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Too Low or Too High? On Birthweight Differentials of Immigrants in Germany

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Abstract: Our paper compares the birth outcomes of international migrant women in Germany to those of non-migrant women. In Germany, about one-third of all newborns are born to migrant mothers. Since immigrant status and socio-economic disadvantages are highly correlated, the health of migrant children and their mothers has received increasing attention in the international literature. When investigating perinatal outcomes, the evidence on the effect of the immigrant status of the mother on the birthweight of her child has been contradictory. We use the sample of newborns collected by the German Socio-Economic Panel (SOEP), which contains pre- and perinatal variables that allow us to analyse the determinants of adverse birthweight outcomes. The data are on 1641 births that occurred between 2001 and 2010. Our study investigates the risk for children to be born with low or high birthweights (LBW and HBW) and small and large size for gestational age (SGA and LGA) by applying logistic regression analyses. We find that immigrant status is associated with a lower prevalence of low birthweight (LBW) and at the same time with a higher prevalence of increased prenatal growth (LGA). Control variables of the mother – age, parity, height, BMI, education, and smoking – cannot explain the birthweight differences between migrants and non-migrants. The findings support recent assumptions in the literature that the risk of low birthweight among newborns of migrant mothers has been levelling off. However, our results also suggest that new disadvantages of immigrants result from large size for gestational age, which increases the child's risk of overweight later in life.

Keywords: Birthweight · Immigrant children · Infant macrosomia · Migrant health · SOEP · Germany

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1 Introduction

Over the last decades, the percentage of births to migrant mothers has increased in many Western European countries. Since immigrant status and socio-economic disadvantages are highly correlated (*Massey* 1981), and, to a large extent, early-life conditions account for health differentials in later life (*Robinson* 2001), the health of migrant children and their mothers has received increasing attention (*Gagnon et al.* 2009). Disadvantages of migrant children have been observed in stillbirth (*Salihu et al*. 2004), in preterm birth (*Goedhart et al.* 2008), and in infant mortality (*Troe et al.* 2006; *Razum et al.* 2008). The correlation between the immigrant status of the mother and the birthweight of her child is not clear. The results mainly vary with the study design, the indicator, and the definition of migrants (*Gagnon et al.* 2009).

Low birthweight is one of the indicators which is commonly used for monitoring public health. It is one of the major causes of neonatal mortality as well as a risk factor of poor growth and health in childhood (*United Nation's Children Fund and World Health Organization* 2004). Further, it is an indicator for health inequalities between international migrants and non-migrants or between ethnic groups (*Gagnon et al.* 2009). In the last years, however, a growing number of studies have suggested that the increased risk of low birthweight (LBW) among newborns of migrant mothers has been levelling off (*Fuentes-Afflick/Lurie* 1997; *Hessol/Fuentes-Afflick* 2000; *Acevedo-Garcia et al.* 2007; *Auger et al.* 2008).

At the same time, there is a relatively small number of studies that investigate high birthweight (or macrosomia or oversized or overweight children; these terms are used interchangeably) (*Bonellie/Raab* 1997; *Schwarz/Teramo* 1999; *Orskou et al.* 2001; *Bergmann et al*. 2003; *Orskou et al.* 2003). These studies show that an increasing percentage of newborns has a high birthweight (HBW) or is too heavy relative to the pregnancy duration, which is termed large for gestational age (LGA). However, these studies do not consider immigrant status.

High birthweight is an independent risk factor, e.g., for diabetes (*Schwarz/Teramo* 1999), obesity in childhood or later in life, and long-term metabolic dysfunction (*Curhan et al*. 1996; *Vohr et al.* 1999; *Schaefer-Graf et al.* 2005; *Armitage et al.* 2008; *Catalano et al.* 2009; *Dyer/Rosenfeld* 2011; *van Rossem et al.* 2011; *Lindberg et al.* 2012). An absolute weight of more than 4,000 grams is associated with higher health risks for both the newborn and the mother, e.g., higher rates of stillbirth, infant mortality, and brachial plexus injury (*Axelsson* 1990; *Bryant et al.* 1998) as well as with higher rates of cesarean sections and instrumental delivery (*Zetterstrom et al.* 1999). Therefore, the aim of our paper is to bring these two directions of research together. We address the following research questions: Are international migrant mothers more likely to experience adverse birthweight outcomes compared to non-migrant mothers? And how do birthweight differentials vary between the indicators used? Our paper contributes to the literature by investigating low and high birthweight in the same analysis. Whereas most of the previous literature has focused on North America, our study is concerned with Germany. We compared births to immigrant mothers to those to non-migrant mothers. We used the data of the sample of newborns of the German Socio-Economic Panel study (SOEP 2003-

2010). We carried out multivariate logistic regression analyses on HBW/LBW and LGA/SGA, and compared the results for the four different indicators (controlled for socio-demographic characteristics and risk factors of the mothers).

