

DEMOGRAPHIC AND SOCIOECONOMIC DETERMINANTS OF LOW BIRTH WEIGHT AND PRETERM BIRTHS AMONG NATIVES AND IMMIGRANTS IN GREECE: AN ANALYSIS USING NATIONWIDE VITAL REGISTRATION MICRO-DATA

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Summary. The present study makes use of nationwide individual-level vital registration data on the single live births occurring in Greece in 2006 to explore associations of socio-demographic factors with adverse pregnancy outcomes, using multinomial logistic regression models. The findings indicate that important risk factors associated with low birth weight preterm and intra-uterine growth retarded births (IUGR) include female sex, primiparity, age of mother over 35, illegitimacy and prior history of stillbirths, infant and child deaths. These constitute risk factors for normal weight preterm births as well, though associations with sex and primiparity in this case point to the opposite direction. Residing in large metropolitan areas is related to a greater risk of an IUGR birth. Among Greek women, educational attainment has a protective effect while housewife status is linked to higher chances of an IUGR birth. For immigrant mothers however, the opposite holds. The study also shows that normal weight preterm births form a distinct group.

Introduction

The WHO definition of low birth weight (LBW) refers to infants below 2500 g at birth, while the concept of prematurity relates to births occurring before the 37th week of gestation (preterm births). Prematurity and LBW have proved crucial by epidemiological studies in determining neonatal mortality in addition to affecting post-neonatal mortality and infant morbidity; babies born under 2500 g are 20 times more likely to die than heavier babies (McCormick, 1985; Kramer, 1987; Wardlaw *et al.*, 2004). There is also overwhelming evidence that these conditions are linked to adverse health outcomes both in early and later life. In particular, they seem related to delays in cognitive and behavioural development (Strauss, 2000), growth retardation and neurological problems in childhood (McCormick, 1985) as well as chronic

diseases such as hypertension, stroke, coronary heart disease and related disorders and diabetes in adulthood (Barker, 1994, 1998; Huxley *et al.*, 2000).

Estimates of the World Health Organization (Wardlaw *et al.*, 2004) indicate that prevalence of LBW in 2000 was around 15.5% worldwide; even though incidence is lower in developed countries (around 7%), the majority of neonatal and infant deaths are observed among LBW and preterm births (Speer & Gahr, 2001; Wang *et al.*, 2002). Hence, both conditions constitute important determinants requiring intervention not only in the developing but also in the developed regions of the world if further reductions in infant mortality are to be achieved. Further, the costs of medical intervention for saving and keeping healthy such infants are quite substantial (Frisbie *et al.*, 1996; Reime *et al.*, 2006). Identification of aetiological as well as of mediating factors is of paramount importance as those that are potentially modifiable could be targeted by public health policies.

Low birth weight is linked to two different conditions: it may be the result of a birth occurring prematurely, but it is also observed among babies born at full term. In the latter case, the condition is termed 'intra-uterine growth retardation' or 'restriction' (IUGR) and is due to a slower rate of fetal growth (Kramer, 2003; Meggiolaro, 2009). Distinguishing between these components of LBW is fundamental since they are linked to different risks of mortality and morbidity as well as to different aetiology; conversely, treating them as one item confuses issues and may hinder development of preventive strategies (Kramer, 1987, 1990; Kramer *et al.*, 2000). Further, there is a sizeable proportion of infants born prematurely (mainly on the 36th week of gestation) whose weight is normal; these babies are rarely recognized as a distinct 'at risk' group and have been very little investigated. Frisbie *et al.* (1996) note that they have found no nationally representative assessment of the mortality risks associated with these infants; in their study they estimate a 2–3 times higher infant mortality rate compared with normal weight full term births and conclude that relevant analyses should expand to include that group, too.

Risk factors related to LBW and prematurity include, among others, sex and parity of the baby, socio-demographic characteristics of the mother, risky health behaviours, insufficient antenatal care, psychosocial stress, low maternal body mass index, poor nutrition, diseases during pregnancy, genetic factors and environmental pollution (Kramer *et al.*, 2000). Although several causal associations are well established, there are mediating and aetiological factors whose effects on the different components of LBW and prematurity are still under investigation; in addition, associations regarding normal weight premature infants have rarely been explored.

