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ORIGINAL ARTICLE

Pregnancy outcomes of overweight and obese women aged 35 years or older — A registry-based study in Finland

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KEYWORDS
Pre-pregnancy BMI;
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Summary
Objective: To compare pregnancy outcomes of overweight and obese pregnant women aged 35 years or older to women aged less than 35 years old.
Methods: A registry-based study covering years 2004—2008 including data on women ≥35 years ($N = 45{,}718$) compared to those <35 years ($N = 203{,}930$) and their pre-pregnancy body mass index (BMI) (<25, 25—29 and ≥30). In multivariable modelling, the main outcome measures were preterm delivery (<28 weeks, 28—31weeks and 32—36 weeks), low Apgar scores at 5 min, small-for-gestational age (SGA), foetal death, asphyxia, Caesarean section, induction, preeclampsia, blood transfusion, admission to a neonatal intensive care unit (NICU), shoulder dystocia, and large for gestational age (LGA).
Results: Maternal overweight and obesity along with advanced maternal age (AMA) significantly increased the risks of preterm delivery, preeclampsia, foetal death, LGA and Caesarean as compared to women of average weight aged <35 years. When comparing overweight and obese women aged ≥35 years to normal weight women

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of the same age, the rates of preeclampsia, preterm delivery <28 weeks, LGA and low Apgar score were significantly increased. When observing overweight and obese women <35 years as a reference group, the risks of preterm delivery and foetal death were significantly increased.
Conclusions: The risks were increased by maternal age ≥ 35 years and both obesity and overweight. The combined effect of AMA and either overweight or obesity appeared to be a high risk state particularly for stillbirth and preterm delivery.

Introduction

Overweight is defined by a BMI of ≥25 and obesity by a BMI of ≥30 [1]. Overweight and obesity are associated with several maternal, foetal and neonatal complications. Maternal complications, such as hypertensive disorders, diabetes and venous thromboembolism, are associated with maternal obesity as well as foetal and neonatal complications including miscarriage and stillbirth, foetal anomalies, macrosomia, preterm birth, prolonged pregnancy, Caesarean delivery, postpartum haemorrhage and complications in anaesthesia [2]. Long-term risks for mothers include, for example, the risks of type 2 diabetes, hypertension and atherosclerotic vascular disease. For the foetus, the risks are similar as to mothers, including childhood obesity, insulin resistance, and hyperlipidaemia [3].

In Finland, in 2013, the average pre-pregnancy BMI of parturients was 24.6. Approximately 35% of women giving birth had a BMI of 25 or more, i.e. were overweight, and around 13% were obese with a BMI of 30 or more [4]. Obesity rates increase by age. Obesity during pregnancy is associated with greater use of health care services, including longer hospital stay for delivery. Mostly the increase is explained by the increased rates of Caesarean delivery, gestational diabetes mellitus or pre-existing diabetes and hypertensive disorders, which are more common in obese pregnant women [5].

AMA has usually been defined as the age of 35 years or older at the time of pregnancy [6]. The proportion of advanced aged pregnant women has increased especially in the Western world and in Finland the number of women aged 35 years or older giving birth was 20% in 2013 [4].

The impact of AMA has been linked to increased risks of maternal death and severe maternal outcomes and preterm birth, a growing number of neonatal intensive care admissions, birth asphyxia, miscarriage, preeclampsia, small-for-gestational-age infants and gestational diabetes as well as stillbirth and large-for-gestational-age infants [7–12].

However, AMA alone in otherwise low risk pregnancies has been associated with nearly as good pregnancy outcomes as in younger women and according to some studies maternal age alone is not a risk factor explaining the adverse outcomes, but associated with other risk factors like hypertension and diabetes may account for the results [13,14]. Co-existing risks accompanied with the ageing process jeopardize the outcome much more than in younger age groups, as we have shown previously in the case of smoking women and women affected by preeclampsia, both having been complicated by advanced age [15,16].