2 Background

Previous research has produced a large number of studies that support the hypothesis that immigrants are socially disadvantaged and that they therefore also have a higher risk of low birthweight. Evidence was found, e.g., among migrants in the U.S. (*Hessol/Fuentes-Afflick* 2000; *Schempf et al.* 2010), in Canada (*Auger et al.* 2012), and in Germany (*Elkeles et al.* 1990).

These differences in LBW were partly traced back to the adverse socio-economic positions of migrants (*Kleinman/Kessel* 1987; *Hessol/Fuentes-Afflick* 2000). People who immigrated to developed countries in the West were found more likely to be malnourished and in bad health, with increased risks of contracting infectious diseases and of developing obesity and diabetes (mainly among women). These factors, in conjunction with social marginalisation in their host countries and a lower tendency to seek health care, lead migrant women to benefit less from the public health system than non-migrant women (*Guendelman et al.* 1999; *Wändell et al.* 2003; *Denktas et al.* 2009; *Ujcic-Voortman et al.* 2009; *Baraka et al.* 2011; *Choté et al.* 2011; *Lebrun* 2012).

In contrast, other studies on LBW have shown that migrant mothers, or certain migrant sub-groups, have equal or even lower perinatal risks than non-migrants (*Fuentes-Afflick et al.* 1999; *Guendelman et al.* 1999; *Reime et al.* 2006; *Troe et al.* 2007). The lower LBW prevalence was cited as evidence in support of the healthy migrant effect (*Guendelman et al.* 1999; *Wingate/Alexander* 2006). According to this hypothesis, international migrants tend to be positively selected for health, and the health status of migrants therefore tends to be better than that of non-migrants. *Hessol/Fuentes-Afflick* (2000: 522) spoke of a "perinatal advantage" and *Acevedo-Garcia et al.* (2007: 2507) claimed to have found a "protective effect of foreign-born status against LBW" across Latino groups in the U.S. though they could not explain it.

Both a declining risk of low birthweight and a decrease in disadvantages among migrants can be regarded as indicators for a healthier migrant population (*Orskou et al.* 2001). An increase in birthweight may, however, not only be due to a decline in LBW, but also to a rise in HBW. There is some evidence of an increasing trend in high birthweight (*Bonellie/Raab* (1997) for the UK, *Orskou et al.* (2001 and 2003) for Denmark, *Bergmann et al.* (2003) and *Reime et al.* (2006) for Germany). For differentials in high birthweight between immigrants and non-migrants, we found only one study that used nationality as a control variable: *Reime et al.* (2006) estimated that women of foreign nationality did not have different birthweight outcomes than German women. However, they merely used German/non-German nationality as the indicator for defining the mother's immigrant status, which may not be sufficient (*Reime et al.* 2006). In a study of HBW risks in Canada, *Rodrigues et al.* (2000) took ethnic background into account and detected significantly higher risks of high birthweight among Cree women than among non-native women. In two studies on migrant births in the US, the authors mentioned higher birthweights among migrants, but attributed them mainly to inaccurate estimations of the gestational age (*Buekens et al.* 2000) or differences in the birthweight distribution between ethnic groups (*Chung et al.* 2003). The very recent study by *West et al.* (2013) on newborns in the UK estimated higher risks of adiposity and increasing birthweights among South Asian infants as an indicator for health inequalities.

Several studies on different indicators of child health have, however, taken into account differentials between migrants and non-migrants or between ethnic groups: High birthweight was also shown to correlate with higher childhood obesity among adolescents in Germany (*BzGA* 2008), among American Indians (*Lindberg et al.* 2012), among African Americans (*Mehta et al.* 2011) in the US, among native ethnic groups in New Zealand compared to European women (*Craig et al.* 2004), among children in preschool-age in the Netherlands (*van Rossem et al.* 2011) and among Turkish children in particular (*de Wilde et al.* 2009). In general, less favourable dietary habits (consumption of energy-dense foods with high levels of sugar and fat), along with a genetic predisposition to gain weight and a lack of exercise among immigrant groups, have led to an increased risk of developing diabetes, obesity, cardiovascular disease, and hypertension (*Gilbert/Khokhar* 2008). In conjunction with this higher prevalence of overweight and obesity, ethnic origin is one of the main risk factors of gestational diabetes (*Berkowitz et al.* 1992; *Dornhorst et al.* 1992).