Numerous studies indicate that first-born infants are lighter and have higher chances of being born prematurely compared with births of higher order (Astolfi & Zonta, 1999; Meggiolaro, 2009), while for the same gestational age, boys are heavier than girls. Weight also varies according to the plurality of birth; singletons are usually heavier than twins or triplets (Mohsin *et al.*, 2003). Further, half of twins and almost all of higher-order multiples are born before 37 weeks of gestation (Joseph *et al.*, 1998). The weight and gestational age of a baby are also affected by the physique, height and weight of the mother before conception; in particular, low pre-pregnancy body mass index or low weight gain during pregnancy have been linked to both IUGR and preterm births (Bener *et al.*, 1996; Kramer, 2003). Maternal age is another

important factor; teenage mothers and those aged 35 or more have higher chances of giving birth to lighter or premature babies (Astolfi & Zonta, 1999; Machado, 2006). Infections during pregnancy and, in particular bacterial vaginosis, are related to preterm births (Chaim *et al.*, 1997); pregnancy-induced hypertension is linked both to IUGR and prematurity (Wessel *et al.*, 1996; Kramer, 2003) while certain genetic conditions and congenital anomalies seem to predispose towards higher chances of a IUGR birth (Kramer, 2003). Prior preterm deliveries also seem to predispose to higher chances of a premature birth (Adams *et al.*, 2000; Kramer, 1987, 2003). Hence, early antenatal care is very important (Letamo & Majelantle, 2001). A healthy lifestyle of the mother (diet and habits) is also essential; there is ample evidence that smoking, drug abuse and alcohol consumption contribute to a high incidence of adverse pregnancy outcomes (Rodriguez *et al.*, 1995; Kesmodel *et al.*, 2002). Environmental conditions also seem to play a part; in fact, a causal relationship between air pollution and LBW has been inferred but specific associations regarding preterm births and IUGR need further investigation (Bobak, 2000; Lee *et al.*, 2003; Štrám *et al.*, 2005).

It seems that socioeconomic characteristics of the mother – which reflect up to a point lifestyle, health behaviours, affluence, health status and frequency and efficiency in the utilization of health care services – act as mediators and are of great consequence (Kramer *et al.*, 2000). Material deprivation, lone motherhood, housewife status (Rodriguez *et al.*, 1995; Pattenden *et al.*, 1999), physically demanding work during pregnancy (Homer *et al.*, 1990), strenuous domestic work (Pritchard & Teo, 1994), unemployment (Reime *et al.*, 2006), low educational attainment (Cheung & Yip, 2001; Meggiolaro, 2009) and psychosocial stress (Mulder *et al.*, 2002) have been linked to adverse pregnancy outcomes.

The present study uses restricted access individual-level registration data on live births of singletons occurring in Greece in 2006 to explore, for the first time, associations of the demographic characteristics of the mother and the baby and of maternal socioeconomic status with adverse pregnancy outcomes in the country. More specifically, low birth weight preterm births, IUGR births and normal weight preterm births are compared with normal weight births occurring at full term, to answer the following research questions: (1) Do associations with socio-demographic attributes observed in other studies hold for the population of Greece? (2) Are there any differentials between Greek and immigrant women? (3) Do preterm infants of normal weight seem to form a distinct group that should be considered separately from normal weight full term births in similar analyses?

Methods

Data

This paper employs nationwide micro-data on the live births recorded by the vital registration system of Greece for 2006. The information used is restricted access and has been kindly provided to the authors by the National Statistical Service of Greece (NSSG). The available statistical material includes sex of the newborn, birth order, illegitimacy status (i.e. whether a birth is extramarital or not), birth weight (in grams)

and gestational age (in weeks). With respect to the mother the data refer to age at birth, educational attainment, occupation and place of usual residence. There is also information on single and multiple deliveries as well as on numbers of prior stillbirths and deceased children. Since 2004 the vital statistics of Greece have been available by citizenship; the notion of citizenship is used by the Ministry of the Interior and the Greek statistical authorities to identify immigrant populations (Hellenic Migration Policy Institute, 2007; Ministry of the Interior Public Administration and Decentralization, 2007). Hence, throughout the paper, the terms 'immigrant' and 'foreign-origin women' as well as 'Greek' and 'native women', are used interchangeably. Birth registration in Greece is complete and as virtually all births (99.9%) to native and foreign-origin mothers occur in maternity wards and hospitals, the information compiled is considered reliable. It should be noted that birth registration forms do not include any information on duration of residence or the legal/illegal status of an immigrant mother in Greece; all immigrant women are allowed to deliver in maternity hospitals independently of their legal/illegal status.