Overweight and obesity during pregnancy is a significant problem globally because of the risks and complications associated with this maternal condition. The relationship between older maternal age accompanied with overweight/obesity and adverse pregnancy outcomes has not been widely studied. The aim of this study was to compare older, over 35-year-old pregnant women to younger ones aged less than 35 years in three different BMI categories (<25, 25–29 and ≥30) to explore the relationship between overweight and obesity and pregnancy outcomes.

Methods

The data for this study consist of the information from the Medical Birth Register (MBR), the Hospital Discharge Register (HDR), and the Register of Congenital Malformations. The permission for using the data in this study was gained from the National Institute for Health and Welfare in September 2009 (THL/906/5.05.00/2009), as required by the national data protection legislation. The ethical considerations were done by the register authorities. Register-based studies do not need an ethical review board statement in Finland.

The MBR is a population-based registry established in 1987 and is currently maintained by the

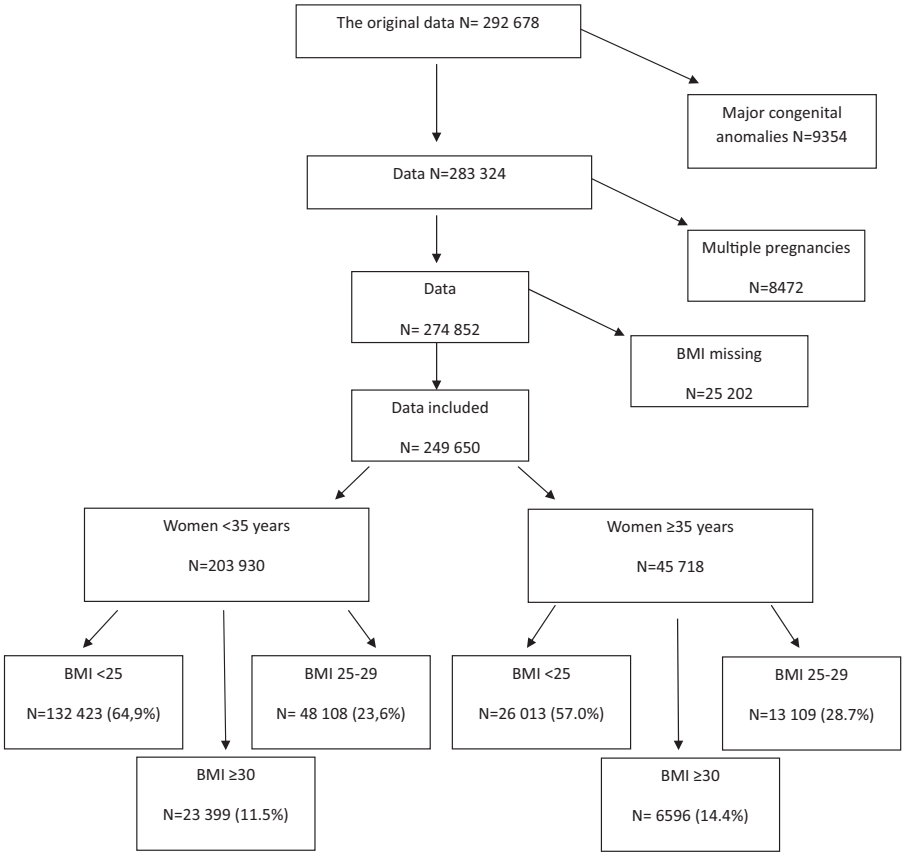

Figure 1 Data flow in the current study.

National Institute for Health and Welfare (THL). The MBR includes information on maternal and neonatal birth characteristics and perinatal outcomes of all women who have given birth in Finland and all newborns up to seven days of age. The form is filled out at hospitals and sent, mostly electronically, to THL [17].

The HDR was established in 1969 and it contains information on all aspects of inpatient care in public and private hospital visits and outpatient visits to public hospitals (since 1998). Hospitals send data electronically to THL [18].