Since these health disadvantages each correlate with high birthweight (*Dyer/Rosenfeld* 2011), we investigated birthweight differentials between migrant and non-migrant newborns using indicators for low and for high birthweight outcomes. The following hypotheses guide our study: H1) The newborn children of immigrant mothers have a higher prevalence of low birthweight (LBW/SGA). H2) The risk of high birthweight (HBW/LGA) is higher among immigrant than among non-migrant children. In addition, we test the role of socio-demographic variables assuming that birthweight differences between migrants and non-migrants diminish when controlling for the different socio-demographic compositions of these groups (H3).

We test these hypotheses for the case of Germany, which has, until recently, been the leading destination country for international migrants in Western Europe. The migrant population consists of three major groups: migrant workers from Mediterranean countries, ethnic Germans from Eastern Europe, as well as refugees and asylum seekers. Whereas the non-migrant population is declining due to persistent lowest-low fertility, the share of the population with a migrant background has been rising continuously. Today, about 20 percent of the 82 million inhabitants of Germany are either immigrants, or are born to one or two parents born abroad; the share of children in preschool-age with a migrant background exceeds 30 percent (*Swiaczny/Milewski* 2012).

3 Methods

3.1 Data

We used data from the German Socio-Economic Panel (SOEP), which is a panel study that started in 1984 as a random sample representative of private households in West Germany. One of the samples, the so-called guest worker sample, consists of migrant workers who mainly came from Turkey, Greece, the former Yugoslavia, Italy, and Spain. A sample of East Germany was added in 1990, and a sample of new immigrant groups was added in 1994/95 (*Wagner et al.* 2007). Furthermore, refreshment samples have been performed in 1998, 2006, 2009, and 2011 in order to counter panel attrition. An additional sample for people with higher incomes was added in 2002. In 2003, a new annual questionnaire was introduced: the newborn sample. It applies to all women participating in the SOEP survey who gave birth to a child from 2002 onwards (*Schupp et al.* 2010). The questionnaire aims at surveying the development process of each mother and her child. It contains information on the type and the circumstances of the delivery, breastfeeding behaviour, health examinations, health status and development of the mother and the child, and the pregnancy-related support provided by others.

The number of interviews in the newborn sample is 1,814 from 2003 to 2010. We excluded the following cases from our analysis: cases without information on the timing of pregnancy, with implausible gestational weeks, missing birthweight, in-vitro fertilisation, twin births, cases in which the child could not be clearly linked to the mother, cases where no migration information could be identified, cases with missing information on the mother's body height or on age. Our final sample consisted of 1,641 newborns (about 40 percent of the cases were repeated observations because the mothers gave birth to more than one child from 2002 to 2010).

3.2 Variables

The dependent variables are two indicators for low birthweight and two indicators for high birthweight; they were coded as a binary response (1 yes/0 no). The absolute weight at birth was used to calculate low birthweight (LBW) with 2,500 grams as the upper threshold; and high birthweight (HBW) with 4,000 grams as the lower threshold. The LBW and HBW were both calculated regardless of the child's sex and the gestational week, which is in compliance with other studies (*Schwarz/Teramo* 1999; *Rodrigues et al*. 2000; *Orskou et al.* 2001; *Bergmann et al.* 2003; *Reime et al.* 2006; *Acevedo-Garcia et al.* 2007). The relative measures of small size for gestational age (SGA) and large size for gestational age (LGA) took into account the sex of the child and its weight relative to the gestational week. The indicator SGA used the lower 10th percentile of the sex-specific birthweight distribution of the total population of Germany for each gestational week as a reference. The indicator for LGA used the upper 10th percentile accordingly[1] (*Auger et al.* 2008; *Voigt et al.* 2010) (see Table 1).

The immigrant status of the mother was identified by using information on her country of origin, her nationality, her place of birth, and the type of sub-sample to which she belonged (migrant or descendant of migrants) (*Milewski* 2007; *Scheller* 2011). If any of these variables indicated a foreign nationality or a foreign place of birth, the woman was defined as migrant (which includes first and second migrant generations). In our sample, 26 percent of the births were given by migrant women, and 74 percent were given by non-migrant mothers. We distinguished migrants into three groups according to the countries of origin: 33 percent of the migrant newborns have mothers who come from a Mediterranean country, 22 percent from Eastern Europe and 44 percent from other countries.[2] Since information is not specifically given on the father of the child, we only used maternal characteristics.

