Anthropological Review • Vol. 82(2), 125–137 (2019)

sciendo

ANTHROPOLOGICAL REVIEW
Available online at: https://doi.org/10.2478/anre-2019-0009

Does extreme maternal age still act as a risk factor for adverse perinatal outcome? Evidence from Poland 20 years after the social and economic transformation

Magdalena Kosińska[1], Tomasz Hadada[1], Grażyna Liczbińska[2]*

[1]Department of Human Developmental Biology, Institute of Anthropology, Faculty of Biology, Adam Mickiewicz University in Poznań, Poland
[2]Department of Human Evolutionary Ecology, Institute of Anthropology, Faculty of Biology, Adam Mickiewicz University in Poznań, Poland

ABSTRACT: It was examined whether positive changes in maternal SES and medical facilities in Poland 20 years after social and economic transformation weakened the role of maternal age in shaping perinatal outcome. Data comprised of 2,979 children born in 2000 and 2,992 – born in 2015. To test the differences between the frequency of indicators of adverse perinatal outcome the chi-square test was applied. The influence of maternal age on the perinatal outcome was estimated using Generalized Linear Models (GLMs), with binomial error distribution and the logit link function. The infants survival was examined using survival analysis. Gestational age and birth weight were influenced by mother's age and the year of survey. Infants of adolescent and older mothers represented the groups with a risk of adverse perinatal outcome: an increase of preterm births and higher risk of having children with LBW in the group of adolescent mothers than in mothers aged >35, infants born SGA and LGA found in both adolescent and adult mothers. GLMs confirmed the impact of maternal age and the year of survey on perinatal outcome. The Cox proportional hazard models showed that the year of survey was the only factor affecting the risk of infants' death. The impact of maternal age on adverse perinatal outcome can be counterbalanced by positive changes in social and economic standard of living of women, improvement in neonatal medical care and better equipment of hospital wards in 2015 as compared to 2000.

KEY WORDS: birth weight, gestational age, infant mortality, maternal SES, preterm birth

Abbreviations used in this paper**:** AUC – Area Under the Curve; CI – confidence interval; CL – confidence level, IM – infant mortality; LBW – law birth weight; LGA – large-for-gestational age; OV – outcome variables; PTB – preterm birth; Q – quartile; ROC – receiver operating; SD – standard deviation; SE – standard error; SGA – small-for-gestational age.

Original Research Article Received: April 26, 2019; Revised: May 16, 2019; Accepted: May 17, 2019
DOI: 10.2478/anre-2019-0009

Introduction

The influence of maternal age on infants' perinatal outcome is a very interesting and often studied topic (Heffner 2004; Luke and Brown 2007; Huang et al. 2008; Kanungo et al. 2011; Kozuki et al. 2013). The increase in mother's age of entry for reproduction is a phenomenon observed in many developed countries (Cavazos-Rehg et al. 2015; Mathews and Hamilton 2016). In Poland it has been clearly noticeable since 2000 (Demographic Yearbook 2001, 2016). In many studies the impact of maternal age on perinatal outcome is discussed with regard to two extreme age groups of women: very young mothers (aged ≤19) and those of advanced age (aged ≥35) (Olausson et al. 2001; Antinori et al. 2003; Jacobsson et al. 2004; Cheng et al. 2007; Schoen and Rosen 2009; Khashan et al. 2010; Kanungo et al. 2011; Cavazos-Rehg et al. 2015).

From the point of view of human developmental biology the best age for the onset of reproduction is the period between 20–35 years (Jolly et al. 2000; Joseph et al. 2005). Within this age range the most women are not exposed to a risk of health problems and complications of pregnancy or birth. This age range is also indicated by researchers as the most favourable for reproduction due to socio-economic reasons. Most of mothers have completed their education and are ready to enter the labour market (Mirowsky 2002; Delbaere et al. 2007).

Early and late reproduction is related to the risk of adverse pregnancy (Ziadeh 2002; Antinori et al. 2003; Carolan and Frankowska 2011; Wang et al. 2011) and adverse perinatal outcomes (Lee et al. 1988; Mirowsky 2002; Odibo et al. 2006; Chen et al. 2007; Schoen and Rosen 2009; Carolan and Frankowska 2011; Kanungo et al. 2011). Numerous studies have demonstrated the association between advanced maternal age and such disorders as intrauterine growth restriction (Heffner 2004; Huang et al. 2008; Schoen and Rosen 2009), stillbirths (Hassold and Chiu 1985; Bateman and Simpson 2006; Odibo et al. 2006; Reddy et al. 2006), genetic anomalies (Zīle and Villeruša 2013) and the occurrence of congenital malformations (Chen et al. 2007). In turn, prematurity, low birth weight, and the increase of infant morbidity and mortality are the most frequently cited adverse outcomes in children born to teenage mothers (Olausson et al. 2001; Chen et al. 2007). In the literature it has been also documented that the same disorders are met in infants born to mothers at advanced age (Bateman and Simpson 2006; Odibo et al. 2006; Reddy et al. 2006; Huang et al. 2008; Schoen and Rosen 2009). Moreover, several studies have found the association between teenage pregnancy and antepartum foetal death (Hassold and Chiu 1985) and the occurrence of congenital anomalies (Chen et al. 2007).