During 2006 a total of 112,042 live births were recorded. Births that occurred in Greece but were assigned to non-residents of the country (0.4% of the total) are not considered in the analysis as they are extraneous to the scope of the study. Multiple births (representing 4.5%) have also been excluded since birth weight of these infants is considerably lower than of singletons, while they also tend to be premature (Joseph *et al.*, 1998; Moshin *et al.*, 2003); further, their inclusion would render the results incomparable with most of the existing literature. Finally, as maternal socioeconomic status, represented here by education and occupation, constitutes an important element of this study, births to women under age 20 (3% of the total) have been disregarded; this cut-off point has been used also in other similar research (National Center for Health Statistics, 2005; Acevedo-Garcia *et al.*, 2007). Hence, the analysis focuses on 103,266 records of single live births to women aged 20 or higher living in Greece. Of this number, 85,676 (83.0%) are births to native and 17,590 (17.0%) are births to foreign-origin mothers. Among the latter category the vast majority of births (61%) are attributable to Albanian mothers.

Measures

The dependent variable, representing adverse pregnancy outcomes, is based on the recorded birth weight and duration of gestation at maternity hospitals. It has four categories distinguishing: (1) low weight preterm births (<2500 g and <37 weeks), (2) intra-uterine growth retarded births (<2500 g and \geq 37 weeks), (3) births of normal weight and short gestational period (\geq 2500 g and <37 weeks) and (4) normal weight births occurring at full term (\geq 2500 g and \geq 37 weeks) henceforth termed 'normal' for the purposes of the analysis; that last category is the most numerous and is treated as reference group. Seven binary indicators and a three-level ordinal variable are included in the analysis as explanatory variables. Concerning newborn babies, female births are coded as 1 (male births=0); first births (=1) are distinguished from live births of higher order (=0), while illegitimate births (=1) are compared with the legitimate ones (=0). Two broad age groups of mothers are considered; the first one includes women aged 20–34 (coded as 0) and the second includes those aged 35

or higher (coded as 1). Place of usual residence is represented by a dummy taking the value of 1 if a woman lives in big metropolitan areas (i.e. the capital of Greece, Athens, or the second largest city, Salonica) and 0 if she lives in other less urbanized regions. With respect to socioeconomic attributes, two indicators have been created. Based on the reporting of occupation, housewives (i.e. non-economically active women) are compared with the economically active women (=0). Educational attainment is introduced in the form of a three-category variable expressing whether the mother has completed up to lower secondary education (0–9 years of schooling), upper secondary education (10–12 years) or tertiary education (at least 13 years of education); low educational attainment is the reference category. A dichotomous variable serves as proxy of past adverse maternity and birth history, denoting whether a woman has had at least one prior stillbirth or deceased child (=1) or she has had no such past experience (=0). Finally, a dummy variable for citizenship is included in the models so that the estimated relative risks of immigrant mothers (=1) are compared with Greeks (=0). Moreover, apart from the main effects of the predictors, interactions with mother's citizenship are considered.

Analysis

The relative effects of demographic and socioeconomic factors on adverse pregnancy outcomes are assessed with multinomial regression models. This is an appropriate technique when the response variable has more than two levels with no natural ordering (Agresti, 2002). The multinomial models involve multiple logistic regression estimations and multiple comparisons to be performed. As the response variable has four categories, in effect three equations are estimated: (a) a model for preterm LBW births relative to 'normal' births, (b) a model for IUGR births relative to 'normal' births, and (c) a model for normal weight preterm births relative to 'normal' births. Thus, the parameters are estimated in relation to the reference group and the results presented in the next section are expressed in terms of relative risk ratios (RRR). On the basis of the standard error of the parameters levels of significance are also estimated and presented. The overall goodness-of-fit of the models is evaluated on the basis of the Likelihood Ratio Chi-squared test. The statistical analysis has been carried out using STATA 10.1.

Results

Descriptive statistics

The percentage distribution of the variables of interest by citizenship is shown in Table 1. The vast majority (91.5%) of the recorded births in 2006 are 'normal' (i.e. normal weight and full term), 2.4% are LBW and preterm, while 3.1% are LBW full term and another 3.1% are preterm normal weight. Overall, proportions of adverse pregnancy outcomes are slightly lower among immigrants. Female births constitute on average 48.4% of the total. First births correspond to a very considerable fraction (49%). Women aged 35 or higher are over-represented among Greek mothers, while the opposite holds concerning illegitimate births. About 0.8% of births occur to

Table 1. Percentage distribution of the variables used in the analysis by citizenship