Our control variables are commonly used in birthweight analyses. We carried out bivariate tests for each of the four birthweight indicators and each explanatory variable using chi^2 tests for categorical variables and t-tests for metric variables (see Table 1). The level of parity was represented in our sample on a scale from 1 to 12 (mean: 1.84, mode: 1, median: 2). A dichotomous variable accounted for primipara (45 percent) and multipara (55 percent), with migrant mothers having slightly more multipara births than non-migrant mothers. Of the maternal characteristics, we used age at delivery as a continuous measure. At delivery, migrant women were on average 1.1 years younger than non-migrant women. Since migrant mothers were significantly shorter than non-migrants, the height of the mother was used as a separate variable accounting both for heterogeneity between migrants and non-migrants and within the migrant group, which is in compliance with comparable studies (*Bergmann et al.* 2003; *Troe et al.* 2007). Both continuous variables (age and height) were centred around their mean values before they were entered in the regression analysis. In order to account for the weight of the mother, we used the body mass index (BMI). This variable had a large share of missing values because of missing answers on weight. Thus, we used BMI as a categorical variable, which distinguished between too low (below 18.5) and normal weight (18.5 to 30) in one pooled category, overweight (30+) in a second category, and missing values (*Doherty et al.* 2006). No significant differences have been observed between migrants and non-migrants regarding their BMI.

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1 Due to the inclusion of the gestational week, LGA and SGA are mainly indicators of prenatal growth, whereas HBW and LBW measure big or small birth outcomes in absolute terms. While both groups of indicators signal unusual weights, only HBW clearly identifies cases with a high risk of birth complications and injuries (*Bergmann et al.* 2003). Newborns with LBW may still be large for their gestational age. HBW, on the other hand, is not associated with small size for gestational age.

2 The Mediterranean countries include Turkey, former Yugoslavia, Greece, Italy, Spain, Portugal, Croatia, Bosnia-Herzegovina, Macedonia and Kosovo-Albania. The group of Eastern European countries in our sample consists of Poland, Bulgaria, Russia, Moldavia, Kazakhstan, Albania, Kyrgyzstan, Ukraine, Uzbekistan, Slovakia, and Belarus.

Tab. 1: Descriptive overview of the sample, by immigrant status of the mother

	Non-migrant		Migrant	
	N	%	N	%
Birthweight indicators				
Low birthweight (LBW)				
No (2500+ grams)	1132	93.2	405	94.8
Yes (<2500 grams)	82	6.8	22	5.2
High birthweight (HBW)				
No (<4000 grams)	1085	89.4	385	90.2
Yes (4000+ grams)	129	10.6	42	9.8
Small for gestational age (SGA)				
No	1082	89.1	387	90.6
Yes	132	10.9	40	9.4
*Large for gestational age (LGA)**				
No	1100	90.6	368	86.2
Yes	114	9.4	59	13.8
Child's characteristics				
*Parity**				
Primipara	563	46.4	173	40.5
Multipara	651	53.6	254	59.5
Sex of child				
Boy	617	50.8	230	53.9
Girl	597	49.2	197	46.1
Maternal characteristics				
BMI				
<30	652	53.7	229	53.6
30+	49	4.0	18	4.2
MV	513	42.3	180	42.2
*Education****				
Low (up to 10 years of schooling)	105	8.6	98	23.0
Medium or high (10+ years of schooling)	915	75.4	248	58.1
MV	194	16.0	81	19.0
Smoking habits before pregnancy				
None or ex-smoker	595	49	194	45.4
Smoker	279	23	114	26.7
MV	340	28	119	27.9
Migrants' country of origin	NA			
Mediterranean countries			142	33.3
Eastern Europe			96	22.5
Other countries			189	44.3
Calendar period				
2001 to 2005	678	55.8	235	55.0
2006 to 2010	536	44.2	192	45.0

Tab. 1: Continuation

	Non-migrant		Migrant	
	N	%	N	%
*Age****	30.7	(mean)	29.6	(mean)
*Height****	168.2	(mean)	165.3	(mean)
*Pregnancy week***	39.3	(mean)	38.9	(mean)
Total	*1214*	*100*	*427*	*100*
Repeated observations				
1x	722	75.8	266	78.2
2x	204	21.4	63	18.5
3x	24	2.5	10	2.9
4x	3	0.3	0	0.0
5x	0	0.0	1	0.3

Note: *$p<0.05$, **$p<0.01$, ***$p<0.001$ via chi2 test or one-way anova for association between variable and immigrant status.

NA=not applicable, MV=missing value.

Source: Calculations based on SOEP 1999-2010; N=1641.