However, research on the association between maternal age and pregnancy outcome has sometimes reported inconsistent conclusions (Odibo et al. 2006; Reddy et al. 2006; Huang et al. 2008; Schoen and Rosen 2009). The lack of cohesion in results may be due to other risk factors modifying pregnancy and perinatal outcome such as: parental socioeconomic status, parental employment and educational level, maternal marital status, level of health awareness and lifestyle (Mirowsky 2002, 2005; Delbaere et al. 2007). Currently many of the risk factors, including the mother's age, can be counterbalanced by medical care,

including advanced gynaecological-obstetric care. The state of medical knowledge, advances in gynaecological and obstetrical care, changes in socio-economic conditions and life style may diminish the action of biological factors, including very young/ advanced maternal age (Kosińska 2011).

The unsatisfactory state of research on changes in maternal age when giving birth to the first child in Poland after the social and economic transformation calls for further studies. The choice of the years 2000 and 2015 allowed not only to compare two distant periods, in which Poland differed in terms of economic and medical progress, but also to compare two groups of women differed in SES, the level of consciousness and lifestyle. Women who gave birth to the first child in 2000, especially older mothers, grew up in the period of communism, which spanned throughout their childhood, adolescence and early adulthood (in the case of the oldest mothers also the pre-pubertal stage). The pre-transformation period influenced their growth and development. The communism equalized the possibility of using social support from the state. Nevertheless, poor economy was associated with poor nutrition, lower social and economic status and lower level of health awareness of people. The lack of comparative research concerning the onset of reproduction of women from the Eastern Europe born and grew up in the pre-transformation period, but giving birth in the post-transformation one has justified our study.

In the context of the above arguments in this work we examined whether positive changes in medical facilities and maternal SES weakened the role of maternal age in shaping perinatal outcome. To achieve this we established three goals of our research: 1) to examine and compare the potential effects of mothers' age on perinatal outcome in two periods separated by a fifteen-year time interval, differed in terms of women's economic and social status (2000 and 2015); 2) to investigate the influence of maternal age on the perinatal outcomes (gestational age, birth weight); 3) to estimate whether adolescent and advanced child bearing is related to an increase risk of infant mortality.

Materials and methods

Data comprised of randomly selected single live-born infants born in the Gynaecological and Obstetric Teaching Hospital of the Poznań University of Medical Sciences in 2000 (N=2,979) and in 2015 (N=2,992). Most of the neonates came from families living in large cities (with a population exceeding 100,000), mainly in Poznań. Their mothers were nulliparous. Nearly 70% of them had at least secondary education, 84% were married or lived in a partnership. Detailed information concerning maternal economic situation were not available from hospital cards in 2015.

Maternal age was defined in completed years at the time of delivery and was categorized into the following three categories: 1) adolescent (aged ≤19), 2) 20–35 years, and 3) older (aged >35). When describing the perinatal outcomes we considered gestational age, birth weight and infants mortality during the first six months of life (180 days). The gestational age of infants was determined with the use of Naegele's rule. Corrections of gestational age were performed on the basis of first trimester ultrasound examination and Ballard scale assessment after delivery of new-borns (Ballard et al. 1991).

Birth weight was measured by qualified medical staff immediately after birth, with a safety margin of up to 10 g. Infants born before 37 completed weeks of gestation were classified as the preterm delivered. New-borns with a birth weight up to 2500 g were classified as the low birth weight group. Determination of the relationships between the gestational age and birth weight of the examined new-borns based on the reference data developed for Western Poland, which was the region of infants' parentage (Gadzinowski et al. 2003). This procedure enabled the indication of the size of the deviation from the target weight for the week of pregnancy and the isolation of groups of new-borns who were small-, appropriate-, or large-for-gestational age. The critical value for being small-for-gestational age (SGA) was expressed in standard deviation scores equals −1.28 while for large-for-gestational age (LGA) as +1.28 (Kosińska 2006). The percentile position was established for children born between 24−42 weeks of gestation (N=2,986). This is the range of gestational age considered in the reference system (Gadzinowski et al. 2003).

To test the differences between the frequency of indicators of adverse perinatal outcome in 2000 and 2015 in the selected groups of mothers according to their age at first birth, we applied the chi-square test. To estimate the influence of maternal age and the year of survey on variables describing the perinatal outcome, we used generalized linear models (GLMs), with binomial error distribution and the logit link function. The following indicators of perinatal outcome: gestational age, birth weight, relationships between the gestational age and birth weight were used as a response variables, while mothers' age and the year of survey as the explanatory ones. Adult mothers (20–34 years) were treated as a reference group. We calculated odds ratios and their 95% confidence intervals (CI) to characterize the effect of the explanatory variable on binary response. Odds ratios allow assessing the risks of adverse perinatal outcome (preterm birth, low birth weight, birth weight small- or large-for-gestational age) depending on distinguished categories of mother's age and the year of survey. To assess the performance of models areas under ROC (receiver operating characteristics) curves (AUC) were calculated. The ROC curve illustrates the diagnostic ability of a binary classifier system as its discrimination threshold (mothers' age, year of survey); i.e. performance of the model. The area under the ROC curve is equal to the probability that a classifier will rank a randomly chosen positive instance higher than a randomly chosen negative one. It measures the decisiveness and accuracy of the model, i. e. it compares different models for a particular variable and assesses the performance of the model.