	Total	Greek citizens	Immigrants
Response variable			
≥2500 g, ≥37 weeks (normal)	91.5	91.2	92.9
≥2500 g, <37 weeks (normal preterm)	3.1	3.2	2.6
<2500 g, ≥37 weeks (IUGR)	3.1	3.2	2.4
<2500 g, <37 weeks (LBW preterm)	2.4	2.4	2.1
Sex			
Male	51.6	51.4	52.5
Female	48.4	48.6	47.5
Parity			
One	49.0	49.4	47.3
Two or higher	51.0	50.6	52.7
Legitimacy			
Legitimate	95.6	96.6	90.7
Illegitimate	4.4	3.4	9.3
Age of mother			
20–34	80.9	79.2	89.2
≥35	19.1	20.8	10.8
Prior stillbirth or deceased child			
Not any	99.2	99.3	99.1
At least one	0.8	0.7	0.9
Educational attainment of mother			
Up to low secondary	23.6	15.9	61.1
Upper secondary	50.6	54.6	31.3
Tertiary	25.8	29.5	7.6
Occupation of mother			
Economically active	54.6	62.1	18.0
Housewives	45.4	37.9	82.0
Usual place of residence			
Big metropolitan areas	41.6	41.2	44.0
Other	58.4	58.6	56.0
<i>N</i>	103,266	85,676	17,590

women who had in the past a stillbirth or a deceased child. Regarding socioeconomic characteristics, 37.9% of Greek women are housewives; the respective proportion for immigrants is a staggering 82.0%. The latter figure, however, seems implausible considering that many of these women immigrated in search of employment; it is likely that most of them work in informal/illegal arrangements despite reporting themselves as housewives. Greek women have more educational qualifications compared with immigrants.

Multinomial logistic regression models

Table 2 shows Relative Risk Ratios (RRR) based on multinomial logistic regression for all women aged 20 or higher, resident in Greece in 2006. The model

Table 2. Relative Risk Ratios for main effects and interaction terms based on multinomial logistic regression for all births; reference category is normal weight full term births ($N=10,3266$)

	Low weight preterm	IUGR	Normal weight preterm
Sex of newborn			
Male (ref.)			
Female	1.130**	1.655**	0.821**
Parity			
Birth order 2 or higher (ref.)			
Birth order 1	1.537**	1.374**	0.895**
Legitimacy of newborn			
Legitimate (ref.)			
Illegitimate	1.771**	1.879**	1.595**
Age of mother			
20–34 (ref.)			
≥ 35	1.729**	1.361**	1.252**
Prior stillbirth or deceased child			
Not any (ref.)			
At least one	5.229**	1.928**	2.491**
Education of mother			
Up to lower secondary (ref.)			
Upper secondary	0.763**	0.875*	0.933
Tertiary	0.724**	0.748**	0.983
Occupation of mother			
Economically active (ref.)			
Housewife	1.016	1.126**	1.007
Usual place of residence of mother			
Less urbanized areas (ref.)			
Big metropolitan areas	1.068	1.223**	1.015
Citizenship of mother			
Greek (ref.)			
Migrant	0.613**	0.749	0.835
Two-way interactions: citizenship by predictors			
Migrants by female	0.897	0.878	1.048
Migrants by birth order 1	0.866	1.152	0.933
Migrants by illegitimate	0.908	0.858	1.051
Migrants by mother aged 35 or higher	1.126	1.137	0.932
Migrants by prior stillbirth/deceased child	0.851	0.929	0.846
Migrants by upper secondary	1.753**	1.167	1.264
Migrants by tertiary	1.626*	0.985	1.294
Migrants by housewives	1.247	0.757*	0.859
Migrants by big metropolitan areas	0.865	0.986	0.928

–2LogLikelihood=4076; χ^2 (df 57)=1022; sig.=<0.001.

**Significant at the 1% level, *significant at the 5% level.

shows main effects as well as interactions of all predictors with the migrant status of the mother. Comparing LBW preterm births, which represent the most compromised pregnancy outcome, with 'normal' births, the following picture emerges: female, first-born and illegitimate babies have higher chances of being LBW preterm rather than 'normal'. Mothers aged 35 or more run a 73% higher risk of having such a birth compared with younger women. Prior history of stillbirths or deceased children seems a very important predictor, increasing chances of a LBW preterm birth by five times. Educational attainment of mother, on the other hand, has a protective effect; in particular, having tertiary educational qualifications would decrease the chances of such an adverse pregnancy outcome by a factor of 0.724. Occupation of mother and usual place of residence are not significant. A substantial differentiation can be observed regarding mother's citizenship; immigrant women are less likely than Greek mothers to have a LBW preterm birth, given that all other variables in the model are held constant. The interaction effects indicate that factors related to LBW preterm births are virtually identical for Greek and immigrant mothers with one exception: educational attainment has a protective effect among natives but the opposite seems the case for immigrants.