The socio-economic status of the mother was measured by a dichotomous variable for education, distinguishing between no school degree, primary or lower secondary schooling (up to 10 years of schooling, termed low educational level) and upper secondary schooling (more than 10 years, termed medium/high educational level). The educational attainment was lower among migrants than among non-migrants (23 percent of the group of migrants and 9 percent of the group of non-migrants had a low education).

Further, we took the mothers' smoking habits into account. Our variable measured whether the mother characterised herself as smoker before the pregnancy (category 1) or if she stopped smoking or never smoked before pregnancy (category 0). Unfortunately, the survey did not directly ask if the mother was still smoking during her pregnancy. Migrant mothers were slightly more often identified as frequent smokers than non-migrants (27 percent vs. 23 percent). Despite the high share of missing values, the prevalence in our sample corresponds to that of the total population in Germany (*Bergmann et al.* 2008). In order to control for changes over the time period and possible effects of the sample refreshment in 2006, we used a dummy variable for births, which occurred before 2005, in 2006, and afterwards. Other predicators of birthweight, such as diabetes type II, gestational diabetes, and smoking during pregnancy are not contained in the sample we used.

3.3 Statistical analysis

In the multivariate analysis, we run binary logistic regression models for each of the four indicators, since we were interested in the extreme values of low or high birthweights. The modelling process was done in multiple steps, estimating the odds ratios for immigrant status without controlling for maternal characteristics first. Whereas the measures SGA and LGA are based on sex, weight, and gestational age, the analyses of the two absolute-weight indicators LBW and HBW used the gestational age and the sex of the newborn as control variables (Model 1). Subsequently, we added the control variables in Model 2: age, height, BMI, education, smoking status of the mother, and parity. Model 3 showed the intra-group variation of migrant mothers by distinguishing between the different groups of countries of origin.

Finally, we carried out some sensitivity analyses (results not shown): in order to test the impact of repeated observations, we estimated a Generalised Linear Model, accounting for the within-subject correlation. Additionally, we tested whether repeated observations affect the models by excluding such cases. Since the variable BMI had the highest shares of missing values, we also used the BMI with imputed values from the SOEP dataset instead of the missing-value category. In addition to the odds ratios (OR), we calculated average marginal effects (AME), as this measure allowed us to compare the respective measures between models and sub-samples (*Mood* 2010).

4 Results

Table 1 displays the percentages of low and high birthweight by immigrant status. For low birthweight, we find LBW slightly less frequent in migrant births than in non-migrant births, at about 5 percent and 7 percent, respectively. The shares of SGA are about 9 percent and 11 percent, respectively (the difference is not statistically significant).

Regarding the distributions of the indicators for high birthweight, we find that about 10 percent of the children of migrant mothers and 11 percent of the children of non-migrants have HBW. Whereas the shares of HBW do not significantly vary between migrants and non-migrants, the differences in LGA are significantly higher: About 14 percent of migrant newborns are large for gestational age compared to about 9 percent among non-migrant newborns.

Tables 2a and 2b display the results of the logistic regression analyses for the four different indicators.

First, we concentrate on the two measures that indicate the weight of a newborn to be low (LBW and SGA in Table 2a). For both indicators (LBW adjusted for sex and gestational age), Model 1 shows that migrant newborns have a reduced risk. The results for LBW are significant. The risk for a migrant newborn to be born with LBW is 53 percent lower than the risk for non-migrants. The risk of SGA is 15 percent lower (not significant). Adjusted for confounding variables, these differences between the groups do not diminish (Model 2), but increase slightly. Migrant newborns are less than half as likely to have LBW and their SGA risk is about 30 percent lower than that for non-migrants. Model 3 distinguishes between the different origins of the migrants. Here we find significant variation between the groups of origin. Both the group of newborns whose mothers come from Eastern Europe and the group

Tab. 2a: Impact of the immigrant status of the mother on LBW and SGA (odds ratios and confidence intervals)

