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Assessing the Effect on Outcomes of Public or Private Provision of Prenatal Care in Portugal

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Abstract To evaluate whether public and private prenatal care users experience similar outcomes, taking into consideration maternal pre-pregnancy social and clinical risk. We studied 7,325 women who delivered single newborns at five public maternity units in Porto, Portugal. Health behaviors and prenatal care were self-reported; pregnancy complications and delivery data were retrieved from medical files. The odds of inadequate weight gain, continuing to smoke, gestational hypertension, gestational diabetes, caesarean section, preterm birth, low birthweight, and small- and large-for-gestational-age were estimated for public and private providers using logistic regression, stratified by pre-pregnancy risk profile, adjusted for maternal characteristics. 38 % of women used private prenatal care. Among low-risk women, public care users were more likely to gain excessive weight (OR 1.26; 95 % CI 1.06–1.57) and be diagnosed with gestational diabetes (OR 1.37; 95 % CI 1.01–1.86). They were less likely to have a caesarean (OR 0.63; 95 % CI 0.51–0.78) and more likely to deliver small-for-gestational-age babies (OR 1.48; 95 % CI 1.19–1.83). Outcomes were similar in high-risk women although preterm and pre-labor caesarean were less frequent in public care users (OR 0.64 95 % CI 0.45–0.91; OR 0.69 95 % CI 0.49–0.97). The amount of care was not significantly related to risk profile in either case. Public care users experienced similar outcomes to those using private care, despite higher pre-pregnancy disadvantage. Low-risk women need further attention if narrowing inequalities in birth outcomes remains a priority.

Keywords Prenatal care · Healthcare provider · Pregnancy complications · Birth outcomes

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Introduction

Strategies to expand quantity, quality and access to prenatal care services were designed during the past half-century to reduce inequalities in birth outcomes [1]. Despite an increase in coverage and the improvement in mortality indicators, low birthweight and preterm births have been rising in several countries, including Portugal [2–4]. Prenatal care should generally be tailored by pregnancy risk, and more care does not guarantee a favorable outcome. For low-risk women, a small number of visits is enough to ensure appropriate screening or treatment interventions, keeping costs affordable; high-risk pregnancies need an adaptation or scaling up of care [5].

Most research focusing on the effect of healthcare setting on pregnancy outcomes is conducted in the United States [6, 7] or in low-income countries [8, 9]. Despite improvements in prenatal care use, programs remained centered on specific disadvantaged populations and the evidence regarding universal health services is scarce and out of date.

Since the launch of the Portuguese National Health Service (NHS) in the early 1980s, the government has guaranteed universal free access to healthcare for all pregnant women and the coverage is high [10]. Also, more than 90 % of all deliveries occur in the NHS. Low-risk pregnancies are followed at primary healthcare centers, by general practitioners, working as gatekeepers to public hospitals where differentiated care is provided. However, alternative or complementary private prenatal care with a gynecologist or obstetrician is frequent, covered by out-of-pocket payment or voluntary/employer health insurance schemes. Despite the extensive offer, at the end of the twentieth century, barriers to care were observed, resulting in social inequalities in its use and in subsequent pregnancy outcomes [11, 12].

Universal healthcare services are moving closer to private solutions in several countries, so it is important to understand if and how public services are able to narrow social inequalities.

In a country where free prenatal care is universally available, we aimed to evaluate whether public and private care users experience equality of pregnancy outcomes, taking into consideration maternal pre-pregnancy risk profile and social characteristics.

Methods

This cross-sectional study used baseline data from Generation XXI, the Portuguese birth cohort [13, 14]. In 2005–2006, at five public maternity units in the Porto Metropolitan Area, in the north of Portugal, resident women delivering live births were invited to take part. The sample includes 92 % of women invited. Women (n = 8,495) were evaluated up to 72 h after delivery in face-to-face interviews using detailed standardized questionnaires. Pregnancy complications and peripartum data were retrieved from medical records. The study was approved by the ethics committee of the University of Porto Medical School/Hospital S. João and a written signed consent form was obtained from all participants.