The Register of Congenital Malformations is run by THL and it contains data on congenital chromosomal and structural anomalies detected in stillborn and liveborn infants and foetuses in pregnancies terminated due to foetal indication in Finland nationwide. The registration of anomalies began in 1963 [19].

Participants

The data of this study contains information on 249,650 women and their newborns in 2004—2008. Cases with major congenital anomalies were excluded ($N = 9354$) as well as women with multiple pregnancies ($N = 8472$). The study population of the current study included women whose pre-pregnancy BMI had been recorded in the data ($N = 249{,}650$). The data included both nulliparous and multiparous women with singleton births. Parity was considered as a confounding factor in statistical analyses. We compared women aged 35 years or older to women aged less than 35 years old. Pre-pregnancy BMI was classified into three categories: <25, 25—29 and ≥30.

Statistical analysis

Statistical analyses were performed using the R-programme version 2.15.2. Variables used in the binary logistic regression analysis were dichotomous and observations which had missing data values were excluded. Nagelkerke's pseudo R2 goodness of fit were calculated in logistic regression analysis for each outcome. Average of Nagelkerke's R^2 were 0.090 and ranged from 0.011 to 0.628.

Table 1 Background information of women aged less than 35 years and 35 years or older stratified by maternal age and pre-pregnancy BMI.

	<35y			*P*	≥35y			*P*
BMI	<25	25–29	≥30		<25	25–29	≥30	
Smoking	14,630	5887	3650	<.001	1796	1089	685	<.001
%	(11.3)	(12.5)	(16.0)		(7.1)	(8.5)	(10.7)	
Previous Caesarean	7715	4103	2542	<.001	3201	2004	1195	<.001
%	(5.8)	(8.5)	(10.9)		(12.3)	(15.3)	(18.1)	
Chronic hypertension	65	70	93	<.001	35	38	49	<.001
%	(0.1)	(0.2)	(0.4)			(0.3)	(0.8)	
Anaemia	2638	737	327	<.001	567	191	93	<.001
%	(2.0)	(1.5)	(1.4)		(2.2)	(1.5)	(1.4)	
Placenta previa	270	89	34	0.154	114	43	25	0.254
%	(0.2)	(0.2)	(0.1)		(0.4)	(0.4)		
Late pregnancy bleeding	1454	490	246	0.329	362	172	93	<.001
%	(1.1)	(1.0)	(1.1)		(1.4)	(1.3)	(1.4)	
Hospitalised because of hypertension	2643	1501	1325	<.001	566	544	554	<.001
%	(2.0)	(3.1)	(5.7)		(2.2)	(4.1)	(8.4)	
Insulin treated GDM	524	873	1297	<.001	256	519	630	<.001
%	(0.4)	(1.8)	(5.5)		(1.0)	(4.0)	(9.6)	
Gestational diabetes	4246	7089	6995	<.001	1747	2903	2681	<.001
%	(3.2)	(14.7)	(29.9)		(6.7)	(22.1)	(40.6)	
Single	55,094	20,295	10,312	<.001	8532	4305	2188	0.894
%	(41.6)	(42.2)	(44.1)		(32.8)	(32.8)	(33.2)	
Fertility treatment other than IVF	1630	559	274	0.425	605	268	129	0.073
%	(1.2)	(1.2)	(1.2)		(2.3)	(2.0)	(2.0)	
IVF	1820	636	256	0.003	1056	413	199	<.001
%	(1.4)	(1.3)	(1.1)		(4.1)	(3.2)	(3.0)	

The following definitions were used to record pregnancy outcomes: low Apgar scores at 5 min, Apgar score < 7; preterm delivery, before 28, 28–31 and 32–36 weeks of gestation; small for gestational age (SGA), infants were considered small when the sex- and age-adjusted birth weight was below the 5th percentile according to the standard tables for the Finnish population data for all births [20]; large for gestational age (LGA), infants were considered large when the sex- and age-adjusted birth weight was above the 95th percentile [20]; preeclampsia. Preeclampsia was defined as repeated periods of blood pressure > 140/90 mmHg accompanied by proteinuria (>0.3 g/day).

