiological studies in maternal and child health (Odland et al., 1999b).

Some evidence on the social characteristics of pregnant women in the beginning of the 1990s is available from the ELSPAC study (Dragonas et al., 1996) and can be summarized as follows:

- Russia has many young parents living with their own parents or in hostels. Most of them are dissatisfied with their homes and suffer high levels of overcrowding.
- The proportion of regular alcohol drinkers was 0.3% in Russia, compared to 11.2% in the UK before pregnancy. A dramatic drop in alcohol consumption from the time of quickening was registered for the Russian mothers.
- The proportion of maternal smoking during the first trimester is 5% (only 1% of the women smoke more than 10 cigarettes a day) and pregnant women in

Russia are far more likely to stop smoking during pregnancy than those in the UK and in Greece.

Further information on smoking habits among pregnant women in Russia was provided by Odland et al (1999a): the prevalence was 17% in 1993-1994 and smoking did not have an independent effect on birth weight in the Russian population, perhaps because of few cigarettes smoked by the Russian women during pregnancy. These data correspond well with the findings of the Russian authors (Usynina, 1996). In neighboring Karelia, the prevalence of smoking in non-pregnant women was 15% in 1997, though it has been suggested that this proportion is likely to be twice as high due to underreporting (Laatikainen et al., 1999; Laatikainen et al., 2002).

According to the Kola birth register, mean birth weight in Murmansk county in the North of Russia decreased from 3440 g in 1989 to 3245 g in 1993 (Odland, 2000). A similar trend was observed in a city of Astrakhan in the South of the country (Iaroslavtsev, 1998). It is recognized that during the time of economic crisis the mean birth weight in the population decreases (Onah, 2000), so we assume that the data presented above may reflect a general trend in the country.

There had been no studies on socio-economic determinants of maternal and infant health in the Soviet Union before 1990 (Danishevski et al., 2003). Unfortunately most of the research papers published in Russian journals fail to meet western standards in relation to research methodology and presentation of information complicating international comparisons (Tkachenko et al, 2000). Sampling procedures are rarely described. Many studies present only bivariate associations between adverse outcomes and studied variables without adjustment for potential confounders.

Social factors have often been proposed as important determinants of pregnancy outcomes and infant health in Russia after the break up of the Soviet Union, although no study has provided comprehensive evaluation of the role of these factors on pregnancy outcomes. Most studies focused on environmental factors or on ethnic minorities, which might be perceived as less politically sensitive than socio-economic factors (Danishevski et al., 2003).

Data on breastfeeding in Russia are scarce but consistent, showing high rates of breastfeeding initiation: only 1.5% of infants were never breastfed and the rates of breastfeeding varied between 72% and 90% at 3 months and between 32% and 50% at 6 months in Moscow in the 1980s (Fomina et al., 1986). However, late initiation, scheduled feeding sessions, separation of mothers and babies, pre-lacteal feeds, and early introduction of weaning foods were widely practiced (Michaelsen et al., 2003). Prolonged breastfeeding was not recommended and most mothers had stopped breastfeeding their infants by 10 months (Fomina et al., 1986). During the first years of transition, the rates of breastfeeding considerably decreased and were 42% at 3 months and 30% at 6 months in 1995 according to the national data (Notzon et al., 1999). Very little is known on socio-demographic determinants of initiation or duration of breastfeeding in Russia.

According to the national representative sample, 34.9% of infants in the age group 0.50-0.99 years were stunted, 6.1% were underweight, and 1.5 % were wasted in 1993 (WHO, 1997). Two years later, the proportions of stunted, underweight, and wasted infants were 28.6%, 3.7%, and 8.8% respectively (WHO, 1997). However, large economic and social differences between the regions make these data of limited use for the local purposes. Little is known on social variations in infant growth in transitional Russia. Moreover, there is no national data on infant growth after the culmination of the economic crisis in August 1998.

1.5. RUSSIAN FEDEREATION AND ITS TRANSITION TO MARKET ECONOMY

The Russian Federation (Russia) covers a territory of 17 million square km, which makes it the largest country in the world even after the collapse of the Soviet Union (Figure 1). The country represents a collection of diverse territories at vastly different stages of development. The population is rather homogenous: Russians constitute more than 80% of the population, though altogether, there are more than 100 nationalities reside on its territory. Russia is rich in natural resources, such as oil, gas, coal, timber and many strategic minerals. However, the peculiarities of climate, terrain, and distance are among the obstacles that limit exploration of the resources.

Figure 1. Map of the Russian Federation.

The Russian Federation is a successor-country of the Soviet Union. Although the Soviet economic system, characterised by central planning, was rather rigid and wasteful, virtually all citizens had state-guaranteed, housing, and income sufficient for an adequate diet and a socially respectable standard of living. Everyone had a right to free education, health care and decent pensions (Klein & Pomer, 2001). Despite of the fact that the standards of living were generally inferior to the Western standards, the country was ranked 33 in 1990 by its Human Development Index (HDI), above some of today's members of the European Union (UNDP, 1990).

A centrally planned system practiced in the Soviet Union and former Warsaw agreement countries distributes income more evenly than do market economies. The levels of inequalities estimated by Gini coefficient were lower in countries of the former Eastern block than in the Western democracies (Table 1). The breakdown of the Soviet Union in 1991 took 15 newly independent states into "transition" period, similar to the one that had started in former Socialist countries of Central and Eastern Europe a couple of years earlier. Transition itself can be seen as a temporary phase of difficulty and consolidation in which the final result is something known, familiar, and desirable (Sampson, 1998). Economic and social reforms were initiated to achieve the following goals: transition from the totalitarian state to the society of an open type founded on democratic principles and values common to all mankind; replacement of the planning-distributive economy by the market economy; creation of the civil society and development of public institutes; transition from industrial to the post-industrial society; and transition from "human-resource" to "human-capital" ideology (UNESCO, 2000).

Table 1. Gini coefficients in selected countries in 1988 (World Bank, 2002).

Warsaw agreement countries		Western democracies	
Czechoslovakia	20.1	Netherlands	29.0
Bulgaria	22.0	UK	30.8
Hungary (1989)	23.3	Canada	31.9
Romania (1989)	23.4	Sweden	32.2
Poland	25.4	Denmark (1987)	33.2
USSR	26.2	USA	37.8

*Gini coefficient is a number between 0 and 100, where 0 means perfect equality e.g., everyone has the same income and 100 means that one person has all the income, and everyone else earns nothing.

Russian economic reforms, despite the good nature of their intentions, gave rise to poverty, almost non-existant during the Soviet era, considerably widened income inequalities and led to a decline in the standards of living and deterioration in health conditions of the majority. The program of reforms has been followed by unprecedented decline of the Russian economy. After the first eight years of transition, Russian GNP per capita decreased by more than 40%. Notably, crisis struck almost all areas of production. From the USSR's 33rd place in 1990, Russia dropped to 72nd place in 1995 according to HDI, though some improvements have been seen since then (Figure 2).

Having started with a relatively equal society, Russia's level of income inequalities greatly increased and became higher than even that of the USA (Table 2). Reduction of subsidies, shift of labour from the state to the private sector and establishment of a black economy that successfully operates in parallel with the formal economy are among the reasons behind this process. Moreover, incomplete coverage of illegal and other informal sources of income may have led to underestimation of the extent of inequality.

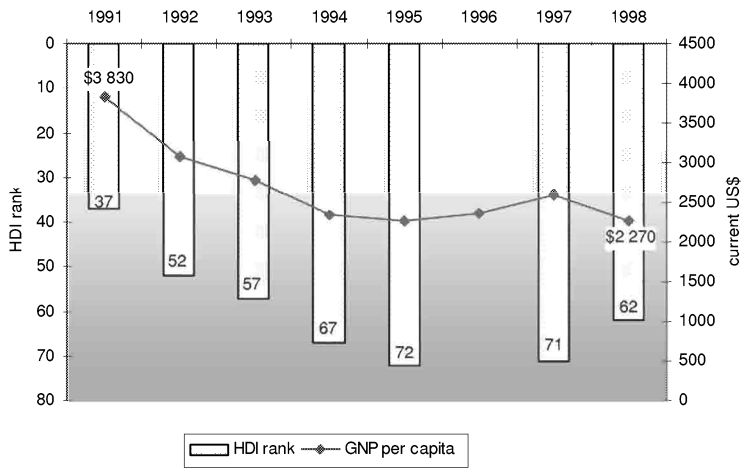

Figure 2. HDI rank and GNP per capita in the Russia Federation 1991 – 1998.

Although the levels of inequalities increased in all former Socialist countries, Russia's changes have been the most profound and paralleled with impoverishment of the majority. Income share of the total income by the poorest quintile dropped from 9.3% in 1988 to 4.4% in 1998. The richest 10% of the population get 38.7% of all income, which is considerably higher than in Europe and the USA, and is comparable to the situation in Latin American and some African countries (World Bank, 2002).

Table 2. Gini coefficients in selected countries in the 1990s (World Bank, 2002).