	Low birthweight (LBW)				Small for gestational age (SGA)			
	OR	95 % C.I. lower	95 % C.I. upper	p-value	OR	95 % C.I. lower	95 % C.I. upper	p-value
Model 1 (unadjusted)								
Immigrant status								
Non-migrant	1				1			
Migrant	**0.47**	0.26	0.86	0.01	0.85	0.58	1.23	0.38
-2 Log Likelihood	*516.68*				*1100.44*			
Model 2 (adjusted)								
Immigrant status								
Non-migrant	1				1			
Migrant	**0.44**	0.24	0.82	0.01	0.68	0.46	1.01	0.06
Sex of child						NA		
Boy	1							
Girl	1.26	0.77	2.06	0.35				
Pregnancy week (centered)	**0.53**	0.48	0.59	<0.001		NA		
Parity								
Primipara	1				1			
Multipara	0.62	0.37	1.05	0.07	**0.58**	0.41	0.82	0.00
Age (centered)	1.03	0.98	1.08	0.29	1.02	0.98	1.05	0.36
Height (centered)	0.97	0.93	1.01	0.12	**0.93**	0.91	0.96	<0.001
BMI								
<30	1				1			
30+	1.71	0.53	5.54	0.37	0.87	0.36	2.10	0.76
MV	1.19	0.69	2.05	0.54	1.10	0.77	1.59	0.59
Smoking habits before pregnancy								
None or ex-smoker	1				1			
Smoker	1.22	0.66	2.24	0.52	1.46	0.98	2.19	0.07
MV	0.80	0.39	1.66	0.55	0.88	0.54	1.42	0.59
Education								
Low	1				1			
Medium or high	1.18	0.55	2.52	0.67	0.77	0.47	1.28	0.31
MV	1.54	0.57	4.18	0.40	1.16	0.60	2.24	0.67
Calendar period								
2001 to 2005	1				1			
2006 to 2010	1.41	0.83	2.41	0.20	1.08	0.76	1.53	0.66
-2 Log Likelihood	*505.30*				*1049.63*			
Model 3 (adjusted)								
Country of origin								
Non-migrant	1				1			
Mediterranean	**0.25**	0.09	0.73	0.01	**0.43**	0.21	0.86	0.02
Eastern Europe	**0.21**	0.05	0.89	0.03	0.78	0.38	1.62	0.51
Others	0.78	0.37	1.65	0.52	0.85	0.51	1.41	0.53
-2 Log Likelihood	*500.50*				*1046.47*			

Note: Model 1 controls for pregnancy week and sex of child in HBW and LBW; Model 3 controls for the characteristics of child and mother as in Model 2.
NA=not applicable, MV=missing value.

Source: Calculations based on SOEP 1999-2010; N=1641.

Tab. 2b: Impact of the immigrant status of the mother on HBW and LGA (odds ratios and confidence intervals)

	High birthweight (HBW)				Large for gestational age (LGA)			
	OR	95 % C.I. lower	95 % C.I. upper	p-value	OR	95 % C.I. lower	95 % C.I. upper	p-value
Model 1 (unadjusted)								
Immigrant status								
Non-migrant	1				1			
Migrant	1.04	0.71	1.51	0.85	**1.55**	1.11	2.16	0.01
-2 Log Likelihood	*1019.09*				*1099.27*			
Model 2 (adjusted)								
Immigrant status								
Non-migrant	1				1			
Migrant	1.24	0.82	1.87	0.30	**1.80**	1.26	2.57	<0.001
Sex of child						NA		
Boy	1							
Girl	**0.69**	0.50	0.97	0.03				
Pregnancy week (centered)	**1.57**	1.39	1.77	<0.001		NA		
Parity								
Primipara	1				1			
Multipara	**2.03**	1.39	2.96	<0.001	**1.49**	1.04	2.13	0.03
Age (centered)	1.01	0.98	1.05	0.57	1.02	0.99	1.06	0.19
Height (centered)	**1.06**	1.04	1.09	<0.001	**1.06**	1.03	1.09	<0.001
BMI								
<30	1				1			
30+	0.90	0.37	2.21	0.82	1.31	0.62	2.76	0.48
MV	1.01	0.69	1.47	0.96	0.95	0.66	1.38	0.79
Smoking habits before pregnancy								
None or ex-smoker	1				1			
Smoker	0.95	0.61	1.49	0.82	0.95	0.62	1.46	0.82
MV	1.42	0.90	2.26	0.14	**1.59**	1.03	2.48	0.04
Education								
Low	1				1			
Medium or high	1.22	0.63	2.37	0.56	0.68	0.41	1.11	0.12
MV	0.95	0.42	2.15	0.89	**0.43**	0.21	0.86	0.02
Calendar period								
2001 to 2005	1				1			
2006 to 2010	**1.49**	1.03	2.14	0.03	1.38	0.97	1.98	0.07
-2 Log Likelihood	*972.20*				*1058.95*			
Model 3 (adjusted)								
Country of origin								
Non-migrant	1				1			
Mediterranean	0.93	0.44	1.95	0.85	1.69	0.96	2.98	0.07
Eastern Europe	**2.68**	1.47	4.89	0.00	**3.53**	2.06	6.04	<0.001
Others	0.89	0.50	1.59	0.69	1.19	0.71	2.02	0.51
-2 Log Likelihood	*963.55*				*1049.43*			

Note: Model 1 controls for pregnancy week and sex of child in HBW and LBW; Model 3 controls for the characteristics of child and mother as in Model 2.
NA=not applicable, MV=missing value.