Prenatal Care Provider and Components

Women were asked about the type of prenatal care used, with options offered being primary healthcare center (always public), out-patient clinic at a public hospital, or private care. There are two major reasons for private care users to use prenatal care in public hospitals as well: pregnancy complications and because care after the 36th gestational week is offered to all women in the hospital where delivery will occur. Providers were further classified as public (primary healthcare center and/or public hospital) or private (exclusive or with public). Almost 70 % of public users and 72 % of private users used only one type of facility. The characteristics of women using each type of healthcare provider can be found in the Supplementary file, Table S1. Women self-reported their gestational age at the first visit and the total number of visits. They also provided the number of routine biochemical tests (blood count, glucose, screening tests for infections), ultrasounds and whether they had received the biochemical aneuploidy screening [plasma protein A (PAPP-A), free-β human chorionic gonadotrophin (free hCGβ)], amniocentesis or chorionic villus sampling.

Maternal Characteristics

Women were asked about their marital status, number of years of formal schooling, employment status and occupation (classified on the National Occupation Classification Scale [15]), and their household monthly income using €500 categories. Migration status was assessed using the women's and their parents' country of birth and age on arrival in Portugal [16]. Women were asked the number of previous pregnancies (none; 1; ≥2) and whether they had planned the current pregnancy.

Smoking status 3 months before conception and at each trimester was reported, including the number of cigarettes per day. Pre-pregnancy weight was reported and height was measured or obtained from the women's identity card registry. Body mass index (BMI) was calculated as "weight (kg)/(height^2) (m)" and grouped as <18.5; 18.5–24.9; 25.0–29.9; ≥30.0 kg/m^2.

Maternal pre-pregnancy risk profile was dichotomized as low and high, based on characteristics before the current pregnancy. As no national guidelines are available, women were classified according to a local hospital's guidelines (one of the units included) [17]. Indicators were added for characteristics which have been shown to increase the risk of pregnancy complications and adverse birth outcomes, and which need specialized care [18, 19]. Women considered to be high-risk fulfilled at least one of the criteria of history of fetal death, ≥3 miscarriages, previous gestational diabetes, placental abruption or placenta praevia, previous preterm birth (<37 weeks), low birthweight (<2,500 g) or macrosomia (>4,500 g), previous fetal congenital anomaly, maternal medical diagnosis of HIV, epilepsy, dyslipidemia, hypertension, diabetes, cancer, cardiac or renal disease, BMI <18.0 kg/m^2 or ≥35.0 kg/m^2, age <18 or >40 years or smoking >10 cigarettes per day.

Prenatal Outcomes

Among smokers (women smoking 3 months before conception), continuation was attributed to those who smoked the same number of cigarettes in the third trimester (vs. women that ceased or reduced). Weight gain during pregnancy was calculated as the difference between the mother's reported weight before delivery and pre-pregnancy weight. Taking in consideration pre-pregnancy BMI, weight gain was categorized according to the Institute of Medicine (IOM) recommendations as adequate, reduced or excessive [20]. Gestational hypertensive disorders (gestational hypertension or preeclampsia/eclampsia) and diabetes were retrieved from clinical records.

Birth Outcomes

Mode of delivery was classified as caesarean or vaginal. Caesareans were also classified as in-labor (vs. vaginal deliveries) or before the onset of labor (vs. vaginal plus in-labor caesareans). Newborns were classified as preterm (<37 gestational weeks), low birthweight (<2,500 g), small- (SGA) or large-for-gestational-age (LGA). Gestational age used ultrasound measurements (if performed up to the 20th gestational week) or, if no data available (15 %), the last menstrual period. SGA and LGA were defined as the sex-specific birthweight <10th or >90th percentile for each gestational age [21].

Analysis

Of 8,495 participants in the birth cohort, a subgroup of 313 women was recruited during pregnancy at two of the hospitals included. They were invited if their first prenatal care visit had occurred before 13 gestational weeks. Because of that, they were excluded from this analysis. Eligible women were therefore recruited at birth, delivered a single fetus (137 multiple pregnancies were excluded) and had had prenatal care [23 (0.3 %) women had had no care or had begun care after the 36th gestational week] (n = 8,022). Women were excluded if had missing data on: source of prenatal care (n = 62), variables that made it possible to define pre-pregnancy risk profile (n = 319), smoking cessation (n = 62), weight gain (n = 194), gestational hypertension/eclampsia/diabetes (n = 30), mode of delivery (n = 1), gestational age (n = 10), or age, education or pregnancy planning (n = 19). The final sample comprised 7,325 women. When compared with those excluded, those included were more educated, more often married, with a higher monthly income, and more likely to have had a planned pregnancy and used private prenatal care.