Former Warsaw agreement countries		Western democracies	
Czech republic (1996)	25.4	Netherlands (1994)	32.6
Bulgaria (1997)	26.4	UK (1995)	36.8
Hungary (1998)	24.4	Canada (1994)	31.5
Romania (1998)	31.1	Sweden (1992)	25.0
Poland (1998)	31.6	Denmark (1992)	24.7
Russia (1998)	48.7	USA (1997)	40.8

Rapid inflation eliminated savings. Gradual increase of salaries lagged far behind the prices for goods and services. By the beginning of 1998, the average salary was more than 2.5 times lower than it was before the reforms were initiated (Klein & Pomer, 2001). Delay of payments has been another characteristic of Russian transition. In some areas the delays were up to 10 or even more months. Besides that, official unemployment rates increased from 4.7% in 1991 to 11.9% in 1998 (Klein & Pomer, 2001). Uncertainty about the future and overwhelming difficulties and misfortunes led to widely spread feelings of hopelessness and helplessness. Crime rates increased considerably. Fight for survival became a major subject of thoughts and talks in Russia. In a 1995 survey, 80% of respondents reported living in conditions of poverty (Klein & Pomer, 2001).

In parallel with the economic and social changes, mortality rates, which were already high compared with levels in the West, rapidly increased and reached their peak in 1994. Some improvements in mortality were observed during the subsequent years. Fluctuations in mortality during the 1990s strongly correlated with underlying economic and societal factors (Men et al., 2001). A clear gradient in adult mortality by the level of education was revealed (Malyutina et al., 2004). Moreover, educational differences in mortality increased during the 1990s (Shkolnikov et al., 1998). Similar processes have been observed in Estonia, another former Soviet republic, during 1989-2000 (Leinsalu et al., 2003). Despite similar intra-population health inequalities in Russia and Estonia, the overall mortality trends in these countries go in the opposite directions. In Estonia, all-cause mortality has decreased during these years, while it has further increased in Russia marking its further divergence from the rest of Europe.

Birth rates started to fall even before the break-up of the Soviet Union and continued to decrease slowly during transition (Figure 3). The natural decrease in population has been partly compensated by immigrants coming mostly from the former Soviet republics. Nevertheless, the population of Russia decreased during the first eight years of transition by 1.7 million (Figure 4), which is comparable to the population of greater Stockholm or the total population of Estonia.

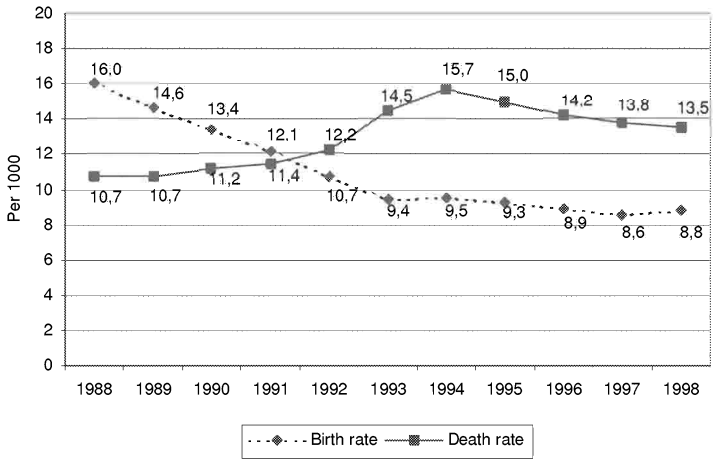

Figure 3. Birth and death rates in Russia, 1988 – 1998.

Decline in life expectancy in transitional Russia, especially in men, is unique in the whole history of Europe. Life expectancy at birth decreased from 63.5 and 74.3 years in 1991 to 57.3 and 71.1 years in 1995 in males and females respectively followed by their increase until 1998 parallel to some minor positive economic changes, although not reaching the levels observed in 1991 (Figure 5).

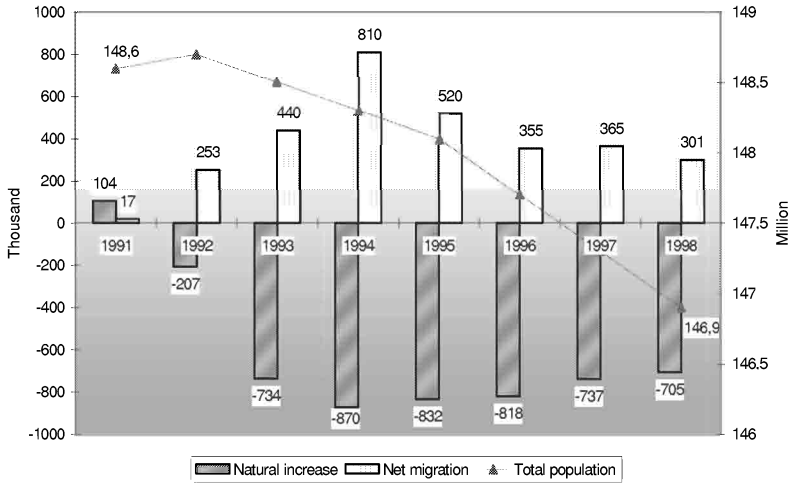

Figure 4. Population dynamics in Russia, 1991-1998.

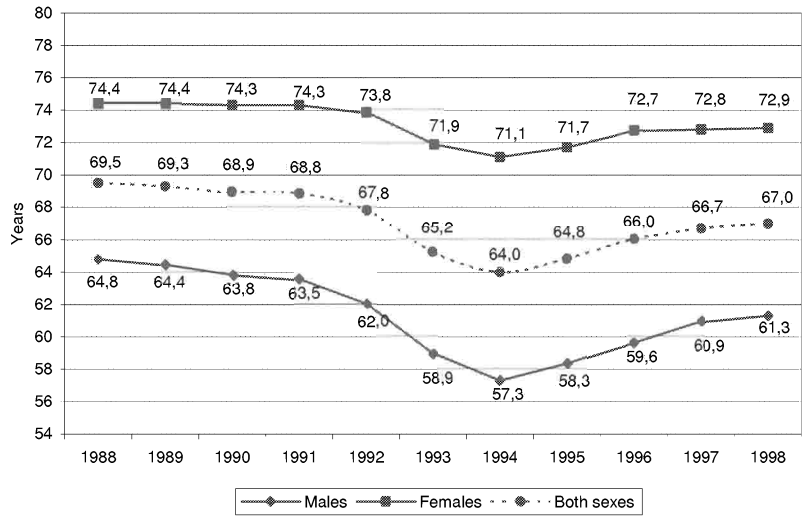

Figure 5. Life expectancy in Russia, 1988-1998.

The difference between life expectancy in males and females is one of the largest in the world. Interestingly, the greatest falls in life expectancy were observed in some of the wealthiest and most urbanized regions in the Northwest and around the cities of Saint Petersburg and Moscow that have been exposed most to social and economic transition and which, despite having greatest increases in average income, have become the most unequal (Walberg et al., 1998). Thus the rise in social inequality

together with impoverishment of the majority and a lack of social cohesion might be among the major social causes of the mortality pattern observed in transitional Russia.

Surprisingly, infant mortality were decreasing from 1993 (Notzon et al., 2003; Figure 6).

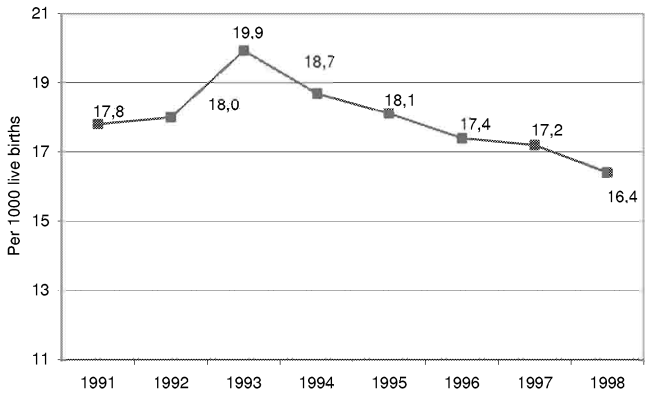

Figure 6. Infant mortality in Russia, 1991-1998.

The peak in infant mortality in 1993 is often explained by the fact that Russia accepted WHO criteria on live birth that year. This means that the rates reported before 1993 may be underestimated. Infant mortality data vary greatly between the regions with the lowest levels observed in Northwestern part of the country. However, infant mortality rates may be underestimated because of the Russian practice of not reporting infant deaths during the first week of life for infants born alive, but weighting less that 1000 grams, or born before the 28th week of gestation. If these do not survive 7 days they are often considered as miscarriages. Notzon et al suggest that correction for the difference in definitions may increase the rates by 25% (Notzon et al., 1999).

The financial collapse in August 1998 was the culmination of economic and social processes with which the authorities were unable to cope suggesting total inadequacy of the reform program (Gorbachev, 2001). The national currency was considerably devalued. Consequently, mortality increased again following a similar pattern to the increase observed in the beginning of the 1990s (Men et al., 2001).

Taking into account profound economic and social changes and their importance for health in general, we suppose that socio-economic factors may play important role in relation to maternal and child health indicators in Russia during the time of transition. The starting point of this study is the year of 1999, the first year that followed the peak of the economic crisis; therefore, one may expect considerable social variations in pregnancy outcomes and infant health to be found.