Source: Calculations based on SOEP 1999-2010; N=1641.

whose mothers come from Mediterranean countries are less likely to have LBW than non-migrant newborns. The Mediterranean group further shows significantly lower SGA risks while no difference was found for the other groups.

Whereas our results reveal that migrant children do not have a higher risk of low birthweight or intrauterine growth restriction and instead have a more favourable risk structure than non-migrants, we find the opposite results for the risk of high birthweight and a high prenatal growth rate (HBW and LGA in Table 2b).

While Model 1 shows that the higher risks of HBW for migrants are insignificant, the values of the LGA are significant. Migrant newborns have a 55 percent higher risk of being large for gestational age. When adjusting for confounders, the risk gap between migrant and non-migrant children increases for both HBW (1.2, not significant) and LGA (1.8). Including the country of origin, Model 3 reveals which groups contribute to the elevated risks: newborn children whose mothers come from Eastern Europe have the highest risks of HBW (2.7) and LGA (3.5). The risks of LGA are also elevated in the Mediterranean group, although the values are not significant. This is because the insertion of the control variables explains a substantial part of the differences between the Mediterranean group and non-migrants, which is not the case for Eastern Europeans. In contrast, the HBW risk does not significantly vary between non-migrants and migrants from Mediterranean or other countries.

Overall, the control variables show the effects which have already been described in the literature: A higher parity is associated with higher rather than lower birthweight. A similar effect was observed for taller mothers. For the group of smokers, the risk of SGA is increased. No significant differences were found for the effect of age, BMI and education of the mother.

The sensitivity analyses showed that the results were robust. The differences between migrant and non-migrant newborns remained the same in direction and degree of significance, and were similar in size. The exclusion of repeated observations slightly affected the size, but not direction of the odds ratios.

5 Discussion

Our analysis investigated birthweight differentials between migrant and non-migrant children in Germany taking into account low and high outcomes with different definitions for the thresholds. The results show different risk profiles for the groups.

Our first hypothesis was concerned with low birthweight outcomes (LBW and SGA). We assumed higher risks for migrant newborns than for non-migrants. Many international studies suggest that the socio-economic disadvantages of the migrant group would also lead to lower birthweight outcomes as low birthweight is traditionally seen as an indicator for social inequalities. Our results do not support this hypothesis. Instead, migrant children in Germany have a significantly lower risk of LBW and, to some extent, also of SGA. In fact, our study supports our second hypothesis: Newborns of migrant mothers face a higher risk of high birthweights than non-migrant children. Here, the results vary with the indicator that is used: Children born to migrant mothers do not exceed the threshold value of 4,000 grams of the absolute birthweight more often than children of non-migrants (HBW). However, they are more likely to exceed the reference values of the gestational-age and the sex-specific weight distribution of the German population of newborns (LGA).

Concerning the conclusions of our third hypothesis, the risk differentials in low and in high birthweights cannot be explained by control variables.

Our study was further concerned with within-group differences and detected substantial variation: Women from Mediterranean countries and Eastern Europe are more likely to have children who are large for gestational age than non-migrants. For the Mediterranean group, the observed higher prenatal growth rate may be related to a higher prevalence of blood glucose and of diabetes among these women. This has been documented for Turkish women in Germany (*Ujcic-Voortman et al.* 2009), who dominate the group of Mediterranean migrants in our sample. Likewise, lower levels of health care utilisation may lead to the increased risks (*Guendelman et al.* 1999). The group of newborns whose mothers come from Eastern Europe consistently is the only group in the sample who exhibits higher risks of HBW and LGA. Consequently, this group faces the challenges arising from both HBW and LGA, i.e., possible complications during delivery due to the absolute size of the newborn and higher risks related to overweight in the life course.

In contrast to previous literature, we used two indicators for the absolute birthweight (LBW/HBW) and two indicators that relate the birthweight to the sex of the child and the gestational week (SGA/LGA). Our results show that the differences between migrant and non-migrant births are more pronounced for LGA than for HBW. We assumed that a higher prenatal growth rate, as suggested by LGA, coincides with higher rates of preterm births among migrants. A recent study estimated higher prevalences of preterm births among Turkish and ethnic German immigrants than among the non-migrant population (*Becker/Stolberg* 2012). We checked this hypothesis with a bivariate rank-test (Kendall's tau b) and found a significant positive correlation between LGA and preterm birth (gestational age lower than 37 weeks). This may explain why migrant newborns do not weigh more than 4,000 grams (the threshold of HBW) more frequently despite a higher prenatal growth rate. Before drawing the conclusion that children of migrants face a double disadvantage here – that of preterm births and of LGA – more detailed analyses are needed in order to explain this pattern.