Binary logistic regression adjusted for potential confounding factors included placenta previa, IVF, fertility treatment other than IVF, smoking, parity, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes and hospitalisation because of late pregnancy bleeding or because of hypertension.

Pre-pregnancy BMI was calculated from pre-pregnancy height and weight, which were recorded in the data from the self-reports by pregnant women. Odds ratios with 95% confidence intervals were estimated in order to compare the pregnancy outcomes with interaction of women aged less than 35 years old to women aged 35 years or older categorised with BMI of <25, 25–29 and ≥30. Preterm delivery was analyzed in three categories: <28, 28–31 and 32–36. *P*-values for interaction between grouping variables maternal age and BMI were calculated and they were not statistically significant.

Women younger than 35 years with a BMI of <25 were used as the reference group to which compare all the other groups. In subgroup analyses, women aged 35 years or older with a BMI of 25–29 and ≥30 were compared first to the group of women aged 35 years or older with a BMI of <25 as a reference group and then women aged 35 years or older were compared to women less than 35 years old separately in each BMI category.

Results

There were 132,423 (64.9%) women less than 35 years old who had a BMI of <25, 48,108 (23.6%) with

Table 2 Outcomes of women aged 35 years or older compared to normal weight women aged less than 35 years old.

Outcome	<35y	≥35y	Adjusted OR (95% CI)	
			<35y	≥35y
Preterm delivery < 28				
BMI < 25	292(0.2)	93(0.4)	1	1.47(1.15—1.87)
BMI 25—29	101(0.2)	47(0.4)	1.34(1.07—1.68)	2.12(1.54—2.92)
BMI ≥ 30	65(0.3)	43(0.7)	1.82(1.38—2.39)	4.32(3.08—6.09)
Preterm delivery 28—31				
BMI < 25	452(0.3)	124(0.5)	1	1.36(1.11—1.67)
BMI 25—29	158(0.3)	73(0.6)	1.21(1.00—1.45)	2.01(1.55—2.61)
BMI ≥ 30	86(0.4)	37(0.6)	1.23(0.97—1.56)	1.83(1.28—2.61)
Preterm delivery 32—36				
BMI < 25	5119(3.8)	1129(4.3)	1	1.14(1.07—1.22)
BMI 25—29	1448(3.0)	519(4.0)	0.94(0.89—1.00)	1.26(1.14—1.38)
BMI ≥ 30	859(3.7)	338(5.1)	1.01(0.94—1.10)	1.42(1.26—1.61)
Low Apgar score (<7) at 5 min				
BMI < 25	2514(1.9)	533(2.0)	1	1.27(1.15—1.39)
BMI 25—29	898(1.9)	263(2.0)	1.21(1.12—1.31)	1.52(1.33—1.73)
BMI ≥ 30	535(2.3)	189(2.8)	1.37(1.24—1.51)	1.98(1.69—2.33)
SGA(<5th percentile)				
BMI < 25	7869(5.9)	1483(5.7)	1	1.23(1.16—1.30)
BMI 25—29	1642(3.4)	518(3.9)	0.72(0.68—0.76)	1.09(1.00—1.20)
BMI ≥ 30	809(3.5)	202(3.0)	0.67(0.62—0.73)	0.79(0.68—0.92)
Foetal death				
BMI < 25	356(0.3)	89(0.3)	1	1.14(0.90—1.45)
BMI 25—29	122(0.3)	59(0.4)	1.22(0.99—1.50)	1.98(1.48—2.64)
BMI ≥ 30	61(0.3)	32(0.5)	1.25(0.95—1.65)	2.23(1.52—3.26)
Asphyxia				
BMI < 25	5455(4.1)	1217(4.7)	1	1.66(1.56—1.78)
BMI 25—29	1554(3.2)	468(3.6)	1.03(0.97—1.10)	1.70(1.54—1.88)
BMI ≥ 30	875(3.7)	279(4.2)	1.15(1.06—1.24)	1.95(1.71—2.22)
Preeclampsia				
BMI < 25	4567(3.4)	969(3.7)	1	1.20(1.06—1.36)
BMI 25—29	2048(4.3)	687(5.2)	1.49(1.36—1.63)	1.97(1.69—2.30)
BMI ≥ 30	1826(7.8)	683(10.3)	2.45(2.22—2.72)	3.39(2.86—4.03)
Admission to a neonatal unit				
BMI < 25	13,166(9.9)	2892(11.1)	1	1.21(1.16—1.26)
BMI 25—29	4789(9.9)	1452(11.1)	1.18(1.14—1.23)	1.39(1.31—1.48)
BMI ≥ 30	3056(13.1)	1132(17.2)	1.32(1.26—1.38)	1.88(1.75—2.02)
Shoulder dystocia				
BMI < 25	332(0.3)	25(0.1)	1	1.25(0.97—1.60)
BMI 25—29	133(0.3)	37(0.3)	1.26(1.03—1.55)	1.26(0.89—1.79)
BMI ≥ 30	92(0.4)	81(1.2)	1.57(1.23—2.00)	1.49(0.97—2.28)
LGA(>95th percentile)				
BMI < 25	4373(3.3)	1217(4.7)	1	1.08(1.01—1.15)
BMI 25—29	2535(5.3)	838(6.4)	1.83(1.74—1.93)	1.60(1.48—1.74)
BMI ≥ 30	1867(8.0)	686(10.4)	2.45(2.31—2.60)	2.37(2.16—2.60)