To capture the effect of maternal age and the year of survey, i.e. 2000 and 2015, on infant mortality we focused on the period of the first 180 days of infants' life. To study the time elapsing between the moment of infant birth and death, we applied the survival analysis. This analysis allowed us to estimate and compare survival functions among groups of infants distinguished by mothers' age and by the year of survey. To investigate the association between the survival time of infants and the independent variables we used the Cox proportional hazards model, for description of survival probability – the Kaplan-Meier method, for comparison of survival curves – the chi-square test (Kosińska 2006). Statistical anal-

yses were carried out in the "MuMin" package using R v.3.3.2 (R Development Core Team 2017). Significance was set at $p<0.001$ and $p<0.05$.

Results

Mothers' age ranged from 13 to 48 years in 2000 (= 24.6 ± 4.2; Me = 24) and from 14 to 43 years in 2015(= 27.7 ± 4.8; Me = 28). In 2000 and 2015 the central 50% quartile ranges (Q1–Q3) of births were observed among women aged 22−27 and 25–31, respectively. The differences between mean ages ($t_{6017}=3.4$; $p<0.001$), quartile ranges and birth frequency indicate a shift towards later motherhood. We observed a decrease in the frequency of births among mothers aged ≤24, with adolescent mothers among them, and the increase in the frequency of births among mothers aged ≥35 (Table 1). In 2000 teenage mothers (≤19 years) constituted 9% of all women

Table 1. Frequency of births in relation to mother's age

Year	Categories of mother's age	Mothers' age (years)	No. of births	%
2000	Adolescent	≤19	275	9
	Adult	20–24	1,283	43
		25–29	1,096	37
		30–34	249	8
	Old	≥35	76	3
2015	Adolescent	≤19	113	4
	Adult	20–24	596	20
		25–29	1,256	42
		30–34	807	27
	Old	≥35	220	7

Table 2. Perinatal outcome variables by the year of survey

Perinatal outcome variables	Category of variable	2000		2015	
		n	%	n	%
Gestational Age	x–28	87	2.9	17	0.6
$\chi^2=148.411$; df=3; $p<0.001$	29–31	115	3.9	46	1.5
	32–36	207	6.9	79	2.6
	37–42	2,570	86.3	2,850	95.3
Birth Weight	x–1000	68	2.3	16	0.5
$\chi^2=145.927$; df=7; $p<0.001$	1001–1500	90	3.0	29	1.0
	1501–2000	83	2.8	37	1.2
	2001–2500	129	4.3	48	1.6
	2501–3000	1,576	52.9	1,679	56.1
	3001–3500	804	27.0	886	29.6
	3501–4500	205	6.9	232	7.8
	4501–x	24	0.8	65	2.2
Birth Weight vs. Gestational Age	< −1.28 SD	303	10.2	282	9.4
$\chi^2=11.918$; df=2; $p<0.001$	−1.28 SD–1.28 SD	2,461	82.6	2,421	80.9
	>1.28 SD	215	7.2	289	9.7
Mortality	Died	104	3.5	25	0.8
$\chi^2=49.800$; df=1; $p<0.001$	Survived	2,875	96.5	2,967	99.2

under study, while in 2015 – 4%. In 2000 and 2015 mothers aged ≥35 represented 3% and 7% of all women, respectively. In 2015 there were 1.5 time more women giving birth to the first child at the age of 25–34 years and less than half of those aged 20–24 as compared to 2000. The distribution of the frequency of births according to mother's age category is statistically significant (chi-square:137.9; df=4; $p<0.001$; Table 1).

The comparison of perinatal status in 2000 and 2015 showed its improvement in the latter period: the decrease of the frequency of adverse outcome parameters and infant mortality (Table 2). An exception was the frequency of deviations from the weight appropriate for gestational age: in both years under study approximately 10% of infants were born with a birth weight SGA (below –1.28 SD), while the frequency of birth