Maternal socio-demographics and pre-pregnancy risk profile were compared by care provider (public and private) using Chi square tests. Because prenatal care components and outcomes could vary with pre-pregnancy risk profile, the analyses were stratified by pre-pregnancy risk [interactions ($\alpha = 10$ %) between pre-pregnancy risk and prenatal care provider were found for smoking continuation, weight gain, gestational diabetes and hypertensive disorders, preterm birth and SGA]. Odds ratio (and respective 95 % confidence intervals) of each adverse pregnancy outcome by care provider were computed using multivariable logistic regression models.

To minimize selection bias because of case mix, all socio-demographic characteristics, clinical history and delivery hospital were included in the first adjusted model (Model 1). Model 2 was adjusted for potential confounders: parity, pre-pregnancy BMI and pre-pregnancy smoking. Interactions between healthcare provider and each variable were tested. When statistically significant ($\alpha = 10$ %), interaction terms were included in the model. Successive models 3 and 4 were adjusted to assess potential mediators of the observed differences. Model 3 included gestational age at the first prenatal care visit and the number of visits. Both variables were removed as no changes in the estimates were observed. Model 4 fitted only for birth outcomes, including prenatal outcomes (smoking in the third trimester, weight gain, gestational diabetes and gestational hypertensive disorders) as possible mediators.

The robustness of our results was tested by conducting sensitivity analyses. First, the association between prenatal care provider and birth outcomes was tested excluding women with gestational diabetes and hypertensive disorders. Then women that used more than one type of facility were excluded, i.e., exclusive primary healthcare center or exclusive public hospital users were compared with exclusive private care users (Tables S2). Finally, multivariate imputation via chained equations was used to test whether the exclusion of participants with missing variables led to distinct results (Table S3).

Results

Thirty-eight percent of women (n = 2,826) used private prenatal care. Of public care users, 30 and 37 % respectively were followed exclusively in primary healthcare and in public hospitals. Public care users were more likely to be younger, less educated, single, migrant (from Brazil or Portuguese-speaking African countries), multigravidae, be unemployed or have unskilled occupations, have lower income and an unplanned pregnancy (Table 1). They more frequently presented a pre-pregnancy high-risk profile (39 vs. 26 %) and were more often overweight or obese (34 vs. 24 %), smokers (30 vs. 20 %) and previously diagnosed with chronic diseases (10 vs. 8 %) (Table 2).

Both low and high pre-pregnancy risk women who opted for public services began care later, and had fewer

Table 1 Maternal socio-demographic characteristics by prenatal care provider

	Prenatal care provider		
	Public (n = 4,499)	Private (n = 2,826)	*p* value*
Maternal age (years)			
<20	351 (7.8)	29 (1.0)	
20–24	987 (21.9)	209 (7.4)	
25–29	1,323 (29.4)	911 (32.2)	
30–34	1,168 (26.0)	1,183 (41.9)	
35–39	553 (12.3)	422 (14.9)	
≥40	117 (2.6)	72 (2.6)	<0.001
Education (schooling years)			
≤5	582 (12.9)	56 (2.0)	
6–8	1,393 (31.0)	334 (11.8)	
9–11	1,282 (28.5)	435 (15.4)	
12	740 (16.4)	688 (24.3)	
≥13	502 (11.2)	1,313 (46.5)	<0.001
Migrant status			
Portuguese born	4,274 (95.3)	2,703 (96.5)	
European	37 (0.8)	36 (1.2)	
Portuguese speaking countries[a]	155 (3.5)	49 (1.8)	
Other migrants	18 (0.4)	13 (0.5)	<0.001
Single women	361 (8.0)	64 (2.3)	<0.001
Working condition			
Employed	2,831 (63.1)	2,425 (86.0)	
Unemployed	1,138 (25.4)	288 (10.2)	
Housewife	363 (8.1)	65 (2.3)	
Student/other	155 (3.4)	43 (1.5)	<0.001
Occupation			
Non-qualified worker	576 (14.3)	70 (2.6)	
Blue-collar worker	747 (18.5)	179 (6.6)	
Clerical worker	2,211 (54.9)	1,235 (45.3)	
Managerial-professional worker	496 (12.3)	1,243 (45.6)	<0.001
Monthly income (€)			
<500	410 (9.3)	35 (1.3)	
500–1,000	1,662 (37.7)	437 (15.9)	
1,001–1,500	1,105 (25.1)	737 (26.9)	
1,501–2,000	447 (10.2)	597 (21.8)	
>2,000	284 (6.4)	733 (26.7)	
No answer/not known	498 (11.3)	203 (7.4)	<0.001
Number of previous pregnancies			
None	2,084 (46.3)	1,502 (53.1)	
One	1,529 (34.0)	915 (32.4)	
Two or more	886 (19.7)	409 (14.5)	<0.001
Planned pregnancy	2,729 (60.7)	2,233 (79.1)	<0.001