1.6. STUDY SETTING

The town of Severodvinsk is situated in northwest Russia, 64°34'00'' N 39°50'00'' E. It is located on the southern coast of the White Sea, 35 km west from Arkhangelsk (Figure 1) and was built in the 1930s to support Stalin's naval shipbuilding program. Severodvinsk has been known as one of the most important shipbuilding centres in Russia. During the Soviet time, the city had a privileged status with special support from the state attracting the most educated people by higher living standards and better salaries compared to other parts of the country. The city grew fast until the initiation of Gorbachev's "Perestroika" in 1985. After the collapse of the Soviet Union in 1991, the situation there has been characterized by a decreasing level of support from the state and initiation of market reforms, which resulted in high levels of unemployment and considerable delays in salary for those who work at state-owned shipbuilding enterprises. A shift from being a town with a special privileged status and with a high degree of equality based on almost universal employment at state-owned enterprises to a town without state support, with developing private companies, entrepreneurship and increasing unemployment resulted in substantial changes in demographic patterns.

Demographic trends have been similar to those for the whole country. The population decreased from 256.7 thousand in 1989 to 234.6 thousand in 1998, due to both natural decrease and migration. Decreasing birth rates and increasing death rates caused natural decrease of the population, although the gap was less pronounced than in Russia in general mostly due to lower mortality rates (Figure 7).

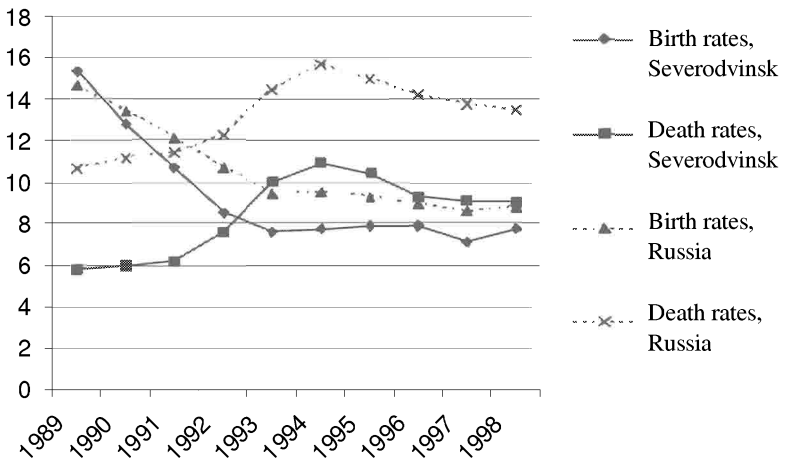

Figure 7. Birth and death rates per 1000 in Severodvinsk and in Russia, 1989-1998.

Trends in life expectancy were also similar to those in Russia. However after 1994, the increase in life expectancy was more notable in Severodvinsk than in Russia in general

(Figure 8). Infant mortality rate increased from 9.8 in 1988 to 14.4 in 1993 but then gradually decreased to 10.5 per 1000 live births in 1997.

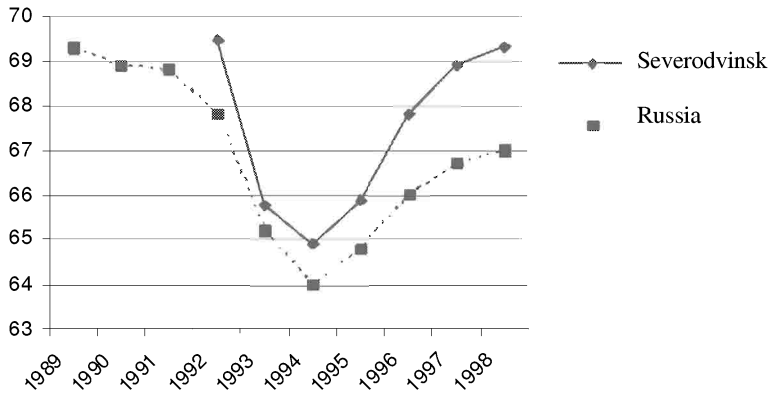

Figure 8. Life expectancy at birth in Severodvinsk and in Russia (both sexes), 1989-1998.

As can be seen from the figures 7 and 8, Severodvinsk generally has had a better demographic situation compared to other parts of Russia, but the pattern has been similar to the rest of the country. This difference can be partly explained by a better baseline socio-economic situation in the city. Infant mortality rates recently decreased probably due to shift of fertility pattern in the city and in the country in general. Only the most well off can afford to have a child during the time of transition.

All prenatal care and services at the maternity home are free of charge (covered by basic medical insurance) and are available for everyone in the town. An antenatal care program is routine for pregnant women, which consists of a number of scheduled visits to the health centres aimed at the detection of complications of their pregnancies and also at giving psychological support and health education (Lindmark & Cnattingius, 1991). The standards for antenatal care in Russia involve a comprehensive baseline assessment of the pregnant woman's health status, a determination of risk factors that will require special care during pregnancy or delivery, and continued surveillance throughout the pregnancy. Every woman is observed by an obstetrician/gynecologist at every visit. The first prenatal visit includes obtaining a medical history of the woman and her family, focusing on risk factors for the pregnancy and delivery, and on genetic disorders that may affect the fetus. A comprehensive physical examination is conducted, including recording of weight, height, measurement of blood pressure, urinalysis, basic blood tests, electrocardiogram, and tests for various types of infections (including sexually transmitted diseases). Finally, the pregnant woman must visit the following specialists: general practitioner, dentist, ophthalmologist, and otorhinolaryngologist. Other specialists are visited in case of chronic somatic diseases. All follow up visits include a physical examination, recording of weight, measurement of blood pressure as well as basic blood tests if necessary. An ultrasound procedure is

carried out at 16 – 18 weeks and at 36 weeks of gestation. The recommended number of antenatal visits is 15.

There are 3 specialized antenatal clinics and one maternity home covering the needs of the population of Severodvinsk. A coverage of prenatal care services in the city has been almost universal during the last years prior to the study according to the Health Care Department of Severodvinsk. Moreover, the proportion of women starting prenatal care before the completed 12 weeks of gestation increased from 87% in 1993 to 90% in 1997 according to the official data. In-hospital care is free of charge and is used frequently. Nearly all deliveries occur in the maternity home.

Private health care facilities also exist in the town but according to the local regulations all pregnant women must be registered at public antenatal clinics and give birth at the municipal maternity home. Private services can be used in addition to public but not as a substitute. High costs of the care in private institutions make their use rare especially in uncomplicated pregnancies. In case of severe complications or serious somatic pathology women are referred to deliver at the regional hospital located in Arkhangelsk.

All infants are registered at the municipal paediatric policlinics. There are five policlinics and one paediatric hospital in the town, which provide medical services to children after discharge from the maternity home and until they reach 18 years of age. All medical care provided to children is free of charge.

Generally, the maternal-and-child health care system in Severodvinsk is similar to that in other regions of Russia in structure and functions.

2. AIM OF THE STUDY

2.1. GENERAL PURPOSE

The overall purpose of the study was to document the existence of social inequalities in mother-and-child health in an urban Russian setting by estimating the influence of a wide range of social, demographic, and lifestyle factors on selected pregnancy outcomes and infant growth pattern.

2.2. SPECIFIC AIMS

The specific aims were as follows:

- To describe the distribution of social, demographic, and lifestyle factors in pregnant women in a Russian town
- To estimate the influence of the studied factors on poor infant outcome in general and on foetal growth (measured by birth weight and ponderal index) and spontaneous preterm birth in particular
- To study initiation rates and duration of breastfeeding as well as their determinants in an urban Russian setting
- To provide information on infant growth pattern in relation to maternal socio-demographic characteristics and duration of breastfeeding in a Russian town

3. METHODS

3.1. STUDY DESIGN AND STUDY POPULATION

This study is a community-based cohort study. All women with viable pregnancies registered at municipal prenatal care centres from 1 January to 31 December 1999 comprised the cohort and were followed through delivery. Women who visited prenatal care centres for abortion counseling were not included in the study. The total number of registered women was 1559. Of these, 36 had miscarriages after registration, 41 had induced abortions on either medical or social indicators, 11 delivered twins, 5 had stillbirths, and files were not available for investigation for 67 women most of which either moved from the town or were referred to the regional level of care (Figure 10). Pregnancy outcomes are analyzed in Papers I – IV. Paper I is based on all singleton deliveries. Papers II and III are based on all live singleton births, whereas Paper IV is based on spontaneous live singleton deliveries only.

In order to study breastfeeding duration and infant growth patterns in the town (Papers V – VI), we attempted to trace all the infants from the cohort who were alive and residing in Severodvinsk at 12 months of age (Figure 10).

3.2. DATA SOURCES

For analyzing pregnancy outcomes and their determinants, medical records at the prenatal care centres and maternity home were examined. Maternal data included age, education, occupation, pre-pregnancy weight, parity, and dates of the last menstrual period and the first antenatal visit. In addition, a non-anonymous questionnaire was administered at the first visit to the prenatal care centre. The questionnaire was tested in a pilot study in December 1998 and contained items on housing conditions, household structure, smoking and alcohol consumption in both parents, partner's employment, stress at work and at home, and whether the index pregnancy was planned or unplanned. Moreover, information on reproductive history and complications of the index pregnancy was collected and included in Paper IV.