Table 3. Relationship between perinatal outcome and mother's age

Year	Perinatal outcome	Categories of mothers' age		
		Adolescent n (%)	Adult n (%)	Older n (%)
2000	Gestational Age (weeks of gestation) $\chi^2=25.412$; df=2; $p<0.001$			
	22–36	64 (23%)	331 (13%)	14 (18%)
	37–42	211 (76%)	2297 (87%)	62 (82%)
	Birth Weight (g) $\chi^2=26.712$; df=2; $p<0.001$			
	<2500	59 (21%)	295 (11%)	14 (18%)
	2500–x	216 (79%)	2333 (89%)	62 (82%)
	Birth Weight-for-Gestational Age $\chi^2=21.400$; df=4; $p<0.001$			
	SGA (< −1.28 SD)	43 (16%)	248 (9%)	12 (16%)
	AGA (−1.28 – 1.28 SD)	223 (81%)	2183 (83%)	55 (72%)
	LGA (>1.28 SD)	9 (3%)	197 (8%)	9 (12%)
	Mortality (days) $\chi^2=2.390$; df=2; $p>0.05$			
	Died	14 (5%)	87 (3%)	3 (4%)
	Survived	261 (95%)	2541 (97%)	73 (96%)
2015	Gestational Age (weeks of gestation) $\chi^2=8.215$; df=2; $p<0.001$			
	22–36	11 (10%)	125 (5%)	6 (3%)
	37–42	102 (90%)	2534 (95%)	214 (97%)
	Birth Weight (g) $\chi^2=23.450$; df=2; $p<0.001$			
	<2500	15 (13%)	109 (4%)	6 (3%)
	2500–x	98 (87%)	2550 (96%)	214 (97%)
	Birth Weight-for-Gestational Age $\chi^2=54.083$; df=4; $p<0.001$			
	SGA (< −1.28 SD)	13 (11%)	266 (10%)	3 (1.4%)
	AGA (−1.28 – 1.28 SD)	97 (86%)	2108 (79%)	216 (98%)
	LGA (>1.28 SD)	3 (3%)	285 (11%)	1 (0.6%)
	Mortality (days) $\chi^2=4.751$; df=2; $p>0.05$			
	Died	3 (3%)	20(1%)	2 (1%)
	Survived	110 (97%)	2639 (99%)	218 (99%)

weight LGA (+1.28 SD) was higher in 2015 than in 2000 (Table 2).

In both years the incidence of all adverse parameters of the perinatal state was dependent on mothers' age, except infants' mortality (Table 3). Regardless of the year of survey, the period between 20–34 years is the time with a low-risk of adverse outcome. The exception was recorded in the frequency of LGA: in 2000 it was the lowest in infants born to adolescent mothers, while in 2015 in the group of new-borns of advanced mothers (≥35 years). As revealed by the ROC curves with AUC placed between 0.6 and 0.7, the accuracy of a decision for the risk of adverse outcome based on mothers age and the year of survey represented a poor test. However, GLMs revealed that being an adolescent mother affected preterm births, low birth weight and deviations from the weight appropriate for gestational age (Table 4). By contrast the advanced maternal age at giving birth to a child did not act separately but in the interaction with the year of survey.

We observed the impact of the year of survey on infant mortality. The directions

Table 4. Model coefficients and odds ratios explaining changes in perinatal outcome according to mothers' age and the year of survey

Outcome variable		Estimate	SE	2.5% CL	97.5% CL	OR (95%CI)
PTB	MA ≤ 19	0.744	0.154	0.436	1.041	2.104 (1.55–2.83)
	MA > 34	0.449	0.302	−0.181	1.011	1.567 (0.83–2.74)
	Year 2015	−1.072	0.109	−1.290	−0.861	0.342 (0.28–0.42)
	MA≤19×Year 2015	0.038	0.364	−0.721	0.720	1.039 (0.49–2.05)
	MA>34×Year 2015	−1.014	0.520	−2.106	−0.033	0.363 (0.12–0.97)
LBW	MA ≤ 19	0.770	0.159	0.451	1.077	2.160 (1.57–2.93)
	MA > 34	0.580	0.302	−0.051	1.143	1.786 (0.95–3.14)
	Year 2015	−1.084	0.116	−1.315	−0.861	0.367 (0.27–0.42)
	MA≤19×Year 2015	0.505	0.334	−0.177	1.141	1.657 (0.84–3.13)
	MA>34×Year 2015	−1.002	0.521	−2.096	−0.018	0.367 (0.13–0.98)
SGA	MA ≤ 19	0.576	0.179	0.214	0.917	1.779 (1.24–2.50)
	MA > 34	0.587	0.322	−0.090	1.181	1.799 (0.91–3.26)
	Year 2015	0.064	0.093	−1.117	0.247	1.067 (0.89–1.28)
	MA≤19×Year 2015	−0.419	0.351	−1.140	0.245	0.658 (0.32–1.27)
	MA>34×Year 2015	−2.671	0.667	−4.183	−1.475	0.069 (0.02–0.23)
LGA	MA ≤ 19	−0.873	0.347	−1.628	−0.252	2.395 (1.29–5.09)
	MA > 34	0.505	0.363	−0.273	2.356	3.970 (1.50–10.55)
	Year 2015	0.393	0.097	0.204	0.584	0.806 (0.18–2.76)
	MA≤19×Year 2015	−0.609	0.683	−2.138	0.637	1.838 (0.53–8.49)
	MA>34×Year 2015	−3.775	1.067	−6.703	−2.065	0.042 (0.00–0.41)
IM	MA ≤ 19	0.449	0.295	−0.171	0.995	1.567 (0.84–2.71)
	MA > 34	0.183	0.599	−1.238	1.195	1.200 (0.29–3.30)
	Year 2015	−1.508	0.250	−2.305	−1.226	0.221 (0.13–0.35)
	MA≤19×Year 2015	0.832	0.693	−2.998	1.669	2.297 (0.49–8.06)
	MA>34×Year 2015	0.009	0.956	−3.514	1.679	1.009 (0.13–6.60)

Abbreviations: SE – standard error; CL – confidence level – OR – odds ratio; CI – confidence interval; PTB – preterm birth; LBW – law birth weight; SGA – small-for-gestational age; LGA – large-for-gestational age; IM – infant mortality; MA – maternal age.