Regarding IUGR babies (i.e. LBW but born after the 36th week of gestation) in relation to 'normal' births it seems that sex is more important in this instance. Primiparity, illegitimacy, age of mother over 35 and prior history of stillbirths or deceased children are also very significant factors increasing the chances of an IUGR birth. Higher educational attainment of mother, and in particular tertiary education, has a protective effect, reducing the chances by a factor of 0.748. Occupation of mother and usual place of residence are important in this instance, showing significantly greater risk of an adverse outcome among housewives and residents of big metropolitan areas. Migrant status of the mother loses significance once interaction terms have been included in the model. The interactions of citizenship with the predictors do not show any significant differentiations between Greek and immigrant mothers, apart from housewife status, which seems to have a protective effect for immigrants.

The last outcome category – normal weight preterm babies – represents the least 'compromised' births. Analysis of risk factors in this case reveals different patterns. Females and first-born babies are now more likely to be normal rather than normal weight but preterm in comparison with males and births of second or higher order. Illegitimacy and older age of mother (35 or more), on the other hand, are still related to higher chances of an adverse outcome, and that holds for prior stillbirth/deceased child history too. Socioeconomic characteristics and usual place of residence of the mother do not seem to matter in this instance, while there are no differentiations between native and immigrant mothers.

Discussion

The present study makes use of restricted access, nationwide, individual-level vital registration data on single live births occurring to women living in Greece in 2006 to explore for the first time socio-demographic factors related to adverse pregnancy

outcomes in the country and differentiations between native and foreign-origin women.

The findings of the study indicate that female sex, primiparity and older age of mother (35 or higher) show the expected unfavourable and significant associations with LBW outcomes. Female sex has a more substantial effect on IUGR while age of mother is more important for LBW preterm births, a finding consistent with other studies (Kramer, 1987; Meggiolaro, 2009). Effects of female sex and primiparity on the chances of a preterm normal weight birth, on the other hand, point to the opposite direction, a finding in accordance with Frisbie *et al.* (1996). An important factor contributing to higher chances of a preterm birth, according to the literature, is a history of prior preterm deliveries, while congenital anomalies and specific genetic factors seem to increase the risk of an IUGR birth (Kramer *et al.*, 2000). The present study made use of information available in the registration data pertaining to prior stillbirths and deceased children to construct a proxy. Since most of neonatal and infant mortality in the developed countries – 65 to 75% of neonatal mortality in Germany (Speer & Gahr, 2001) and 65% of infant mortality in the US (Wang *et al.*, 2002) – are related to these conditions (Kramer, 1987; WHO, 2004), such an indicator includes mainly deaths due to preterm and LBW status. In practice, the indicator of adverse pregnancy outcome history proved the most significant predictor of preterm births, though it was significant also for IUGR. Moreover, it had the greatest impact on the chances of a compromised birth and, in particular, preterm LBW births, a result similar to other analyses that employed information based on medical records (Reime *et al.*, 2006).

Adverse socioeconomic conditions such as parental deprivation, unemployment, low occupational status and few educational qualifications have been linked to LBW (Pattenden *et al.*, 1999; Reime *et al.*, 2006; Meggiolaro, 2009). Educational attainment represents one of the most suitable dimensions of socioeconomic status for predicting health of mothers and their offspring (Bloomberg *et al.*, 1994). The present study shows that more educational qualifications (having completed at least upper secondary education) have a very significant protective effect for Greek mothers; the effect is stronger among low birth weight babies. In contrast, results for LBW preterm births point to the opposite direction for immigrants; this unexpected finding may be partly related to the small numbers of births but also to inconsistencies when comparing attainment based on different educational systems. In addition, it seems questionable that education represents satisfactorily socioeconomic status among recent immigrants, who constitute the vast majority of migrants in Greece, since it may be unrelated to their occupation or income (Acevedo-Garcia *et al.*, 2007).

Illegitimacy of a birth has several connotations, in particular regarding the native population of Greece; it is usually associated with lone motherhood and represents a non-widely acceptable practice. Single mothers have low income, while social provisions are meagre. Such a status may contribute to unfavourable psychosocial circumstances and unhealthy lifestyles through material deprivation as well as increased stress and depression (Kramer *et al.*, 2000; Reime *et al.*, 2006). The findings of the present study show that illegitimacy has a very significant unfavourable effect across all adverse outcomes both for Greek and immigrant women, a result in line with other research (Kramer *et al.*, 2000; Reime *et al.*, 2006; Meggiolaro, 2009).