The number of participants in each category may not add up due to missing data

[a] Brazil, Angola, Mozambique, Cape Verde, S. Tome and Principe, Guinea-Bissau

* Chi square tests were performed excluding the category "does not know"

visits, ultrasounds and routine blood analyses. Private care users reported more visits and ultrasounds, even for similar gestational ages at the beginning of care. Among low-risk early care users (<6 gestational weeks), 52 % of women in public and 64 % in private settings reported at least 10 visits and differences remained for late care users (>13 gestational weeks): ≥10 visits were reported by 17 % public vs. 28 % private. Biochemical aneuploidy screening tests were less frequently reported by public care users, as were amniocentesis/chorionic villus sampling among younger women (<35 years), although for those aged ≥35 years no difference was observed (Table 3).

Table 2 Maternal pre-pregnancy risk profile by prenatal care provider

	Prenatal care provider		
	Public (n = 4,499)	Private (n = 2,826)	*p* value
Pregnancy risk classification			
Low-risk	2,758 (61.3)	2,079 (73.6)	
High-risk	1,741 (38.7)	747 (26.4)	<0.001
Body mass index (kg/m^2)			
<18.5	200 (4.4)	99 (3.5)	
18.5–24.9	2,775 (61.7)	2,045 (72.4)	
25.0–29.9	1,047 (23.3)	512 (18.1)	
≥30.0	477 (10.6)	170 (6.0)	<0.001
Pre-pregnancy smoking status			
Never smoker	2,698 (60.0)	1,900 (67.2)	
Ex-smoker	456 (10.1)	362 (12.8)	
Smoker, ≤10 cig/day	663 (14.7)	317 (11.2)	
Smoker >10 cig/day	682 (15.2)	247 (8.8)	<0.001
Chronic disease	452 (10.0)	241 (8.5)	0.030
Among multigravidae			
Previous fetal deaths	50 (2.1)	20 (1.5)	0.227
Previous miscarriages	504 (21.0)	357 (27.1)	<0.001
Previous preterm birth (<37 weeks)	201 (8.7)	84 (6.5)	0.021
Previous low birthweight (<2,500 g)	194 (8.3)	71 (5.4)	0.002
Previous macrosomia (>4,500 g)	25 (11)	7 (0.5)	0.102
Previous congenital anomaly	95 (4.0)	36 (2.8)	0.056
Previous placental disorder	34 (1.5)	28 (2.2)	0.124
Previous gestational diabetes	52 (2.2)	39 (3.0)	0.133

The number of participants in each category may not add up due to missing data

Prenatal Outcomes

When compared with private care, pre-pregnancy low-risk public users presented higher frequency of excessive weight gain (38 vs. 33 %) and of gestational diabetes (7 vs. 4 %), while high-risk women were more likely to continue smoking (11 vs. 3 %) (Table 4). After adjusting for maternal characteristics (Table 5, Model 2), excessive weight gain (OR 1.29; 95 % CI 1.06–1.57) and gestational diabetes (OR 1.37; 95 % CI 1.01–1.86) remained significantly different among pre-pregnancy low-risk women. No differences were found after adjustment for prenatal care components (Model 3). High-risk women presented similar prenatal outcomes in both settings.

Birth Outcomes

Women in public care had lower proportions of caesarean deliveries, both before and during labor. Low-risk women delivered more SGA babies in public care (14 vs. 11 %) (Table 4). After adjustment (Table 5, Model 2), the differences remained significant: in-labor caesarean OR 0.70 (95 % CI 0.54–0.91), pre-labor caesarean OR 0.62 (95 % CI 0.47–0.2), SGA (OR 1.48; 95 % CI 1.19–1.83). The adjustment for prenatal care components and for pregnancy mediators did not explain the differences (Table 5, Models 3–4). High-risk women attending public care were less likely to have pre-labor caesareans (OR 0.69; 95 % CI 0.49–0.97) and to deliver preterm babies (OR 0.66; 95 % CI 0.48–0.92).