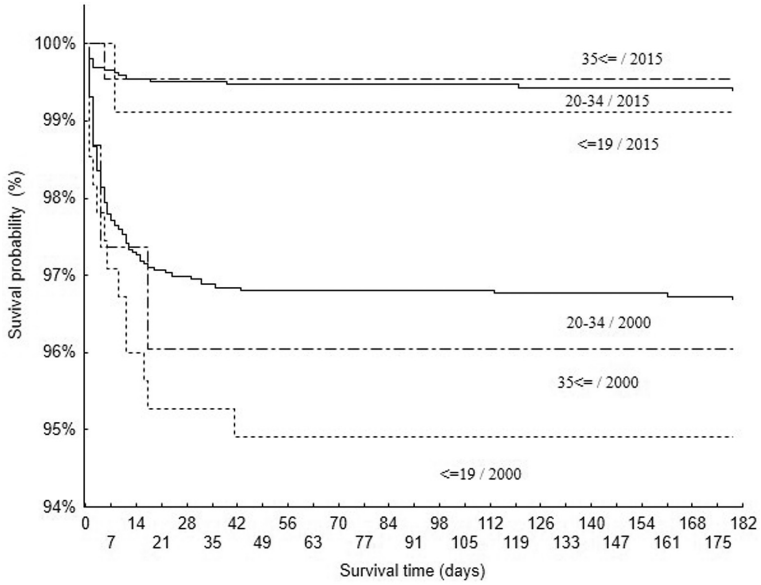

Fig. 1. Infants' survival time according to mother's age at first birth

of the effects were negative and odds ratios were lower than 1; it means that odds of events (adverse outcome parameters) were lower in infants born in 2015 than in those born in 2000 (Table 4).

Results of survival analysis confirmed the lack of the impact of mothers' age on the probability of survival time (Fig. 1). The Cox proportional hazard models showed that the year of survey was the only factor affecting the risk of death, irrespective of mother's age. The hazard ratio (HR) indicated that infants born in 2000 ran a higher risk of death than those born in 2015 (Table 5).

Discussion

The year 2000 coincided with the 10th anniversary of the political transformation in Poland and in the neighbouring post-communist countries. The period of political transformation brought many social and economic changes, including changes in the family formation and reproductive sphere, as well as changes in mentality and customs. It seems that changes in the onset of motherhood could be a result of such social and life style changes. This translated into a decrease in the frequency of births among adolescent

Table 5. Cox proportional hazards models explaining the effects of the year of survey and mothers' age on infants mortality risk

Variable	Estimate	SE	Wald Statistic	p	HR (95% CI)
Mother's Age	0.253	0.202	1.249	0.212	0.777 (0.866–1.913)
Year	−1.462	0.508	−2.875	<0.005	4.314 (0.086–0.628)
Mother's Age Year	0.011	0.364	0.029	0.977	0.990 (0.495–2.063)

LR = 54.47, df = 3, $p < 0.001$.
Abbreviations: SE – standard error; LR – likelihood ratio; HR – hazard ratio; CI – confidence interval.

mothers and an increasing trend of postponing childbearing. According to national statistics, in Poland in 2000 the proportion of primiparous women aged ≥35 was 2% and the proportion of the first-time adolescent mothers (aged ≤19) was 14% (Demographic Yearbook… 2001). In 2015 these rates were 7% and 6%, respectively (Demographic Yearbook… 2016). In our study, the mean age of mothers giving birth to the first child was almost 25 years in 2000 and almost 28 years in 2015. The proportion of teenage mothers (aged ≤19) in all women giving birth to the first child was 4% and mothers aged ≥35 – 7%. Differences between our estimations and the results obtained from demographic statistics for Poland as a whole were due to the fact that women under study were recruited mostly from large cities, where to postpone the moment of motherhood is most common. Moreover, large cities are characterized by a higher incidence of contraceptives use, including a higher access in the groups of teenagers (Mirowsky 2002). The difference between mean ages, quartile ranges and birth frequency indicated a shift towards the later onset of reproduction in Poland in 2015 as compared to 2000.