Strenuous work, physical activity and prolonged standing during pregnancy are associated with a slightly increased risk of preterm deliveries (Homer *et al.*, 1990). Strenuous housework, on the other hand, may make an even greater, though non-quantifiable, contribution (Pritchard & Teo, 1994). Housewife status was found in the study to increase significantly (but not substantially) the risk of an IUGR birth among Greek women, while it had the opposite effect for immigrants. This latter result, however, may be related to misreporting of employment on the part of immigrant women. Associations were not significant regarding preterm births.

Environmental conditions/pollution have very rarely, if ever, been explored in the context of studies based on vital statistics. Studies monitoring levels of pollution due to various sources have shown a causal effect on adverse pregnancy outcomes, though the exact mechanisms and the critical period of exposure of a pregnant woman are yet to be determined (Lee *et al.*, 2003; Štrám *et al.*, 2005). The present study used a proxy based on the usual place of residence of the mother and estimated a very significant negative association of living in big metropolitan areas with IUGR, especially among Greek women; this finding is consistent with the literature on ambient air pollution effects (Maisonet *et al.*, 2004).

With respect to citizenship, the present study shows that, for all outcomes, there was a significant differentiation in favour of immigrant women which, however, persisted only for LBW preterm births once interaction terms were included in the model. There is some research indicating that certain ethnic/racial groups have worse outcomes compared with native or white populations; for instance, slower fetal growth has been observed among blacks in the US, aborigines in Australia and Asians in the UK (Sayers & Powers, 1993; Parker *et al.*, 1994). These findings may be partly related to worse socioeconomic conditions prevailing within these minority groups; they may also be associated with true biological/genetic differences (Wen *et al.*, 1995). By contrast, studies comparing foreign-born with US-born immigrants consistently find better birth outcomes among foreign-born women (Wingate & Alexander, 2006; Acevedo-Garcia *et al.*, 2007). Such a feature may be partly explained by the 'healthy migrant' theory, according to which healthier people are more likely to migrate (selection bias). Further, it has been argued that recent immigrants tend to retain the more favourable health behaviours and diet observed in their country of origin, and hence avoid the higher risks attached to their low socioeconomic status (Kramer *et al.*, 2000). Both hypotheses could very well apply in the case of Greece, since the majority of immigrants, according to the 2001 census data, arrived in the country fairly recently (Bagavos *et al.*, 2008).

A final point emerging from the analysis is that predictors of normal weight preterm births differentiate substantially compared with normal weight full term births. In particular, a significant divergence was observed for specific demographic factors such as sex of the birth, primiparity, age of mother, illegitimacy and prior stillbirth/deceased child history. Frisbie *et al.* (1996), having estimated a higher risk of infant mortality for these babies in comparison with normal births, suggest that they constitute a distinct group. Indeed it seems that these births differentiate in several aspects and should be considered separately in similar analyses; conversely, inclusion of that group in normal births may bias the estimates, particularly if sample sizes are small.

The findings of the study highlight specific groups of women in need of intervention. Women with an adverse pregnancy history and those over age 35 should be informed of their relatively high risks and be given extra attention while pregnant. In addition, women of low socioeconomic status, housewives and lone mothers should be given priority by public health policies and should be offered psychosocial support. The strong negative association between illegitimacy and all adverse pregnancy outcomes is especially worrying since births outside of wedlock are on the increase in the country. Implementation of effective measures and policies targeting this vulnerable group of women seems crucial.

Certain limitations of the study should be mentioned. The measures used in the analysis are based on registration rather than medical data. Hence, identification of IUGR babies is based on full term LBW births rather than growth percentiles, while past adverse pregnancy history has been approximated by information on prior stillbirths and infant and childhood deaths rather than medical records. Further, the available data do not include any information on birth intervals, mother's pre-pregnancy body mass index, diet, smoking or other health-related behaviours. Finally, the numbers of births to immigrant women are rather small, making drawing conclusions difficult.

Nevertheless, the analysis has several strengths, too. It is based on nationwide information while records of birth weight and gestational period are derived at maternity wards and hospitals and are accurate. Further, it has been suggested that defining IUGR births based on LBW rather than percentiles has certain advantages (Reime *et al.*, 2006). The study makes a significant contribution towards exploring factors associated with adverse pregnancy outcomes in Greece, pinpointing differentiations between native and immigrant women and identifying vulnerable groups of population in need of support. Evidence has also been presented supporting the argument that normal weight preterm births are a distinct group and should be treated accordingly in forthcoming analyses. Finally, in the future it would be desirable to use series of data for more years, to increase sample size and to examine whether associations are robust.