Infant data at birth were collected from the records at the maternity home and included sex, Apgar scores at the first minute, weight, and length. Infant weight and length at 12 months of age as well as the data on breastfeeding were obtained from the medical records at the paediatric policlinics.

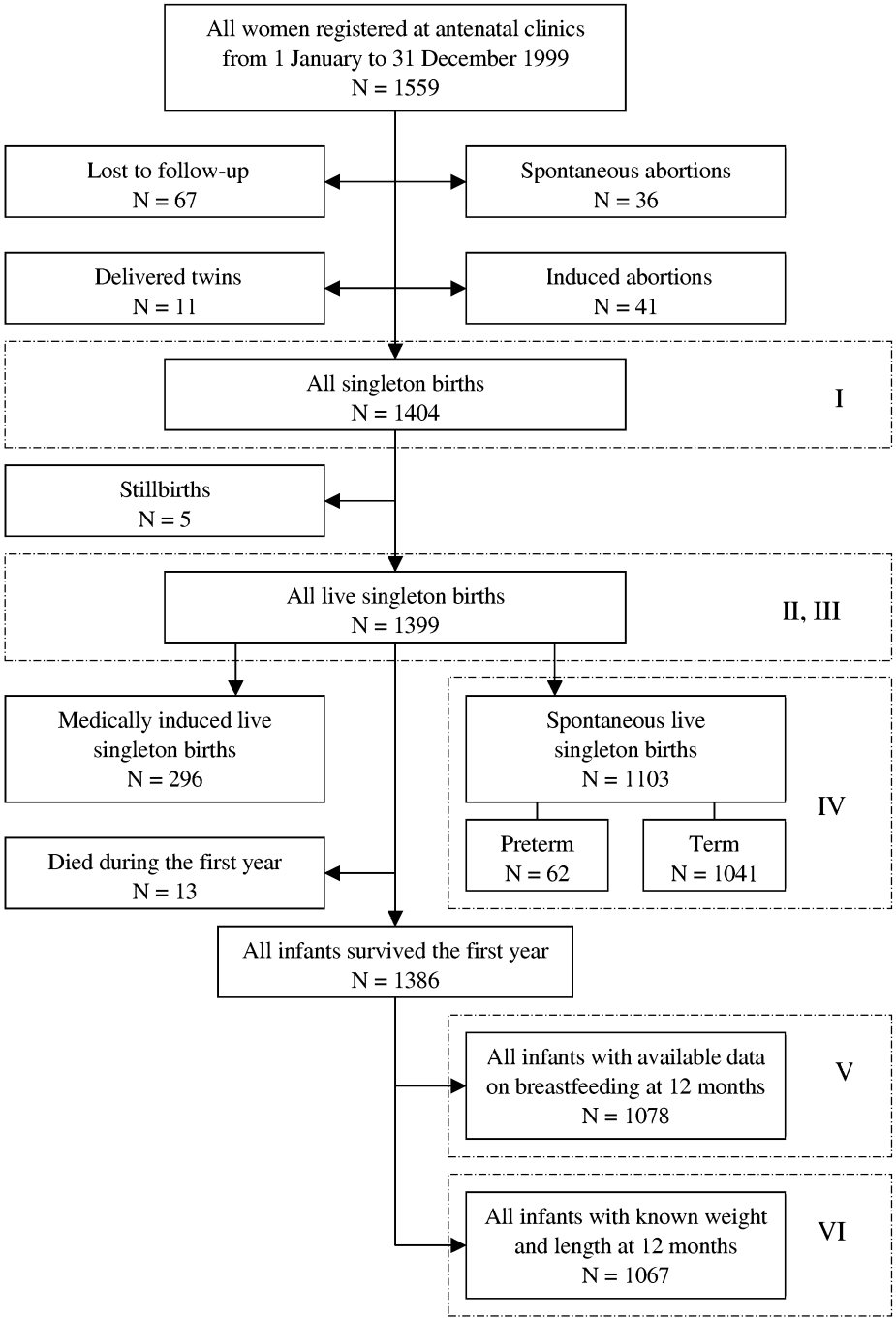

Figure 10. Sampling frame of the Severodvinsk cohort study with references to the publications presented in the thesis.

3.3. STUDIED OUTCOMES

PIO was used as a dichotomous dependent variable in Paper I. PIO was defined as any of the following outcomes: preterm birth, LBW, perinatal deaths, and Apgar score lower than 7 at the 1st minute.

Birth weight measured in grams and PI defined as weight in kg divided by length in m^3 were analyzed as continuous dependent variables in Papers II and III.

Spontaneous preterm birth as a dichotomous outcome and gestational length in weeks as a continuous variable were studied in Paper IV. The delivery was classified as preterm if it occurred before the 37th completed week of pregnancy measured from the last menstrual period.

Breastfeeding initiation as a dichotomous variable and breastfeeding duration in months and weeks as a continuous variable were studied in Paper V.

Length-for-age, weight-for-age, and weight-for-length Z-scores at 12 months of age were calculated using CDC-2000 reference population in the NutStat program of the Epi-Info software and analyzed as continuous dependent variables in Paper VI.

3.4. SOCIO-DEMOGRAPHIC VARIABLES

3.4.1. Data available from the medical records

Maternal education was classified according to the official Russian classification into one of 5 groups: basic, secondary, vocational, incomplete and complete university levels of education. Mothers with unknown education comprised a separate group. Marital status was either married or unmarried according to official marital status. Women living with partners without registered marriage were included in the unmarried group. The following groups were used for occupation: unskilled and skilled blue-collar workers, students (of all kinds of educational establishments), white-collar workers, and unemployed. Classification of pre-pregnancy weight was based on the doctors' diagnosis (as written in medical records) and divided into three categories: underweight, normal weight and overweight. Nulliparas are women with no previous deliveries and paras are those with at least one previous delivery. Women who started prenatal care after a completed first trimester of pregnancy were classified as late attenders. Gestational age was calculated in weeks starting from the first day of the last menstruation period as recommended by the ICD-10.

3.4.2. Data collected using the questionnaire

The number of cigarettes smoked daily was recorded for both partners. Amount and frequency of typical alcohol consumption per week was obtained for each beverage (beer, wine, and spirits) for both partners. An alcohol score was calculated to assess the absolute alcohol content from all types of beverages. The alcohol percentage used for the calculations was 5% for beer, 11% for wine, and 40% for spirits. Living conditions

were classified in terms of type of housing (room in a hostel, communal flat, shared or own apartments), household structure (living alone, with parents, with partner, with partner and his or own parents) and crowded housing situations. The situation was termed crowded if the number of people permanently living in the household was 1.5 times higher than the number of rooms available. Perceived stress was assessed by two direct questions about exposure to stressful situations at work and at home. We considered the stress to take place if any of these two questions was answered positively. The data obtained from the questionnaire were used only in papers related to pregnancy outcomes.

3.5. STATISTICAL ANALYSES

Bivariate relationships between nominal variables were analyzed using chi-square tests (Papers I – VI) and Fisher's exact tests (Paper V). Paired t-tests were employed to compare infant anthropometric characteristics at birth and at 1 year of age (Paper VI). Mean values for three or more groups were compared using one-way ANOVA (Paper IV) and Kruskall-Wallis tests (Paper V) for normally and non-normally distributed data respectively.

Multiple linear regression was used to quantify the effects of independent variables on birth weight (Papers II, III), PI (Papers II, III), duration of gestation (Paper IV), and length-for-age, weight-for-age, and weight-for-length Z-scores at 12 months of age (Paper VI) with and without adjustment for potential confounders.

Multivariable logistic regression was applied to study independent associations between the studied factors and PIO (Paper I), LBW (Paper II), and preterm birth (Paper IV).

Proportional hazard analysis (Cox regression) was employed to estimate the individual influences of the studied factors on duration of breastfeeding (Paper V).

Odds ratios greater than 1.0 refer to elevated risks of PIO (Paper I), LBW (Paper II), preterm birth (Paper IV), and breastfeeding discontinuation (Paper V).

In addition, trends across maternal age, weight, and educational categories were studies by introducing these categories as continuous independent variables in multivariable models (Papers V – VI).

All statistical procedures were performed using SPSS software.

4. SUMMARY OF ARTICLES

4.1. PAPER I

Grjibovski AM, Bygren LO, Svartbo B. Socio-demographic determinants of poor infant outcome in north-west Russia. *Paediatr Perinat Epidemiol* 2002; 16: 255 – 262.

Pregnancy outcomes are associated with parental socio-economic status in both developing and developed countries. Russian transition to democracy and market economy has been characterized by major social transformations including impoverishment of the majority of the population and a considerable increase in income inequalities. However, the information on the influence of social factors on pregnancy outcomes in transitional Russia is scarce.

Poor infant outcome (PIO) is a complex indicator, meaning any of the following unfavourable pregnancy outcomes: preterm delivery, LBW, perinatal death, and low first-minute Apgar score. A total of 1404 women residing in Severodvinsk, who attended prenatal care clinics in 1999 and delivered at the maternity home were include in the study, which aimed to estimate the importance of socio-demographic factors for the risk of PIO.