The results of the sensitivity analyses (Tables S2–S3) were similar to those mentioned above. When excluding mixed care users, estimates remained similar or with stronger significant associations. Among high-risk women, preterm and caesarean deliveries were no longer different by healthcare provider. When models were fitted using multiple imputed data, in-labor caesareans among pre-pregnancy low-risk women were no longer different by prenatal care providers.

Discussion

Women using public prenatal care showed less favorable clinical and social pre-pregnancy characteristics and had less care than women using private prenatal care. Nonetheless, pre-pregnancy high-risk public care users presented outcomes similar to those using private care, while

Table 3 Prenatal care components by prenatal care provider and pre-pregnancy risk profile

	Low risk			High risk		
	Public (n = 2,758)	Private (n = 2,079)	*p* value	Public (n = 1,741)	Private (n = 747)	*p* value
First prenatal visit (gestational age)						
<6	619 (22.8)	631 (30.7)		351 (20.6)	235 (32.1)	
6–12	1,746 (64.4)	1,348 (65.6)		1,062 (62.2)	453 (61.8)	
≥13	347 (12.8)	76 (3.7)	<0.001	294 (17.2)	45 (6.1)	<0.001
Does not know	1.4	1.1		1.9	1.6	
Number of visits						
≥10	1,136 (41.7)	1,123 (54.5)		733 (42.7)	380 (51.8)	
7–9	1,216 (44.6)	833 (40.5)		744 (43.4)	307 (41.8)	
3–6	361 (13.2)	103 (5.0)		228 (13.3)	45 (6.1)	<0.001
1–2	12 (0.4)	0 (0.0)	<0.001	11 (0.6)	2 (0.3)	
Does not know	0.3	0.2		0.6	0.3	
Number of ultrasounds						
≥7	162 (6.0)	860 (42.5)	<0.001	131 (7.7)	323 (44.6)	
4–6	1,475 (54.5)	674 (33.3)		925 (54.4)	247 (34.1)	
3	912 (33.7)	465 (23.0)		533 (31.3)	142 (19.6)	
0–2	158 (5.8)	23 (1.1)		113 (6.6)	13 (1.8)	<0.001
Does not know	0.7	1.2		0.8	1.5	
Number of routine biochemical analysis						
≥7	64 (2.4)	60 (3.0)		57 (3.4)	23 (3.3)	
4–6	1,005 (38.2)	772 (39.2)		621 (37.3)	290 (41.1)	
3	1,312 (49.9)	1,035 (52.5)		785 (47.2)	350 (49.6)	
0–2	249 (9.5)	105 (5.3)	<0.001	201 (12.1)	43 (6.1)	<0.001
Does not know	2.5	2.1		2.0	1.3	
Biochemical aneuploidy screening[a]						
Maternal age <35 years	881 (40.7)	1,327 (78.4)	<0.001	513 (42.2)	397 (74.5)	<0.001
Does not know	8.8	2.5		11.5	4.3	
Maternal age ≥35 years	138 (42.3)	149 (51.4)	0.025	92 (30.9)	76 (43.4)	0.006
Does not know	3.3	4.3		6.9	1.7	
Amniocentesis/chorionic villus sampling						
Maternal age <35 years	107 (4.5)	111 (6.3)	0.008	65 (4.7)	38 (6.8)	0.056
Does not know	0.2	0.2		0.3	0.4	
Maternal age ≥ 35 years	162 (47.6)	154 (49.8)	0.577	175 (54.4)	104 (58.1)	0.418
Does not know	0.0	0.0		0.0	0.0	

The number of participants in each category may not add up due to missing data. Proportions were calculated excluding women reporting “not know”

[a] Plasma protein A (PAPP-A), free-β human chorionic gonadotrophin (free hCGβ)

in low-risk pregnancies, only part of the inequalities seemed to be attenuated. Public prenatal care users showed higher rates of pregnancy-related adverse behaviors and an increased likelihood of fetal growth restriction.

Strengths and Limitations

All women delivered in public hospitals so the impact of peripartum context on pregnancy outcomes was attenuated. At the time of recruitment, public hospitals were responsible for 95 % of deliveries in the region. We would expect the inclusion of the small group of women delivering in a private setting to increase the differences found in this study, as we predict that these women would be more advantaged, presenting lower prevalence of the most adverse outcomes. Also, caesarean deliveries are more frequent in private than in public hospitals [22].