References

- Acevedo-Garcia, D., Soobader, M. J. & Berkman, L. F. (2007) Low birthweight among US Hispanic/Latino subgroups: the effect of maternal foreign-born status and education. *Social Science & Medicine* **65**, 2503–2516.
- Adams, M. M., Elam-Evans, L. D., Wilson, H. G. & Gilbertz, D. A. (2000) Rates of and factors associated with recurrence of preterm delivery. *Journal of the American Medical Association* **283**, 1591–1596.
- Agresti, A. (2002) *Categorical Data Analysis*. Wiley, New York.
- Astolfi, P. & Zonta, L. A. (1999) Risks of preterm delivery and association with maternal age, birth order and fetal gender. *Human Reproduction* **14**(11), 2891–2894.
- Bagavos, C., Tsimbos, C. & Verropoulou, G. (2008) Native and migrant fertility patterns in Greece: a cohort approach. *European Journal of Population* **24**(4), 245–263.
- Barker, D. J. P. (1994) The fetal origins of adult disease. *Fetal and Maternal Medicine Review* **6**, 71–80.
- Barker, D. J. P. (1998) In utero programming of chronic disease. *Clinical Science* **95**, 115–128.

- Bener, A., Abdulrazzaq, Y. M. & Dawodu, A.** (1996) Sociodemographic risk factors associated with low birthweight in United Arab Emirates. *Journal of Biosocial Science* **28**, 339–346.
- Bloomberg, L., Meyers, J. & Braverman, M. T.** (1994) The importance of social interaction: a new perspective on social epidemiology, social risk factors, and health. *Health Education Quarterly* **21**, 447–463.
- Bobak, M.** (2000) Outdoor air pollution, low birth weight and prematurity. *Environmental Health Perspectives* **108**, 173–176.
- Chaim, W., Mazor, M. & Lieberman, J. R.** (1997) The relationship between bacterial vaginosis and preterm birth: a review. *Archives of Gynecology and Obstetrics* **259**, 51–58.
- Cheung, Y. B. & Yip, P. S. F.** (2001) Social patterns of birth weight in Hong Kong, 1984–1997. *Social Science & Medicine* **52**, 1135–1141.
- Frisbie, W. P., Forbes, D. & Pullum, S. G.** (1996) Compromised birth outcomes and infant mortality among racial and ethnic groups. *Demography* **33**(4), 469–481.
- Hellenic Migration Policy Institute** (2007) *Legislation and Requirements Concerning Acquisition of the Greek Citizenship*. URL: www.imepo.gr.
- Homer, C. J., Beresford, S. A. A., James, S. A., Siegel, W. & Wilcox, S.** (1990) Work-related physical exertion and risk of preterm, low birthweight delivery. *Paediatric & Perinatal Epidemiology* **4**, 161–174.
- Huxley, R. R., Shiell, A. W. & Law, C. M.** (2000) The role of size at birth and postnatal catch-up growth in determining systolic blood pressure: a systematic review of the literature. *Journal of Hypertension* **18**, 815–831.
- Joseph, K. S., Kramer, M. S., Marcoux, L. S., Ohlsson, A., Wen, S. W., Allen, A. et al.** (1998) Determinants of secular trends in preterm births in Canada. *New England Journal of Medicine* **339**, 1434–1439.
- Kesmodel, U., Wisborg, K., Olsen, S. F., Henriksen, T. B. & Secher, N. J.** (2002) Moderate alcohol intake during pregnancy and the risk of stillbirth and death in the first year of life. *American Journal of Epidemiology* **155**, 305–312.
- Kramer, M. S.** (1987) Determinants of low birth weight: methodological assessment and meta-analysis. *Bulletin of the World Health Organization* **65**(5), 663–737.
- Kramer, M. S.** (1990) Birth weight and infant mortality: perceptions and pitfalls. *Paediatric & Perinatal Epidemiology* **4**, 381–390.
- Kramer, M. S.** (2003) The epidemiology of adverse pregnancy outcomes: an overview. *Journal of Nutrition* **133**, 1592–1596S.
- Kramer, M. S., Séguin, L., Lydon, J. & Goulet, L.** (2000) Socio-economic disparities in pregnancy outcome: why do the poor fare so poorly? *Paediatric & Perinatal Epidemiology* **14**, 194–210.
- Lee, B. E., Ha, E. H., Park, H. S., Kim, Y. J., Hong, Y. C., Kim, H. & Lee, J. T.** (2003) Exposure to air pollution during different gestational phases contributes to risks of low birth weight. *Human Reproduction* **18**(3), 638–643.
- Letamo, G. & Majelantle, R. G.** (2001) Factors influencing low birth weight and prematurity in Botswana. *Journal of Biosocial Science* **33**, 391–403.
- McCormick, M. C.** (1985) The contribution of low birth weight to infant mortality and childhood morbidity. *New England Journal of Medicine* **312**(2), 82–90.
- Machado, C. J.** (2006) Impact of maternal age on birth outcomes: a population-based study of primiparous Brazilian women in the city of Sao Paulo. *Journal of Biosocial Science* **38**, 523–535.
- Maisonet, M., Correa, A., Misra, D. & Jaakkola, J. J. K.** (2004) A review of the literature on the effects of ambient air pollution on fetal growth. *Environmental Research* **95**, 106–115.
- Meggiolaro, S.** (2009) Low birth weight and parental resources in Italy. *Genus* **65**(1), 103–121.