We did not only examine which of the birthweight indicators adequately detects birthweight inequalities, but also analysed the quality of the SOEP data. As in other studies on differences related to migrant or ethnic group membership, it is not easy to distinguish our study populations. Further, the populations themselves are not homogenous (*Howard* 1999). The observed birthweight differences could be an artefact of comparing the migrant groups to a common point of reference; our study used the national birth distribution dominated by German mothers. It has been shown that optimal birthweights differ substantially between countries (*Graafmans et al.* 2002; *Kierans et al.* 2008). Future research could therefore apply the birthweight distributions of the respective countries of origin to migrant mothers in order to test whether birthweight rates would change. However, the results of our study are similar to those of previous studies. The shares of, e.g. HBW, are similar to the respective percentages found in a population wide study by *Bergmann et al.* (2003 – they used citizenship as the criterion and found that 9.5 percent of births to foreign mothers and 11.3 percent of births to German mothers had HBW). The evidence that migrant groups have overweight-related health problems at all stages in their life courses supports our finding of higher LGA risks among migrants (*Gilbert/Khokhar* 2008). In addition, shifts in birthweight distributions that are unrelated to adverse birth outcomes typically occur only when populations have experienced favourable living conditions for several generations (*Eveleth/Tanner* 1990). Presumably, this is not the case for the migrant groups under study.

We acknowledge that the sample size in our study is rather small. In particular, the results comparing the migrant subgroups should be treated with caution. The sample selection may not be optimal. Even though the SOEP is a sample that is representative at the national level, with an oversampling of migrants,[3] the newborn questionnaire is a voluntary add-on. Detailed statistics on the participation rate and a potential selection bias towards lower-risk individuals are not available. We argue, however, that such a selection effect would rather support our findings, as noncompliance is likely to be higher among high-risk groups.

Despite these limitations, our results suggest that future research should take both into consideration, intra-group variation as well as variation between different birthweight indicators. Our finding of higher rates of a large size for gestational age among migrant newborns, which points at a faster intrauterine growth rate, is in line with the above findings of a higher prevalence of obesity, diabetes, and especially gestational diabetes, which are known to enhance fetal growth.

As the focus of this study is on detecting birthweight variation among immigrant and non-migrant groups using different indicators, a more profound explanation of the differences is beyond the scope of this paper. In general, lifestyle factors play an important role together with socio-economic disadvantages and integration polices (*Bollini et al.* 2009; *Auger et al*. 2012). Furthermore, birthweight is highly heritable – to a degree of up to 40 percent (*Clausson et al.* 2000). At the same time, it is difficult to distinguish between genetic and environmental and lifestyle factors (*Howard* 1999; *Hessol/Fuentes-Afflick* 2000). In our study, we could use only a small number of confounding variables due to limitations in the sample. We found that the inclusion of these variables only partly explains birthweight differentials between migrants and non-migrants. In some respects, the lifestyle of migrant women tends to be healthier, e.g. they are less likely to consume alcohol. In other respects, however, it tends to be less healthy, e.g., they are less likely to make use of perinatal care than non-migrants (*Guendelman et al.* 1999; *Orskou et al.* 2003). Consequently, it seems

3 Although the sample size is relatively small, the data quality is high. Whereas previous studies in Germany used mainly cross-sectional hospital records, our data contain more reliable information on the immigrant status. The SOEP has several indicators that allow for the reconstruction of the migration history of a person, including the country of birth, the age at immigration, and the nationality in each survey year. Moreover, the longitudinal structure of the SOEP contains other socio-demographic characteristics of the mother that were measured prior to the pregnancy, which allows for causal conclusions.

promising to compare the migrant groups to the women in the respective countries of origin in order to gain a deeper understanding of the impact of the migration process. Distinguishing between the first, second, and third generations of immigrants would also help to identify patterns related to their adaptation processes in the host country and their effects on birthweight differentials.

In sum, if we wish to understand the impact of social inequalities on birthweight, we should consider high birthweight (*Orskou et al.* 2001; *West et al.* 2013) as well as low birthweight when investigating birth outcome differentials between migrants and non-migrants. Whereas low birthweight is the main challenge among non-migrant children, migrant women are at a higher risk of having children that are large for gestational age. Undoubtedly, a reduction of the share of newborns with a low birthweight is a success – but only if the amount of obese children does not increase to the same degree.

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