Confounding factors: placenta previa, parity, IVF, fertility treatment other than IVF, smoking, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes, hospitalisation because of late pregnancy bleeding or because of hypertension.

Table 3 Obstetric interventions among women aged ≥35 years and <35 years.

Outcome	<35y	≥35y	Adjusted OR <35y	(95% CI) ≥35y
Caesarean				
BMI < 25	17,846(13.5)	4930(19.4)	1	1.81(1.74–1.88)
BMI 25–29	5889(18.1)	2009(24.3)	1.36(1.32–1.40)	2.43(2.30–2.56)
BMI ≥ 30	2881(21.7)	946(29.6)	1.70(1.64–1.77)	3.18(2.97–3.40)
Induction				
BMI < 25	18,870(13.9)	4420(16.3)	1	1.09(1.05–1.13)
BMI 25–29	7703(19.5)	2456(22.2)	1.35(1.31–1.39)	1.37(1.30–1.44)
BMI ≥ 30	5139(26.8)	1566(29.1)	1.82(1.75–1.89)	1.71(1.60–1.82)
Blood transfusion				
BMI < 25	2260(1.7)	538(2.1)	1	1.20(1.08–1.33)
BMI 25–29	488(1.5)	173(2.1)	0.97(0.89–1.07)	1.28(1.10–1.49)
BMI ≥ 30	225(1.7)	65(2.0)	1.03(0.91–1.17)	1.40(1.15–1.72)

Confounding factors: placenta previa, parity, IVF, fertility treatment other than IVF, smoking, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes, hospitalisation because of late pregnancy bleeding or because of hypertension.

a BMI of 25–29 and 23,399 (11.5%) with a BMI of ≥30. In the group of women aged 35 years or older, 26,013 (57.0%) women had a BMI of <25, 13,109 (28.7%) a BMI of 25–29 and 6596 (14.4%) a BMI of ≥30. (Fig. 1).

Table 1 summarises the background information of the participants, stratified by maternal age and pre-pregnancy BMI. The groups of pregnant women were different in terms of smoking, placenta previa and marital status. Women of advanced maternal age had higher rates of chronic hypertension and gestational diabetes as well as insulin treated gestational diabetes, and they had more previous IVF treatments and other fertility treatments and previous Caesarean sections. The rates of hospitalisation because of late pregnancy bleeding and hypertension were higher as well compared to their younger counterparts.