Recent research have shown that the average age at menarche in Poland is slightly over 12 years (e.g. Łaska-Mierzejewska et al. 2016; Nieczuja-Dwojacka et al. 2019). However some studies have reported cases of menarche attained in girls aged 10, and thus indicated the onset of female reproduction capacity around this age (Szwed and Kosińska 2012; see also: Astolfi and Zonta 2002; Bottomley et al. 2009). From the biological perspective maternal age of 18–30 years is treated as the best timing for the most successful pregnancy (Olausson et al. 2001; Billari et al. 2011). Both the biological and socio-economic aspects commonly suggest that a woman's optimal age for her first birth is ranged between 20 and 35 years (Olausson et al. 2001; Mirowsky 2002; Billari et al. 2011; Kosińska 2011). As it was mentioned in this paper, adolescent and advanced maternal ages are associated with a range of adverse perinatal outcomes. However, over the past decades, political, social and public health changes have challenged the health care sector to provide optimal medical care to women before, during, and after pregnancy. Improvements in maternal, foetal and child health are key public health goals. In consequence, mothers can achieve healthy outcomes for both themselves and their new-borns. Moreover, parental SES is considered as the most important factor which can offset or counterbalance the negative effects of mother's age at first birth, especially in older women, on the occurrence of adverse perinatal outcomes. Literature has emphasized this fact with regard to European countries (e.g. Myrskylä et al. 2014, 2017; Barclay and Myrskylä 2016). The economic conditions of Poles between 2000 and 2015 significantly improved, which translated into the fact that mothers who gave birth to the first child in 2015 were beneficiaries of better economic conditions than those in 2000. The income per capita in 2015 was 2.7 times higher than in 2000 (12,021.2 USD vs. 4,440.1 USD). The unemployment rate in women in 2015 was half of its value noted in 2000 (Polska…. 2014).

Regardless of the above, our results confirmed the negative influence of early and advanced maternal age on the perinatal outcome in two periods under study, what is in concert with the results of other authors (Hassold and Chiu 1985; Mirowsky 2002; Ziadeh 2002; Bateman

and Simpson 2006; Delbaere et al. 2007; Schempf et al. 2007; Carolan and Frankowska 2011; Wang et al. 2011). First of all, the increase in preterm births among adolescent mothers was observed. In the group of mothers aged up to 17 preterm births were not reported, except the case of one 14-year girl. But they were recorded in women aged 18–19. The reduction of the time of pregnancy in adolescent mothers is not only due to their biological immaturity, but rather due to their low socio-economic status. Very young pregnant teenagers (up to 16 years) are usually in the care of the family and financially supported by their parents, while older adolescents usually leave their parental households and start out their adult life on their own. Early pregnancy may limit them educational and career opportunities and disturb apparently the socioeconomic development (Olausson et al. 2001; Mirowsky 2005; Chen et al. 2007; Dougall et al. 2012; Kaczmarek 2013). These individuals represent a low level of educational attainment and, in consequence, have unstable employment. Many teen mothers are recruited from large families hence lower distribution of resources per family members, more severe level of poverty, and poorer health status (Bateman and Simpson 2006; Odibo et al. 2006; Reddy et al. 2006; Huang et al. 2008; Schoen and Rosen 2009). Sometimes they were stigmatized by family members or society, especially in rural milieu. They are full of anxiety about their and their children future.

Adolescent mothers are also the group with the highest risk of having infants with low birth weight. In our study the lowest percentage of infants with LBW was found among mothers over 35 years old, being in contrast to other studies (Odibo et al. 2006; Schoen and Rosen 2009). The birth of a new-born with low birth weight may result from preterm termination of pregnancy, intrauterine growth restriction, and the co-occurrence of both (Kosińska 2011). Birth weight SGA is the consequence of intrauterine growth restriction. By contrast LGA is the most frequently observed in adult mothers in 2015. It is assumed that the main reason of LGA is gestational diabetes mellitus in advanced age mothers. The risk of the occurrence of this disease is positively correlated with woman's age. Older women are more aware of the risk of diabetes, hence they are more likely to perform tests on the occurrence of this disease during pregnancy. Meanwhile, the highest LGA in adult mothers observed in 2015 may be a result of not using professional medical care and not undergoing medical examinations (Bobak et al. 2000; Mirowsky 2002; Sass et al. 2011). As revealed by the AUC values, all evaluated models have a weak performance. It means that maternal age had a low predictable value. Its impact should be considered in the interaction with other correlates of physiological, clinical, and socio-economic nature.

Our results indicated the significant decline of infant mortality in 2015 as compared to 2000, irrespective of mothers' age. Comparing 2000 and 2015, neonatal medical care significantly improved in Polish hospitals. In 2015 hospital wards were better equipped than in 2000: they had more respirators, incubators, and antibiotics and parenteral nutrition care was better developed and more often used. All these facilities translated the decline of child mortality during the first months of life (Demographic Yearbook… 2001, 2016).

In conclusion, it appears that the negative impact of maternal age on adverse

perinatal outcome can be counterbalanced by positive changes of social and economic status of women, improvement and the progress in medical care and the increase in the awareness of the needs to monitor and examine pregnancy and maintain the healthy life style. Such social, economic and mental changes have taken place in Poland after political transformation. The significant improvement of neonatal medical care and hospital wards led also to a decline in early-child mortality in 2015 as compared to 2000.