Maternal education was found to be the most influential factor even after adjustment for potential confounders. Mothers with secondary or less education (OR = 1.9, 95% CI: 1.2, 3.0), vocational (OR = 1.8, 95% CI: 1.1, 2.9), and unknown education (OR = 1.8, 95% CI: 1.1, 3.0) were more likely to have PIO than mothers with university level of education. Unmarried women and women aged 30 or older also had higher risks of PIO (OR = 1.4, 95% CI: 1.0, 1.9 and OR = 1.6, 95% CI: 1.1, 2.5 respectively). Other well-known determinants of adverse pregnancy outcomes, such as smoking, alcohol consumption, occupation, young maternal age, stress, and poor living conditions were not associated with the studies outcome.

The study shows that maternal socio-demographic factors, such as education, marital status, and advanced age are important determinants of pregnancy outcomes in general in transitional Russia.

4.2. PAPER II

Grjibovski AM, Bygren LO, Svartbo B, Magnus P. Social variations in fetal growth in a Russian setting: an analysis of medical records. *Ann Epidemiol* 2003; 13: 599 – 605.

Compromised foetal growth is associated with infant mortality and morbidity. Moreover, recent studies have demonstrated an association of foetal growth indicators, such as birth weight and PI with a number of chronic diseases in adults. Given that birth weight and PI are sensitive to social factors, studying their social determinants in

Russia may contribute to the understanding of the vulnerability of the growing foetus and may also have long-term implications.

The paper estimates the influence of maternal socio-demographic characteristics on birth weight, PI, and LBW in Severodvinsk using the data on 1399 mothers and their live born infants.

Crude analyses revealed clear gradients of birth weight, PI, and proportions of LBW across maternal educational levels. These associations persisted after adjustment for maternal age, occupation, marital status, parity, pre-pregnancy weight, sex of the baby, timing of prenatal care initiation, and gestational age indicating that maternal education is significantly associated with foetal growth in transitional Russia. The differences in birth weight and PI between the most and the least educated mothers (207 g, 95% CI: 55, 358) are among the largest in Europe. Besides education null-parity and low pre-pregnancy weight were associated with reduced fetal growth. Babies born to women in age group 30-34 years were significantly heavier than babies in the reference group.

Intermediate mechanisms, which are involved in the revealed associations, have yet to be identified. Maternal education is recommended for use in studies in Russia as an indicator of a socio-economic status. Monitoring of social variations in foetal growth indices during the time of transitions should be introduced to ensure that all parts of the society benefit from on-going social and economic reforms.

4.3. PAPER III

Grjibovski AM, Bygren LO, Svartbo B, Magnus P. Housing conditions, perceived stress, smoking and alcohol – determinants of foetal growth in Northwest Russia. *Acta Obstet Gynecol Scand* 2004; 83: 1159 – 1166.

Although PIO was not associated with poor living conditions, smoking, and alcohol in Paper I, it is unlikely that in a country that is the largest importer of tobacco, where alcohol plays an important role in social life and living conditions vary a lot, these factors don't affect early human development. Birth weight and PI are sensitive indicators of foetal growth and are both linked to maternal social circumstances. The aim of the paper is to quantify the importance of living conditions, smoking, alcohol, and stress on foetal growth in Severodvinsk.

Birth weight of the infants whose mothers reported smoking was on average 126 g (95% CI: 54, 198) lighter than the infants of non-smoking mothers. One cigarette per day was associated with a reduction of birth weight by 27 g (95% CI: 10, 44) independently of other factors. Living in shared apartments, crowded housing, and self-perceived stress were associated with birth weight loss by 89 g (95% CI: 25, 153), 82 g (95% CI: 28, 136), and 61 g (7, 116), respectively. Living with parents was positively associated with both birth weight (142 g, 95% CI: 25, 259) and PI (0.70, 95% CI: 0.15, 1.24). Excessive paternal drinking was associated with a decrease in average PI by 0.51 kg/m^3 (95% CI: 0.05, 0.98). Surprisingly, infants whose mothers reported occasional alcohol drinking were on average 65 g (95% CI: 2, 129) heavier than those born to

mothers who reported no alcohol consumption. In addition, maternal education remained significantly associated with birth weight even after all factors mentioned above were included in the model.

Poor housing, maternal smoking, and stress are important mediating factors explaining a part of social variations in foetal growth.

4.4. PAPER IV

Grjibovski AM, Bygren LO, Yngve A, Sjöström M. Large social disparities in spontaneous preterm births in transitional Russia. *Public Health* 2005; 119: 77 – 86.

It is recognized that the determinants of preterm birth are different from those of foetal growth restriction. Moreover, the determinants of spontaneous preterm birth differ from the determinants of medically induced preterm deliveries. The former are much less known.

The aim of the paper is to estimate the effects of maternal socio-demographic, obstetric and lifestyle factors on spontaneous preterm birth in Severodvinsk.

Preterm births constituted 5.6% of all spontaneous preterm births. Mothers with lower education had considerably higher preterm birth rates in crude analysis: OR = 9.1, 95% CI: 2.8, 30.3; OR = 6.1, 95% CI: 6.1, 95% CI: 1.8, 21.1, and 4.8, 95% CI: 1.3, 17.2 respectively, for mothers with secondary or less, vocational, and unknown levels of education compared with mothers with at least 3 years of university studies. Adjustment for other socio-demographic characteristics actually increased the variations in preterm birth across the levels of maternal education. After incorporating the data on maternal reproductive history, pregnancy complications and life-style factors in the multivariable models, placental complications, history of antenatal death in previous pregnancies, being a student, and self-perceived stress were independently associated with increased risks of preterm birth while skilled blue-collar workers had lower risks of preterm delivery. Smoking, hypertension, and multigravidity were associated with reduced duration of pregnancy in the metric form.

This study emphasizes that in addition to traditional medical risk factors, social factors are important determinants of spontaneous preterm delivery in transitional Russia.

4.5. PAPER V

Grjibovski AM, Yngve A, Bygren LO, Sjöström M. Socio-demographic determinants of initiation and duration of breastfeeding in Northwest Russia. *Acta Paediatr* 2005, in press.

Data on breastfeeding in Russia is scarce, though the available evidence suggests that the economic crisis considerably aggravated the negative effects of Soviet maternity

routines in relation to breastfeeding, resulting in decline in breastfeeding rates after the collapse of the Soviet Union.

This paper presents the data on the pattern and socio-demographic determinants of initiation and duration of breastfeeding in transitional Russia using the data from the Severodvinsk cohort.

Based on the information from the medical files at the paediatric clinics, only 1.3% of infants were never breastfed. Breastfeeding rates at 1, 3, 6, 9, and 12 months were 96%, 75%, 47%, 27%, and 18% respectively. Maternal age and early initiation of prenatal care were associated with breastfeeding initiation rates. Proportional hazard analysis showed that teenage mothers (OR = 1.5, 95% CI: 1.1, 2.0), mothers with basic education (OR = 1.7, 95% CI: 1.1, 2.7), and unmarried mothers (OR = 1.2, 95% CI: 1.0, 1.4) were more likely to stop breastfeeding their infants earlier. Women with no previous deliveries were more likely to breastfeed longer (OR = 0.7, 95% CI: 0.6, 0.9).

The initiation of breastfeeding in Severodvinsk is almost universal. The rates of breastfeeding at specific time points were considerably higher than previously reported from Russia, but still far from those recommended by the WHO. Data on exclusiveness and the total length of breastfeeding are not routinely collected and reported, indicating the lack of background for breastfeeding promotion according to the WHO recommendations. Social variations in breastfeeding practices should raise concern of inequalities in breastfeeding practices in transitional Russia.

4.6. PAPER VI

Grjibovski AM, Bygren LO, Yngve A, Sjöström M. Social variations in infant growth performance in Severodvinsk, Northwest Russia: community-based cohort study. *Croat Med J* 2004; 45: 757 – 763.

Infant anthropometric characteristics are the main criteria to assess infant growth. Although infants have similar growth potential in infancy, there is wide variation in infant growth between and within countries.

The paper describes infant anthropometric data assessed at 1 year of age and their socio-demographic determinants using the data from the Severodvinsk cohort.

We managed to trace 1067 infants from the original cohort with available anthropometric data at 12 months of age. Only 1.1% of infants were stunted, 1.1% underweight, and 0.5% wasted at the age of 12 months. The mean Z-scores for length-for-age, weight-for-age, and weight-for-length were 0.48 ± 0.93, 0.38 ± 1.04, and 0.65 ± 1.03 respectively. Mean weight-for-length Z-scores considerably increased from birth to 12 months, while length-for-age Z-score remained largely unchanged. In regression analysis, length-for-age Z-scores were lower by 0.77 ($p = 0.017$) and by 0.30 ($p < 0.001$) in infants born to mothers with basic and unknown education respectively. Positive trends between linear growth and maternal age ($p = 0.024$) and education ($p = 0.023$) were observed though no associations between socio-demographic factors and

ponderal growth were found. Duration of breastfeeding was negatively associated with linear growth. Small-for-gestational age infants remained shorter, lighter, and thinner than infants who had adequate weight at birth. Infant length and weight at birth were significantly associated with length and weight at 12 months respectively, whereas no association between weight-for-length at birth and at 12 months was found.

Compared with previous studies from Russia, prevalence of stunting, underweight, and wasting were lower and similar to those from developed countries. This may reflect relatively good overall socio-economic conditions in the town. However, we found social variation in linear growth that may indicate the existence of inequalities in infant health, which may further increase with age.