- Ministry of the Interior, Public Administration and Decentralization** (2007) *Legislation Concerning the Foreign Citizens in Greece*. URL: www.ypes.gr.
- Mohsin, M., Wong, F., Bauman, A. & Bai, J.** (2003) Maternal and neonatal factors influencing premature birth and low birth weight in Australia. *Journal of Biosocial Science* **35**, 161–174.
- Mulder, E. J., Robles de Medina, P. G., Huizink, A. C., Van de Bergh, B. R., Buitelaar, J. K. & Visser, G. H.** (2002) Prenatal maternal stress: effects on pregnancy and the (unborn) child. *Early Human Development* **70**(1–2), 3–14.
- National Center for Health Statistics** (2005) *Health, United States, 2005 with Chartbook on Trends in the Health of Americans*. NCHS, Hyattsville, MD.
- Parker, J. D., Schoendorf, K. C. & Kiely, J. L.** (1994) Associations between measures of socioeconomic status and low birth weight, small for gestational age, and premature delivery in the United States. *Annals of Epidemiology* **4**, 271–278.
- Pattenden, S., Dolk, H. & Vrijheid, M.** (1999) Inequalities in low birth weight: parental social class, area deprivation, and “lone mother” status. *Journal of Epidemiology and Community Health* **53**, 355–358.
- Pritchard, C. W. & Teo, P. Y. K.** (1994) Preterm birth, low birthweight and the stressfulness of the household role for pregnant women. *Social Science & Medicine* **38**(1), 89–96.
- Reime, B., Ratner, P. A., Tomaselli-Reime, S. N., Kelly, A., Schuecking, B. A. & Wenzlaff, P.** (2006) The role of mediating factors in the associations between social deprivation and low birth weight in Germany. *Social Science & Medicine* **62**, 1731–1744.
- Rodriguez, C., Regidor, E. & Gutierrez-Fisac, J. L.** (1995) Low birth weight in Spain associated with sociodemographic factors. *Journal of Epidemiology and Community Health* **49**, 38–42.
- Sayers, S. M. & Powers, J. R.** (1993) Birth size of Australian aboriginal babies. *Medical Journal of Australia* **159**, 586–591.
- Speer, C. P. & Gahr, M.** (2001) *Pädiatrie*. Springer, Berlin.
- Štrám, R. J., Binková, B., Dejmeš, J. & Bobak, M.** (2005) Ambient air pollution and pregnancy outcomes: a review of the literature. *Environmental Health Perspectives* **113**(4), 375–382.
- Strauss, R. S.** (2000) Adult functional outcome of those born small for gestational age: twenty-six-year follow-up of the 1970 British birth cohort. *Journal of the American Medical Association* **283**, 625–632.
- Wang, X., Zuckerman, B., Pearson, C., Kaufman, G., Chen, C., Wang, G. et al.** (2002) Maternal cigarette smoking, metabolic gene polymorphism and infant birth weight. *Journal of the American Medical Association* **287**(2), 195–202.
- Wardlaw, T., Blanc, A., Zupan, J. & Ahman, A.** (2004) *Low Birthweight: Country, Regional and Global Estimates*. United Nations Children’s Fund (UNICEF), New York, and WHO, Geneva.
- Wen, S. W., Kramer, M. S. & Usher, R. H.** (1995) Comparison of birth weight distributions between Chinese and Caucasian infants. *American Journal of Epidemiology* **141**, 1177–1187.
- Wessel, H., Cnattingius, S., Bergstrom, S., Dupret, A. & Reitmaier, P.** (1996) Maternal risk factors for preterm birth and low birth weight in Cape Verde. *Acta Obstetrica et Gynecologica Scandinavica* **75**(4), 360–366.
- Wingate, M. S. & Alexander, G. R.** (2006) The healthy migrant theory: variations in pregnancy outcomes among US-born migrants. *Social Science & Medicine* **62**, 491–498.