When compared to younger lean women aged less than 35 years old, the rates of preterm delivery <28 weeks of gestation, Caesarean and preeclampsia were the highest in overweight and obese women aged 35 years or older showing three- to four-fold risk in obese women. The risk of foetal death and preterm delivery at 28–31 weeks of gestation were higher in these women. (Tables 2 and 3).

In a subgroup analysis, the relationship between overweight and obesity and maternal age 35 or older was seen as an increase in preeclampsia, LGA and preterm delivery <28 weeks of gestation rates, when the risk more than doubled compared to normal weight women of the same age. There was also an increase in the need for neonatal intensive care, low Apgar scores at 5 min and foetal death as well as Caesarean and induced births in these women. (Tables 4 and 5).

In another subgroup analysis, where the overweight and obese women of advanced age were compared to younger women of the same BMI categories, the relationship between overweight and obese women of advanced maternal age and women aged less than 35 years was seen as an increase in preterm deliveries and foetal death (Tables 6 and 7).

Discussion

The main finding of our study was that AMA and overweight and obesity appeared to be a combination particularly negatively affecting preterm delivery and stillbirth rates. The risk of adverse outcomes was found to increase with a higher degree of obesity in the AMA group but also in the younger age group.

In a study of Cnattingius et al. (2013) it was shown, that overweight and obesity were associated with preterm delivery, especially during 22–27 gestational weeks. The similar association between maternal overweight and obesity and very preterm deliveries were found in our study showing that obesity seemed to increase very preterm deliveries (<28 weeks), preeclampsia and LGA in both older and younger women, where the risks were around twofold or higher than in normal-weight women. Independently of age, overweight and obesity increased the risks for preterm deliveries,

Table 4 The relationship between overweight/obesity and outcomes in women aged 35 years or older.

Outcome	Adjusted OR (95% CI) ≥35y
Preterm delivery < 28	
BMI < 25	1
BMI 25—29	1.44(1.01—2.06)
BMI ≥ 30	2.95(2.03—4.27)
Preterm delivery 28—31	
BMI < 25	1
BMI 25—29	1.48(1.10—1.98)
BMI ≥ 30	1.34(0.92—1.96)
Preterm delivery 32—36	
BMI < 25	1
BMI 25—29	1.10(0.99—1.22)
BMI ≥ 30	1.24(1.09—1.42)
Low Apgar score (<7) at 5 min	
BMI < 25	1
BMI 25—29	1.20(1.03—1.40)
BMI ≥ 30	1.57(1.32—1.87)
SGA(<5th percentile)	
BMI < 25	1
BMI 25—29	0.89(0.80—0.99)
BMI ≥ 30	0.64(0.55—0.75)
Foetal death	
BMI < 25	1
BMI 25—29	1.73(1.24—2.41)
BMI ≥ 30	1.95(1.29—2.94)
Asphyxia	
BMI < 25	1
BMI 25—29	1.02(0.91—1.14)
BMI ≥ 30	1.17(1.02—1.35)
Preeclampsia	
BMI < 25	1
BMI 25—29	1.64(1.37—1.97)
BMI ≥ 30	2.83(2.33—3.45)
Admission to a neonatal unit	
BMI < 25	1
BMI 25—29	1.15(1.07—1.23)
BMI ≥ 30	1.55(1.43—1.68)
Shoulder dystocia	
BMI < 25	1
BMI 25—29	1.01(0.68—1.50)
BMI ≥ 30	1.19(0.75—1.89)
LGA(>95th percentile)	
BMI < 25	1
BMI 25—29	1.49(1.35—1.63)
BMI ≥ 30	2.19(1.98—2.43)

Confounding factors: placenta previa, IVF, fertility treatment other than IVF, smoking, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes, hospitalisation because of late pregnancy bleeding or because of hypertension.