5. DISCUSSION

Studying societies in crisis or transition can contribute to the understanding of foetal and infant vulnerability to adverse social circumstances. The Severodvinsk study accomplished its overall purpose to document the existence of social inequalities in mother-and-child health in transitional Russia. As this study is among the first Russian studies on the topic, the interpretation of the results should be done carefully taking into account methodological strengths and limitations of the study.

5.1. SELECTION BIAS

Universal access to the free antenatal care ensured that almost all pregnant women in the town were registered at the prenatal care centres during the study year. According to local health care authorities, more than 99% of pregnant women were registered in antenatal clinics in 1999 and all of these women were enrolled in the cohort. However, sixty-seven women (6.4% of the initial sample) were lost to follow up. The main reasons were moving from the town and having somatic pathology resulting in referral to the regional level of care. Their pregnancy outcomes were unknown. Given that unregistered women and women who were lost to follow up were more likely to have PIO, the estimated preterm birth rate may be slightly underestimated and average birthweight overestimated.

In spite of the fact that Russia officially accepted the WHO criteria of live birth in 1993, the common practice is still to consider infants who were born before the 28th week of gestation and who died during the first week as miscarriages. This may lead to underestimation of the number of preterm births, perinatal and infant deaths. It may also result in overestimation of the anthropometric parameters at birth since the smallest babies appear to be excluded. However, the number of such infants is generally very small – only 0.6% of all preterm births were born at 20-27 weeks in Ukraine (Little et al., 2004).

Altogether, 27% of the women who delivered at the maternity home did not fill in the questionnaire on social circumstances. A special category "no information" was introduced for the variables with missing data making it possible to include all 1399 and 1103 women into the studies of foetal growth and spontaneous preterm births respectively. Interestingly, the mean values for birth weight, PI, and duration of pregnancy, as well as percentages of PIO in general and preterm births in particular, in the "no information" groups were close to the values in the reference groups. It is therefore unlikely that the women who did not complete the questionnaire had considerably higher proportion of smokers, drinkers or women living in adverse social environments.

Information on breastfeeding and infant anthropometrics at 1 year of age was missing for approximately 22% of infants who survived the first year (n = 386). Comparisons

of maternal baseline characteristics and infant characteristics at birth between the infants whose information was available for the study at 12 months and for those whose information was not available at 12 months revealed that there were more women with basic education, more preterm and LBW infants in the latter group. Therefore, it is likely that infant growth indices and breastfeeding rates in Severodvinsk are overestimated. This overestimation is probably small given that the proportions of mothers with basic education, LBW infants, and preterm infants were 3.6%, 5.1%, and 6.1% respectively.

5.2. MEASUREMENT BIAS

Measurement bias seems unlikely for most data obtained from the medical records. Qualified medical professionals accurately recorded birth characteristics, infant anthropometric measurements, and maternal baseline data as a part of their daily routine work. Critical evaluation of Russian medical documentation in relation to reproductive health data in a neighbouring Murmansk county confirmed its sufficient validity for international epidemiological studies (Odland et al., 1999). One variable, namely, maternal education, had a considerable amount of missing values in the medical records (21%). The reason is that this variable is not used for the reports and therefore the staff does not pay much attention to recording the level of education. Validity of the data on some pregnancy complications is questionable. Contrary to what might be anticipated, the prevalence of diagnosed genitourinary infection was considerably lower than in previous studies from Russia (Vaktskjold et al., 2004) and Ukraine (Monaghan et al., 2001). Moreover, women who delivered preterm were less likely to have infection, which contradicts the existing evidence (Haram et al., 2003; Kramer et al., 2000; Slattery & Morrison, 2002).

Validity of the questionnaire (Papers I, III, IV) was tested in a pilot study, which included 50 randomly selected women at the maternity home in December 1998 and face validity of the questionnaire was accepted. Nevertheless, a rather high level of non-response makes us suggest that some questions, for example, on smoking and alcohol consumption might be culturally sensitive thus threatening the validity of our estimates. The validity of each variable derived from the questionnaire will be discussed below together with consistency with other studies.

5.3. CONFOUNDING FACTORS AND INTERVENING VARIABLES

Most of the known potential confounders were controlled for in multivariable analyses. Nevertheless, one cannot exclude a probability of unknown and therefore uncontrolled confounding factors. Theoretically, serious somatic/mental disease might be a confounding factor for the association between social factors and pregnancy outcomes by limiting the ability to get the best education and having direct (probably through some intermediate factors) effects on the course of pregnancy. We did not include pre-pregnancy somatic/mental conditions in this study, but the number of such women is likely to be very low.

Smoking, alcohol and stress are associated with adverse pregnancy outcomes and vary inversely with social factors; therefore they may be considered as intervening variables (Kramer et al., 2000). If adjustment for these variables results in reduction of previously significant association between maternal education and studied outcomes to non-significant levels, one may conclude that the social variations in adverse pregnancy outcomes are attributed to the higher prevalence of these intermediate factors among women with lower level of education. However, in our study, social variations in pregnancy outcomes remained to be significantly associated with all studied pregnancy outcomes even after adjustment for the intervening variables. This means that there may be other intermediate factors involved. Poor nutrition, insufficient weight gain during pregnancy, complications of the index pregnancy and the use of medical services for timely treatment of these complications might be the pathways through which better social status may be associated with better pregnancy outcomes.

No adjustment for intermediate variables was performed in our studies on social variations in breastfeeding duration and infant growth leaving the question about the mechanisms through which social factors are related to the studied outcomes unanswered. It was found that a substantial number of the participants changed their addresses during the year of follow up after delivery making the data on living conditions and family structure collected during pregnancy inappropriate for further use. Smoking and alcohol consumption patterns after childbirth could also differ from those during pregnancy. This forced us to exclude all the data obtained by means of the questionnaire from our studies on breastfeeding and infant growth.

5.4. COMPARISONS WITH OTHER STUDIES

Besides being potentially overestimated, the mean birth weight (3,358 g) in the sample was lower than then in developed countries (Hesse et al., 2003; Koupilova et al., 1998b; Arntzen et al., 1994; Nordström & Cnattingius, 1996; Odland et al., 1999a; Vangen et al., 2002), similar to that in Czech Republic in 1996 (Koupilova et al., 1998a) and slightly higher than reported from previous smaller studies conducted in Northwest Russia (Odland, 2000; Usynina, 1996; Vershubsky & Kozlov, 2002).

The mean value of the PI (25.17 kg/m^3) was lower not only than in Sweden in 1991 but also lower than in Czech Republic (Koupilova et al., 1998b) and in Sweden in the 1920s (Vågerö et al., 1999). These differences are unlikely to be attributed to genetic differences between populations. PI increased in Sweden from 26.0 kg/m^3 in the 1920s to 27.4 kg/m^3 in 1985 parallel to general improvements in social standards (Vågerö et al., 1999). We did not find data showing a decrease in PI during crises but there is evidence from different settings that fetal growth decreases in societies undergoing economic turmoil (Onah, 2000).

Altogether, 6.1% of all singleton births were preterm, which is two times higher than in Denmark (Haram et al., 2003) and only slightly exceeds the rates in Estonia (Koupilova et al., 2000) and Ukraine (Little et al., 2004; Monaghan et al., 2001). Including stillbirths increases this proportion to 6.3%. However, different inclusion criteria in different countries make international comparisons complicated.

Almost universal initiation of breastfeeding is typical for Russia (Fomina et al., 1986), however our study revealed considerably higher breastfeeding rates at 3, 6, 9, and 12 months than previously reported. This success may be at least partly attributed to the regional strategies to promote breastfeeding by introducing the Baby-Friendly Hospital Initiative (BFHI) in the Arkhangelsk Region. By now, all maternity homes in the regional center are certified by WHO/UNICEF as baby-friendly hospitals, however, this is not the case for the maternity home in Severodvinsk, although significant changes in the maternity routines took place during the last 10 years. The rates of breastfeeding at specific time-points are similar to those obtained in other settings implementing BFHI (Hoyer & Horvat, 2000; Kramer et al., 2001a), although not all interventions promoting breastfeeding in Russia were as successful as the one in Northwest Russia (Chalmers et al., 1998; Rhyne & Hertzman, 2002).

All mean values for infant growth indices at one year are higher in Severodvinsk than in the reference population. The proportions of stunted, underweight, and wasted infants are very low reflecting relatively good overall conditions in the town. Interestingly, Z-scores of linear growth remained largely unchanged while weight-for-length Z-scores considerably increased during the first year of life. Given that excessive weight gain in infancy may be associated with obesity in childhood (Stettler et al., 2002) and even in adulthood (Stettler et al., 2003), further follow up of this cohort is recommended.