Acknowledgements

The authors wish to thank the Editor- in-Chief and the anonymous Reviewers for their helpful and valuable remarks and advice, which improved the quality of this paper.

Ethical Issues

The project was realized with the permissions of the Bioethics Committee (Statement of the Institutional Review Board at Poznań University of Medical Sciences, no. 2431/00 and 538/14).

Authors' contributions

MK contributed to establishing the database, analysis and interpretation of data, drafting and critical revision of manuscript, study conception and design; TH contributed to establishing the database, acquisition of data, analysis of data, drafting and critical revision of manuscript; GL contributed to study conception and design, drafting and critical revision of manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declare that they have no competing interest.

Note

This work was delivered in a lecture as part of the seminar "Histoire de la Famille" in École des Hautes Études en Sciences Sociales in Paris in January 2019.

Corresponding author

Grażyna Liczbińska, Department of Human Evolutionary Ecology, Institute of Anthropology, Faculty of Biology, Adam Mickiewicz University, Uniwersytetu Poznańskiego 6, 61-614 Poznań, Poland
e-mail: grazyna@amu.edu.pl

References

Antinori S, Gholami GH, Versaci C, Cerusico F, Dani L, Antinori M, Panci C, Nauman N. 2003. Obstetric and prenatal outcome in menopausal women: a 12-year clinical study. Reprod Biomed Online 6:257–261.

Astolfi P, Zonta LA. 2002. Delayed maternity and risk at delivery. Paediatric Perinat Epidemiol 16:67–72.

Ballard JL, Khoury JC, Wedig K, Wang L, Eilers-Walsman B, Lipp R.1991. New ballard score, expanded to include extremely premature infants. J Pediatr 119:417–23.

Barclay K, Myrskylä M. 2016. Advanced maternal age and offspring outcomes: Reproductive aging and counterbalancing period trends. Popul Dev Rev 42:69–94.

Bateman BT, Simpson LL. 2006. Higher rate of stillbirth at the extremes of reproductive age: a large nationwide sample of deliveries in the United States. Am J Obstet Gynecol 194:840–45.

Billari FC, Goisis A, Liefbroer AC, Settersten RA, Aassve A, Hagestad G, Speder Z. 2011. Social age deadlines for the child-

bearing of women and men. Hum Reprod 26:616–22.

Bobak M, Pikhart H, Rose R, Hertzman C, Marmot M. 2000. Socioeconomic factors, material inequalities, and perceived control in self-rated health: cross-sectional data from seven post-communist countries. Soc Sci Med 51:1343–50.

Bottomley C, Daemen A, Mukri F, Papageorghiou AT, Kirk E, Pexsters A, De Moor B, Timmerman D, Bourne T. 2009. Assessing first trimester growth: the influence of ethnic background and maternal age. Hum Reprod 24:284–90.

Carolan M, Frankowska D. 2011. Advanced maternal age and adverse perinatal outcome: a review of the evidence. Midwifery 27:793–801.

Cavazos-Rehg PA, Krauss MJ, Spitznagel EL, Bommarito K, Madden T, Olsen MA, Subramaniam H, Peipert JF, Bierut LJ. 2015. Maternal age and risk of labor and delivery complications. Matern Child Health J 19:1202–11.

Chen X-K, Wen SW, Fleming N, Demissie K, Rhoads GG, Walker M. 2007. Teenage pregnancy and adverse birth outcomes: a large population based retrospective cohort study. Internat J Epidemiol 36:368–73.

Delbaere I, Verstraelen H, Goetgeluk S, Martens G, De Backer G, Temmerman M. 2007. Pregnancy outcome in primiparae of advanced maternal age. Eur J Obstet Gynecol Reprod Biol 135:41–46.

Demographic Yearbook of Poland. 2001. Warszawa: Główny Urząd Statystyczny.

Demographic Yearbook of Poland. 2016. Warszawa: Główny Urząd Statystyczny.

Dougall KM, Beyene Y, Nachtigall RD. 2012. Inconvenient biology: advantages and disadvantages of first-time parenting after age 40 using in vitro fertilization. Hum Reprod 27:1058–65.

Gadzinowski J, Kaliszewska-Drozdowska MD, Kosińska M, Mazela J, Stoińska B. 2003. Urodzeniowa masa ciała a wiek płodowy noworodków regionu Wielkopolski i Ziemi Lubuskiej. Ginekologia Polska 74:186–92.

Hassold T, Chiu D. 1985. Maternal age-specific rates of numerical chromosome abnormalities with special reference to trisomy. Hum Genet 70:11–17.

Heffner LJ. 2004. Advanced maternal age-how old is too old?. N Engl Med 351:1927–29.

Huang L, Sauve R, Birkett N, Fergusson D, van Walraven C. 2008. Maternal age and risk of stillbirth: a systematic review. Canadian Med Assoc J 178:165–72.

Jacobsson B, Ladfors L, Milsom I. 2004. Advanced maternal age and adverse perinatal outcome. Obstet Gynecol 104:727–33.