Our data are from 2005 to 2006, and changes in prenatal care are likely to have occurred. Primary healthcare was restructured after 2005, resulting in the creation of Family Health Units that, as using a more flexible and multidisciplinary approach [23], might positively impact the

Table 4 Prevalence of pregnancy and birth outcomes by healthcare provider

	Low risk			High risk		
	Public (n = 2,758)	Private (n = 2,079)	*p* value	Public (n = 1,741)	Private (n = 747)	*p* value
Prenatal outcomes						
Smoking continuation[b]	61 (12.8)	26 (10.6)	0.400	92 (10.6)	11 (3.4)	<0.001
Reduced weight gain[c]	689 (25.0)	529 (25.4)	0.191	492 (28.3)	191 (25.6)	0.244
Excessive weight gain[c]	1,051 (38.1)	689 (33.1)	<0.001	648 (37.2)	290 (38.8)	0.913
Gestational Diabetes[d]	186 (6.7)	88 (4.2)	<0.001	144 (8.4)	61 (8.3)	0.892
Gestational hypertensive disorders[e]	87 (3.2)	58 (2.8)	0.462	55 (3.3)	34 (4.8)	0.084
Birth outcomes						
Caesarean delivery	883 (32.0)	825 (39.7)	<0.001	607 (34.9)	317 (42.4)	<0.001
Caesarean in labor	567 (23.2)	458 (26.8)	0.009	349 (23.5)	172 (28.6)	0.016
Caesarean before labor	316 (11.5)	367 (17.6)	<0.001	258 (14.8)	145 (19.4)	0.004
Preterm birth	171 (6.2)	131 (6.3)	0.886	144 (8.3)	88 (11.8)	0.006
Low birthweight	164 (6.0)	110 (5.3)	0.329	163 (9.4)	76 (10.2)	0.529
Small-for-gestational-age	396 (14.4)	220 (10.6)	<0.001	330 (19.0)	132 (17.7)	0.450
Large-for-gestational-age	101 (3.7)	74 (3.6)	0.850	83 (4.8)	32 (4.3)	0.598

quality of care. However, recent policies on cost controls and the economic crisis seem to be negatively affecting access to and use of public care services [24], although prenatal care remains free of charge.

Most outcomes were collected from medical files, so we expect misclassification to be minimal. Misclassification may have occurred in the report of pre- and in-pregnancy smoking habits and weight [25]. However, these characteristics are in accordance with what would be expected for this group of women [13, 26]. However, it is possible that more educated women underreport their smoking consumption, because of social desirability. If so, smoking cessation among private care users would be overestimated and differences between healthcare providers may be attenuated. Other pre-pregnancy characteristics are less likely to be biased.

Prenatal care providers were distinguished by the system of payment. However, healthcare professionals are differently distributed in the public and private sectors. In private settings, care is mainly provided by gynecologists/obstetricians. In public settings low-risk women are followed by general practitioners in primary healthcare centers and high-risk women referred to hospitals, where specialized care is offered. Differences between sources of care may, therefore, represent different healthcare providers. However, public care is designed assuming that different levels of risk need different levels of specialization. Low-risk pregnancies, followed by general practitioners, are expected to present similar outcomes to those with comparable risk followed by gynecologists/obstetricians. Unfortunately, to the best of our knowledge, no clinical trial in developed settings has tested this hypothesis.

We did not collect the number or sequence of visits to each prenatal care facility. However, a large proportion of women received care from only one setting, reinforcing our results. When excluding mixed users, similar estimates were observed and significant differences were emphasized (Table S2).

Differences in preterm observed in high-risk women were probably explained by selection bias. Most women delivering preterm (and all delivering very preterm) are transferred to public settings with neonatal intensive care facilities. Preterm delivery was therefore likely to be overestimated among private users, explaining the observed differences.

Another possible limitation of our study was the chosen definition of pre-pregnancy risk. No consensual definitions are available and we opted for the features that are most often reported and so generally agreed to be relevant [17–19]. Most of the characteristics listed were included in our definition, although that excluded factors such as previous pre-eclampsia or severe asthma. Though most are rare conditions, the low-risk group may include some high-risk women.