The most notable finding of our study is the independent association of poor pregnancy outcomes in general (Paper I) and birth weight (Papers II, III), PI (Papers II, III), and preterm delivery (Paper IV) in particular as well as breastfeeding duration (Paper V) and linear infant growth (Paper VI) with the level of maternal education in a graded way. The crude difference in birth weight between the most and the least educated mothers was 298g, which is comparable with the findings in Czech Republic (Koupilova et al., 1998a), but larger than in Lithuania (Dickute et al., 2004), Estonia (Koupilova et al., 2000), Sweden (Koupilova et al., 1998b), Hong Kong (Cheung & Yup, 2001) and Thailand (Tuntiseranee et al., 1999). The difference in thinness at birth between the babies born to the most and the least educated women was also larger than in Sweden and Czech Republic (Koupilova et al., 1998b). Moreover, maternal education remains significantly associated with birthweight and PI after adjustment for all studied factors including smoking. Even after adjustment the difference was larger (137g, 95% CI: 57, 217) than in most previous studies except the studies from transitional countries. Until now, the largest differences in birth weight (256g) between the infants born to the least and the most educated women were registered in Czech Republic in 1996. Using the same factors in the multivariable model, the differences in Severodvinsk were 274 g (95% CI: 88, 459), which is similar to the findings by Koupilova et al (1998b).

Our findings together with the results of the other Eastern European studies contradict the conclusion made by Nordström & Cnattingius (1996), that there are no further social differences when adjustments for factors like age, parity and smoking have been made. These differences do exist in countries of the Eastern Europe, which are currently undergoing a process of social and economic transition. The gradient between

both indices of fetal growth and maternal education is independent of age, parity, smoking and other factors and the mechanisms of these associations need to be further studied.

Differences in spontaneous preterm birth rates in Severodvinsk appear to be higher than previously reported from any European setting (Kramer et al., 2000). Adjustment for obstetric history and pregnancy complications did not eliminate the association between education and preterm delivery, which means that either there are other intermediate mechanisms involved or there is a substantial error in reporting genitourinary infections, which are known to be one of the most important factors directly associated with spontaneous preterm birth.

Social gradients by education with regard to infant growth (Paper VI) and breastfeeding rates (Paper V) are not due to confounding factors, such as age and parity. However, information on breastfeeding-related procedures and feeding patterns in infancy was not available for this study leaving the direct mechanisms explaining social variations in breastfeeding practices and linear infant growth unexplored. Observed social variations in infant linear growth but not in ponderal growth suggest that the differences in infant nutrition are of long-term character and refer to the quality of nutrition rather than to its quantity. Importantly, social variations in linear growth increased during the first year of life mostly due to slower growth of infants born to mothers with basic education.

Mothers whose educational level was missing in the records have significantly lighter babies at birth and shorter babies at one year of age, more preterm births or PIO in general, independently of other factors. Thus, we recommend more careful registration of maternal education by health care personnel in prenatal care centres, because these women who do not report their education may be at risk of adverse pregnancy outcomes and growth faltering in infancy.

Maternal education has a similar interpretation in most industrialized countries, although some minor differences between educational systems may be present. It is easy to define, collect and interpret making it the most suitable indicator of socio-economic status, which can be used for international comparisons. However, in different studies, education may be grouped in different ways. The length of formal education in years was suggested to be more practical to use for international comparisons by Nordström & Cnattingius (1996), however it is more suitable to use nominal variables in contemporary studies in Russia given the peculiarities of the Russian educational system.

Maternal education is recommended to be recorded more carefully in the documentation for both predictive and scientific purposes. Special attention in prenatal care should be given to the women with low education as a risk group for adverse pregnancy outcomes due to associations with both well established risk factors such as smoking, and with some sort of social deprivation for which the mechanisms are not yet clear and which warrant further studies. Variations in pregnancy outcomes according to the level of education can serve as an indicator of social inequalities and should be monitored.

Occupations may be grouped in different ways in different countries, because there is still no universal standard for recording occupation for international comparisons. The income and position in a social hierarchy of a person with a particular occupation may considerably differ between countries, complicating international comparisons. Moreover, in Russia, as in many other countries in transition, white-collar occupation does not guarantee the highest income and the same occupation can provide different incomes depending on the employer. The effect of being unemployed on studied outcomes in Russian settings may also be underestimated because housewives who may belong to the better-off group are still registered as unemployed in the records. Given these limitations of occupation as a social indicator, it is not surprising that occupation was not associated with all the studied outcomes in Severodvinsk except preterm birth. Lower risk of preterm delivery in skilled blue-collar workers can be partly explained by the fact that most of these workers were employed at state-owned shipbuilding enterprises, where medical check-ups are regular and obligatory probably resulting in lower prevalence of infections in these women.

The proportion of babies born out of wedlock is rather high in the study setting (35%), since living together without getting married is becoming more and more popular in Russia, especially in the western part of the country following the trend in Western Europe. Since cohabitation is becoming more socially accepted, being unmarried and pregnant is for many people no longer viewed as stressful and stigmatized situation (Arntzen et al., 1996). It has been found that in countries where the proportion of out-of-wedlock births is more than 20%, unmarried status is not a risk factor for some adverse pregnancy outcomes (Zeitlin et al., 2002). Pregnant unmarried women are not marginalized in Russia nowadays – they have the same access to free antenatal care, medical services, maternity leave and pregnancy-related counseling. The effect of being a "real" single mother in this study might be underestimated because cohabiting partners were included in the "unmarried" group. This may explain the smaller differences in birth weight between married and unmarried mothers than those found in the Estonian study where cohabiting mothers were analyzed as a separate category (Koupilova et al., 2000). In Czech Republic, where the proportion of out-of-wedlock births is lower than 20% (Zeitlin et al., 2002), this difference was much larger (-165 g) in spite of the fact that cohabiting mothers were registered as unmarried women (Koupilova et al. 1998a) as in our study. Being unmarried, however, was a risk factor for early cessation of breastfeeding (Paper V). The degree of marginalization of unmarried pregnant women could be one of the explanatory factors for the differences in pregnancy outcomes between married and unmarried mothers in different settings.

Maternal age distribution in the sample was close to those in other studies from Eastern Europe (Koupilova et al., 1998a; Koupilova et al., 2000). Most studies show an inverse U-shaped distribution of adverse pregnancy outcomes related to maternal age. Whereas other studies found that the heaviest babies are born to mothers in 25-29 years old group (Koupilova et al., 2000; Nordström & Cnattingius, 1996), our data suggest that the age group 30-34 was significantly associated with giving birth to heavier babies. The PI in this age group was also the highest, though the difference with the reference group did not reach the level of statistical significance.

Teenage mothers had significantly lighter babies than mothers in the reference group in crude analysis, but this disappeared after adjustment for potential confounders (Paper II). Milaat and du Florey (1992) suggested that the U-shaped relationship between maternal age and adverse pregnancy outcomes found in earlier studies was mainly the result of a combined effect of social class difference and parity. It seems that youthfulness itself is not a risk factor for restricted fetal growth and preterm birth in this setting and can be seen as a social rather than a medical problem. However, teenage mothers had significantly shorter babies at one year of age than women in the reference group and also had a higher risk of decreased breastfeeding duration, independently of other factors, which is in line with international evidence (Rogers et al., 1997; Yngve & Sjöström, 2001).

Women with no previous deliveries are at higher risk of fetal growth restriction (Kramer et al., 2000). Our results are in agreement with this statement showing significantly lower birth weight in nulliparous women. However, at 12 months, these infants were taller and heavier than those born to pregnancies with higher order. Resource deficit in families with more than one child may be proposed as an explanation given that many women postpone childbirth due to economic reasons: birth rates in the town decreased from 15.3‰ in 1989 to 6.6‰ in 1999. Primiparous women in Severodvinsk breastfed longer than women with more previous births. Moreover, when parity was introduced into the multivariable model as a continuous variable, the risk of breastfeeding discontinuation increased as the number of previous deliveries increased. The positive trend between number of children and probability of breastfeeding up to 6 months was observed in Norway (Lande et al., 2003) and in North America (Bourgoin et al., 1997; Piper & Parks, 1996), while the opposite findings (similar to ours) were reported in the UK (White et al., 1990). Previous infant feeding experience is an important predictor of breastfeeding duration in both developed and developing countries (Rogers et al., 1997; Victora et al., 1992; White et al., 1990). Before the initiation of the regional breastfeeding promotion program, the local breastfeeding practices and recommendations were similar to the old Soviet ones. Because of this, one could speculate that women who had previous births might retain these practices with the index baby, whereas primiparas with no previous breastfeeding experience might comply with the modern recommendations.

Smoking is the most important modifiable risk factor related to intrauterine growth restriction in industrialized countries, which accounts for a major part of the social variations in LBW in industrialized countries (Kramer, 1987a; Kramer, 1987b; Kramer et al., 2000). Its contribution to the burden of preterm birth is much lower. A dose-response association between smoking and birth weight reduction is well documented (Adriaanse et al., 1996). The effect of smoking on fetal growth is complicated and is probably related to several factors such as ischaemic and toxic effects of nicotine and carbon monoxide, impaired placental function and fetal susceptibility (Longo, 1979; Spinello et al., 1994). Besides direct effects of nicotine and carbon monoxide, maternal smoking is associated with poor dietary intake in pregnancy (Haste et al., 1990).