Jolly M, Sebire N, Harris J, Robinson S, Regan L. 2000. The risks associated with pregnancy in women aged 35 years or older. Hum Reprod 15:2433–37.

Joseph KS, Allen AC, Dodds L, Turner LA, Scott H, Liston R. 2005.The perinatal effects of delayed childbearing. Obstet Gynecol 105:1410–18.

Kaczmarek M. 2013. Assessing social status effects on age of primiparity in Polish women. Anthropol Rev 76:229–40.

Kanungo J, James A, McMillan D, Lodha A, Faucher D, Lee SK, Shah PS, 2011. Advanced maternal age and the outcomes of preterm neonates: a social paradox? Obstet Gynecol 118:872–77.

Khashan AS, Baker PN, Kenny LC. 2010. Preterm birth and reduced birth weight in first and second teenage pregnancies: a register-based cohort study. BMC Pregnancy and Childbirth 10:36.

Kosińska M. 2006. Two methods for estimating age of newborns in catch-up growth studies. Early Hum Dev 82:575–82.

Kosińska M. 2011. Stan okołourodzeniowy potomstwa jako efekt interakcji układu płód-matka-środowisko. Poznań: Wydawnictwo UAM.

Kozuki N, Lee ACC, Silveira MF, Victora CG, Adair L, Humphrey J, Ntozini R, Black RE, Katz J. 2013. The associations of birth intervals with small-for-gestational-age, preterm, and neonatal and infant mortali-

ty: a meta-analysis. BMC Public Health 13 Suppl 3:S3.

Lee KS, Ferguson RM, Corpuz M, Gartner LM. 1988. Maternal age and incidence of low birth weight at term: a population study. Am J Obstet Gynecol 158:84–89.

Luke B, Brown MB. 2007. Elevated risks of pregnancy complications and adverse outcomes with increasing maternal age. Hum Reprod 22:1264–72.

Łaska-Mierzejewska T, Dobosz J, Nowacka-Dobosz S, Olszewska E, Wilczewski A. 2016. Social distances dicrease of body height and the maturation rate of Polish girsl in urban and rural population in the period 1967–2009. Anthropol Rev 79: 281–99.

Mathews TJ, Hamilton BE. 2016. Mean age of mothers is on the rise: United States, 2000–2014. NCHS Data Brief 232:1–8.

Mirowsky J. 2002. Parenthood and health: the pivotal and optimal age at first birth. Soc Forces 81:315–49.

Mirowsky J. 2005. Age at first birth, health, and mortality. J Health Soc Behav 46:32–50.

Myrskylä M, Barclay KJ, Goisis A. 2017. Advantages of later motherhood. Der Gynäkologe 50:767–72.

Myrskylä M, Elo IT, Kohler IV, Martikainen, P. 2014. The association between advanced maternal and paternal ages and increased adult mortality is explained by early parental loss. Soc Sc Med 119:215–23.

Nieczuja-Dwojacka J, Borowska-Strugińska B, Janiszewska A, Kozieł S. 2019. Influence of socioeconomic factors during adolescence on the menarcheal age in Central Poland girsl. Anthropol Anz 71: 29–35.

Odibo A, Nelson D, Stamilio D, Sehdev H, Macones G. 2006. Advanced maternal age is an independent risk factor for intrauterine growth restriction. Am J Perinat 23:325–28.

Olausson PO, Haglund B, Weitoft GR, Cnattingius S. 2001. Teenage childbearing and long-term socioeconomic consequences: a case study in Sweden. Family Plan Perspect 33:70–74.

Polska 1989–2014. 2014. Warszawa: Główny Urząd Statystyczny.

Reddy UM, Ko Ch-W, Willinger M. 2006. Maternal age and the risk of stillbirth throughout pregnancy in the United States. Am J Obstet Gynecol 195:764–70.

Sass A, Gravena AAF, Pelloso SA, Marcon SS. 2011. Perinatal outcomes in the extremes of reproductive age and factors associated with low weight at birth. Revista Gaucha de Enfermagem 32:352–58.

Schempf AH, Branum AM, Lukacs SL, Schoendorf KC. 2007. Maternal age and parity-associated risks of preterm birth: differences by race/ethnicity. Paediatr Perinat Epidemiol 21:34–43.

Schoen C, Rosen T. 2009. Maternal and perinatal risks for women over 44—a review. Maturitas 64:109–13.

Szwed A, Kosińska M. 2012. Biological maturity at birth, the course of the subsequent ontogenetic stages and age at menarche. HOMO – Journal of Comparative Human Biology 63:292–300.

Wang Y, Tanbo T, Åbyholm T, Henriksen T. 2011. The impact of advanced maternal age and parity on obstetric and perinatal outcomes in singleton gestations. Arch Gynecol Obstet 284:31–37.

Ziadeh SM. 2002. Maternal and perinatal outcome in nulliparous women aged 35 and older. Gynecol Obstetric Investi 54:6–10.

Zīle I, Villeruša A. 2013. Maternal age-associated congenital anomalies among newborns: a retrospective study in Latvia. Medicina 49:29–35.