Table 5 Obstetric interventions among women aged ≥35 years BMI 25—29 and ≥30 compared to women ≥35 with BMI <25.

Outcome	Adjusted OR ≥35y	(95% CI)
Caesarean		
BMI < 25	1	
BMI 25—29	1.34	(1.27—1.42)
BMI ≥ 30	1.76	(1.63—1.89)
Induction		
BMI < 25	1	
BMI 25—29	1.26	(1.19—1.33)
BMI ≥ 30	1.57	(1.47—1.68)
Blood transfusion		
BMI < 25	1	
BMI 25—29	1.07	(0.90—1.27)
BMI ≥ 30	1.17	(0.95—1.45)

Confounding factors: placenta previa, parity, IVF, fertility treatment other than IVF, smoking, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes, hospitalisation because of late pregnancy bleeding or because of hypertension.

preeclampsia, admission to NICU, LGA, Caesarean section, and induction. These results are in line with previous studies [21—26].

Maternal age of 35 years or above within each maternal weight group appeared to increase the risks of preterm deliveries and foetal death. These women had more Caesarean deliveries and their newborn infants were more likely to need intensive care than their younger counterparts. The overall age-dependent risk increase was within the range of 40—80% or below, except for preterm delivery before 28th weeks of gestation, suggesting that, as risk factors, overweight and obesity were more significant than AMA.

Based on the results of our study, maternal age of 35 years or more combined with a BMI of ≥25 showed, that the impact on adverse pregnancy outcomes was clearly increasing preterm delivery and stillbirth rate. Adipose tissue, an endocrine organ, increases insulin resistance and impairs physiological metabolic, vascular, and inflammatory pathways. AMA, in turn, increases the risks of pre-gestational hypertension and abnormal glucose tolerance [27]. This was clearly seen in the increased risk of LGA and preeclampsia. Furthermore, the need for neonatal intensive care and Caesarean deliveries both increased in overweight and obese older women, as expected on the basis of higher rates of prematurity and LGA.

It has been shown in previous research that foetal death is associated with advanced maternal age. The association has been recognised especially

Table 6 The relationship between maternal age and outcomes independently of BMI.

Outcome	<35y	Adjusted OR (95% CI) ≥35y
Preterm delivery < 28		
BMI < 25	1	1.47(1.15—1.87)
BMI 25—29	1	1.58(1.11—2.25)
BMI ≥ 30	1	2.39(1.61—3.54)
Preterm delivery 28—31		
BMI < 25	1	1.36(1.11—1.67)
BMI 25—29	1	1.67(1.25—2.22)
BMI ≥ 30	1	1.49(1.00—2.20)
Preterm delivery 32—36		
BMI < 25	1	1.14(1.07—1.22)
BMI 25—29	1	1.34(1.20—1.48)
BMI ≥ 30	1	1.51(1.33—1.72)
Low Apgar score (<7) at 5 min		
BMI < 25	1	1.27(1.15—1.39)
BMI 25—29	1	1.25(1.09—1.44)
BMI ≥ 30	1	1.45(1.22—1.72)
SGA (<5th percentile)		
BMI < 25	1	1.23(1.16—1.30)
BMI 25—29	1	1.52(1.37—1.69)
BMI ≥ 30	1	1.18(1.00—1.38)
Foetal death		
BMI < 25	1	1.14(0.90—1.45)
BMI 25—29	1	1.63(1.18—2.24)
BMI ≥ 30	1	1.78(1.15—2.76)
Asphyxia		
BMI < 25	1	1.66(1.56—1.78)
BMI 25—29	1	1.64(1.48—1.83)
BMI ≥ 30	1	1.70(1.48—1.96)
Preeclampsia		
BMI < 25	1	1.20(1.06—1.36)
BMI 25—29	1	1.32(1.12—1.56)
BMI ≥ 30	1	1.38(1.15—1.66)
Admission to a neonatal unit		
BMI < 25	1	1.21(1.16—1.26)
BMI 25—29	1	1.17(1.10—1.25)
BMI ≥ 30	1	1.42(1.32—1.54)
Shoulder dystocia		
BMI < 25	1	1.25(0.97—1.60)
BMI 25—29	1	1.00(0.69—1.45)
BMI ≥ 30	1	0.95(0.61—1.49)
LGA(>95th percentile)		
BMI < 25	1	1.08(1.01—1.15)
BMI 25—29	1	0.87(0.80—0.95)
BMI ≥ 30	1	0.97(0.88—1.06)