The prevalence of mothers who reported daily smoking at the time of pregnancy recognition was 16%. The average decrease in birth weight in infants born to smokers was 126 g. Similar difference between non-smokers and women smoking 1-5

cigarettes per day (as most of the women in Severodvinsk) was found in Sweden (Persson et al., 1979). Taking into account the fact that previously estimated prevalence of female smoking in different settings of the European part of Russia was 5% in the beginning of the 1990s (Dragonas et al., 1996), 17% in the mid-1990s (Odland et al., 1999a), and the fact that the number of female smokers in the general population increased from 11% in 1992 to 15% in 1997 in neighboring Karelia (Laatikainen et al., 2002), we consider our estimate of the proportion of smokers to be close to the real situation. At the same time, female smoking in Russian settings might be almost two times higher than self-reported rates since in Russia smoking has traditionally been seen as a masculine habit (Laatikainen et al., 1999). We do not think that the risk of underestimation of the real prevalence of smoking is as high as mentioned above, because the population of pregnant women is different from the general female population. Recall bias in relation to smoking and other variables studied by means of the questionnaire is unlikely given that the questionnaire was completed at the first antenatal visit.

To the best of our knowledge, the Severodvinsk study is the first international study, which showed an independent effect of maternal smoking on foetal growth and gestational length in Russia providing the evidence that smoking in pregnancy in Russia reached the level when harmful effects can be detected. Taking into account the steadily increasing prevalence of female smoking it must become an important public health concern and personnel at prenatal care centres should give more attention to smoking women providing smoking cessation counseling. Moreover, the effect of smoking in this study might be underestimated because only those women who reported daily smoking were classified as smokers i.e. those who smoked less frequently than daily were included in non-smoking group.

The most critical time for exposure to smoking has been considered to be the third trimester (Lieberman et al., 1994). The growth restriction in that period is reflected by PI. The fact that the PI was not significantly lower in a group of smokers might be related to the changes in smoking habits among Russian women in late pregnancy similar to those described previously by Dragonas et al (1997).

Further research is needed to identify the major determinants of smoking and cessation during pregnancy in Russia in order to develop adequate antismoking interventions. Nicotine replacement therapy is currently discussed as one of the possible methods to abstain from smoking, though the efficacy is still to be established. Laboratory validation of self-reported data concerning maternal smoking in pregnancy is strongly recommended to avoid or estimate the degree of measurement error.

Surprisingly, our study showed that women who reported occasional alcohol consumption gave birth to heavier babies. Moreover, alcohol drinking was not associated either with PIO in general or with the risk of spontaneous preterm birth. Drinking alcohol was not associated with any of maternal baseline characteristics except parity. A study from Sweden showed that women who report higher alcohol consumption even in pregnancy were better educated and had more social activities explaining that drinking alcohol in small amounts is more a social behavior than substance abuse (Dejin-Karlsson et al., 1997). The same might be true for our sample.

Women reported only small amounts of alcohol and wine and beer were the beverages of choice. Moreover, the questionnaire was answered at the time of the first antenatal visit, i.e. at the early stage of pregnancy. Lundsberg et al (1997) found that light wine drinking had a protective effect on growth retardation in the early pregnancy.

Binge drinking, so typical of the Russian lifestyle, was found to increase the risk for LBW, a higher proportion of small for gestational age infants and other adverse pregnancy outcomes (Kaminski et al., 1978; Sulainam et al., 1988). We would like to emphasize here that binge drinking is not typical for Russian women, especially for pregnant women. The ELSPAC study showed that a relatively small proportion of Russian women drink alcohol during pregnancy and a dramatic drop in alcohol consumption for those who do so was registered from the time of quickening (Dragonas et al., 1997). Nevertheless, our findings should not be used for changing the existing official Russian recommendation of total abstinence during pregnancy. For future research we would recommend validation of self-reported alcohol consumption by using blood markers of alcohol use.

Our study confirms the previous findings of a high prevalence of unfavourable living conditions and levels of overcrowding in Russia (Dragonas et al., 1997), but also extend them by providing quantitative estimates of fetal growth reduction related to living in shared apartments and in crowded housing situations. Given the hard economic situation at the time of the study, our findings that living with parents has a considerable protective effect on fetal growth throughout all stages of pregnancy, reflected by higher birth weights and ponderal indices, seems to be reasonable. Being a "real" single mother, i.e. living alone was not associated with adverse pregnancy outcomes. However, the small number of women in this category (n = 19) does not allow us to make a firm conclusion.

Generally, stress can be interpreted as the outcome of a disruption of the balance between environmental demands and resources available to the person to handle these demands (Dejin-Karlsson, 1999). Kramer et al (2001b) suggested that the earlier associations between stress and LBW were due to its effect on gestation length but not fetal growth. Increased secretion of placental corticotropin releasing hormone and subsequent prostaglandin production may be the mediating factors between maternal chronic exposure to stress and preterm delivery. It has been proposed that chronic stress may be one of the most important factors that may explain large social disparities in preterm birth rates in developed countries (Kramer et al., 2001b).

The exposure to stressful conditions may have adverse effects on fetal growth through two basic mechanisms: direct effects on the hormonal or neuroendocrine axis and by promoting harmful behaviors such as smoking, alcohol and substance use (Tamburaja & Mongelli, 2000). The stress hormones decrease the blood flow to the uterus via the uterine arteries, giving rise to fetal hypoxia (Hoffman & Hatch, 1996). Wadhwa et al (1996) showed that maternal-placental-fetal axis might be more responsive to chronic stress than to episodic stress. Pagel et al. (1990) have shown an association between maternal stress and fetal growth independent of maternal smoking, while others found no effect when smoking was controlled for (Brooke et al., 1989; Jacobsen et al., 1997; Nordentoft et al., 1996).

Our study revealed a considerable prevalence of self-reported stress in Severodvinsk (43%) and found independent associations between stress and both birth weight and spontaneous preterm delivery after adjustment for other factors. However, stress could not explain all social variations in pregnancy outcomes in Severodvinsk, although it appears to be among the mediating factors.

The validity of our estimation of stress should be limited to self-perceived stress because it was based on two direct questions. The word "stress" exists in the Russian language and is often used in everyday life and in mass media. It was well understood by the women in the pilot study. However, given limited validity, we consider our results more as a point of departure for further research on stress during pregnancy in Russia than as a basis for firm conclusions.

In summary, our main findings are in line with many other studies from the developed countries about the mediating factors influencing birth weight, PI, and risk of preterm birth, whereas social variations in fetal growth characteristics and preterm delivery based on the level of maternal education, are similar to those found in the transitional economies of Eastern Europe. Although, adjustments for various potential confounders and intervening variables were made, the associations between studied outcomes and education remain significant calling for further research which will aim to study the direct mechanisms explaining social variations in foetal growth and preterm birth in Russia. Investigating intermediate mechanisms of the variations in infant growth and breastfeeding was beyond the scope of this study.

5.6. RUSSIA BETWEEN 1998 AND 2003

This study was performed shortly after the culmination of the Russian crisis in August 1998. Since then positive trends in the Russian economy have been registered: the annual growth of GDP was 6.8% in 1999, 10.6% in 2000, 5.7% in 2001, 5.2% in 2002, and 7.8% in 2003; GDP per capita based on purchasing power parity increased from $6028 in 1998 to $9195 in 2003. However, these economic improvements do not seem to be enjoyed by the majority according to the health statistics: life expectancy decreased from 67.0 years in 1998 to 65.3 in 2000 and remained below 66 years in 2002. The infant mortality rate was 18.0‰ in 2000 and 2002. The population continued to decrease by an average of 0.4-0.5% every year, which is more rapid than during the first eight years of transition.

We suspect that social variations in pregnancy outcomes may have further increased during the years after our study, although we cannot confirm this with data. There is a need for the monitoring of social inequalities in Russia as well as in other countries undergoing economic and social transition to ensure that everyone benefits from on-going reforms.

5.5. GENERALIZATION OF THE FINDINGS

Given that Russia consists of a number of regions at different stages of development, one can generalize our findings only to similar urban areas in Northwest Russia. Social variations in pregnancy outcomes in large cities where the degree of inequalities is higher may be even more pronounced. We do not recommend generalizing our data for the rural areas where the social structure, lifestyle factors, accessibility of the medical services and even cultural attitudes may be different. Based on the sample characteristics we cannot generalize our findings to the women with serious somatic diseases or serious pregnancy complications requiring referral to the regional level of care.

6. CONCLUSIONS

1. Socio-demographic characteristics of pregnant women in an urban setting in Northwest Russia setting are similar to those from the studies in Central and Eastern Europe, but substantially different from those in the Western societies

2. The mean values of birth weight and PI in Severodvinsk are considerably lower than in the Western countries, though the rates of LBW and preterm birth are lower than one might expect

3. Social variations in all studied pregnancy outcomes by maternal education are among the highest in Europe. They persist even after known or suspected explanatory variables were included in the analyses. Besides maternal education, poor housing conditions, maternal smoking and stress are also negatively associated with foetal growth while complications of the index pregnancy, stress, maternal smoking, and poor obstetric history are associated with reduced duration of gestation

4. The initiation of breastfeeding in Severodvinsk is almost universal. The rates of any breastfeeding at specific time points are higher than in many European countries. Young maternal age, low education, and unmarried status are associated with higher risks of early termination of breastfeeding, although the magnitude of social variations in breastfeeding practices are lower than in pregnancy outcomes

5. All growth parameters at one year of age in infants from the Severodvinsk cohort are slightly higher than in the reference population. The proportions of stunted, underweight, and wasted infants are much lower than in the latest national Russian dataset and comparable with those in developed countries. Infants born to younger and less educated mothers have lower indices of linear growth than infants of older and better educated women.

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