Confounding factors: placenta previa, parity, IVF, fertility treatment other than IVF, smoking, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes, hospitalisation because of late pregnancy bleeding or because of hypertension.

Table 7 Obstetric interventions among women ≥35 with BMI 25—29 and ≥30 compared to women <35 with BMI >25.

Outcome	Adjusted OR		(95% CI)
	<35y	≥35y	
Caesarean			
BMI < 25	1	1.81	(1.74—1.88)
BMI 25—29	1	1.79	(1.69—1.89)
BMI ≥ 30	1	1.86	(1.73—2.00)
Induction			
BMI < 25	1	1.09	(1.05—1.13)
BMI 25—29	1	1.02	(0.96—1.07)
BMI ≥ 30	1	0.94	(0.88—1.00)
Blood transfusion			
BMI < 25	1	1.20	(1.08—1.33)
BMI 25—29	1	1.32	(1.12—1.55)
BMI ≥ 30	1	1.36	(1.09—1.69)

Confounding factors: placenta previa, parity, IVF, fertility treatment other than IVF, smoking, anaemia, previous Caesarean section, insulin-treated gestational diabetes, gestational diabetes, hospitalisation because of late pregnancy bleeding or because of hypertension.

in women 40 years and older [28,29]. In the present study the association between AMA and foetal death was also found, but the increase in the foetal death rates seemed to be more evident when exploring the relationship between overweight/obesity in AMA women and pregnancy outcomes (Table 4) than the relationship between AMA and pregnancy outcomes (Table 6) suggesting that the impact of overweight and obesity in AMA women on foetal death rates is more significant than the impact of AMA itself.

When comparing the internal validity in Finnish health registries, it has been shown that their validity and coverage are good, as practically all events are included in the data and the registries comply with reality [30]. The information of compulsory, population-based health registries is comprehensive and high in quality, and the information can be utilised in scientific research [31]. The risks related to pregnancy at AMA has been recognised in previous research, but less is known about the impact of different risk factors independently. The present study explored the impact of AMA and overweight/obesity also separately.

The limitations of our study concern the possibility of errors in the data collection, such as coding errors, but, due to the large scope of the data, the impact of these errors is likely to be minor. Maternal height and weight are usually self-reported, so when the BMI is calculated there is a possibility of

errors in maternal height and weight, which affect the BMI calculated of the pregnant woman.

Conclusions

Based on our study, we suggest that due to the increased risks during pregnancy, overweight and obesity in pregnant women aged 35 or above is even more challenging than in younger overweight and obese women due to increased risk for adverse pregnancy outcomes and complications. In addition to age-related and adipose tissue-related problems, the contributions of AMA among overweight and obese women to preterm delivery and stillbirth were found to be significant. These women are a distinct high-risk group for preterm delivery <28 weeks of gestation and stillbirth, which should be paid attention to in maternity care in order to provide appropriate counselling and interventions before and during pregnancy.

Conflict of interests

The authors have no competing interests.

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RL conceived the study with contributions from SH and KVJ. RL prepared the data and TS performed the statistical analysis. RL and SH interpreted the results with contributions from KVJ, TS and MG. RL reviewed the literature and wrote the manuscript with the assistance of SH, KVJ and MG. SH, KVJ and MG critically revised the manuscript for scientific quality and content. All authors approved the final version for publication.

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