Finally, causal inference should be drawn carefully due to the observational design of our study. Self-selection of healthcare provider is likely to have occurred, which limits generalizability of the results. However, we have adjusted for a large number of socio-demographic and clinical characteristics that may be related to the decision to use particular healthcare providers, minimizing potential selection bias. Nevertheless, the differences observed may result from uncontrolled variables. We tested propensity score matching (considering all the variables that we used

Table 5 - Effect of prenatal care provider on prenatal and birth outcomes by pre-pregnancy risk profile

	Adjusted odds ratio (95 % CI): public versus private healthcare provider							
	Pre-pregnancy low risk				Pre-pregnancy high risk			
	Models #1	Models #2	Models #3	Models #4	Models #1	Models #2	Models #3	Models #4
Prenatal outcomes								
Smoking continuation[a]	0.65 (0.33–1.25)	0.61 (0.31–1.20)	0.63 (0.32–1.25)	–	1.64 (0.78–3.41)	1.41 (0.66–3.02)	1.36 (0.63–2.97)	–
Reduced weight gain[b]	1.08 (0.90–1.29)	1.10 (0.92–1.32)	1.10 (0.92–1.32)	–	0.98 (0.75–1.28)	0.96 (0.73–1.26)	0.96 (0.73–1.26)	–
Excessive weight gain[b]	1.20 (1.02–1.40)	1.29 (1.06–1.57)	1.29 (1.06–1.57)	–	1.04 (0.82–1.31)	1.12 (0.40–3.11)	1.18 (0.42–3.33)	–
Gestational Diabetes[c]	1.42 (1.05–1.93)	1.37 (1.01–1.86)	1.39 (1.02–1.90)	–	1.18 (0.81–1.73)	1.09 (0.74–1.60)	1.09 (0.74–1.61)	–
Gestational hypertensive disorders[d]	0.97 (0.65–1.46)	1.11 (0.72–1.70)	1.12 (0.73–1.72)	–	0.61 (0.37–1.03)	0.54 (0.29–0.99)	0.53 (0.29–0.98)	–
Birth outcomes								
Caesarean delivery	0.79 (0.69–0.92)	0.63 (0.51–0.78)	0.65 (0.53–0.81)	0.62 (0.50–0.76)	0.94 (0.76–1.16)	0.88 (0.67–1.16)	0.86 (0.65–1.13)	0.89 (0.68–1.17)
Caesarean in labor	0.83 (0.70–0.99)	0.70 (0.54–0.91)	0.72 (0.56–0.94)	0.70 (0.54–0.91)	0.92 (0.71–1.20)	1.08 (0.76–1.53)	1.05 (0.74–1.50)	1.10 (0.78–1.56)
Caesarean before labor	0.78 (0.64–0.95)	0.62 (0.47–0.82)	0.65 (0.49–0.86)	0.61 (0.46–0.81)	0.96 (0.73–1.26)	0.69 (0.49–0.97)	0.68 (0.48–0.95)	0.70 (0.50–0.98)
Preterm birth	0.96 (0.72–1.28)	0.97 (0.73–1.30)	0.87 (0.65–1.17)	0.99 (0.74–1.33)	0.67 (0.48–0.95)	0.68 (0.48–0.95)	0.66 (0.46–0.94)	0.70 (0.49–1.00)
Low birthweight	1.25 (0.92–1.69)	1.29 (0.96–1.75)	1.17 (0.86–1.60)	1.29 (0.95–1.76)	0.80 (0.56–1.12)	0.83 (0.58–1.17)	0.83 (0.58–1.18)	0.90 (0.62–1.30)
Small-for-gestational-age (SGA)	1.44 (1.16–1.78)	1.48 (1.19–1.83)	1.49 (1.20–1.84)	1.47 (1.19–1.82)	0.95 (0.72–1.24)	0.97 (0.74–1.28)	0.96 (0.72–1.26)	0.98 (0.74–1.29)
Large-for-gestational-age (LGA)	0.83 (0.57–1.22)	0.78 (0.53–1.14)	0.77 (0.52–1.14)	0.74 (0.50–1.09)	1.40 (0.85–2.31)	1.30 (0.79–2.15)	1.30 (0.78–2.17)	1.28 (0.78–2.13)

Models #1 - Adjusted for hospital of delivery + maternal age + education + migrant status + marital status + working condition + occupation + income + pregnancy planning + chronic conditions

Models #2 – Models #1 + parity (except for gestational diabetes; interaction with prenatal care provider included for caesarean deliveries models) + pre-pregnancy body mass index (except for smoking continuation and preterm; interaction with prenatal care provider included for excessive weight gain) + smoking before pregnancy (except for caesarean deliveries models, preterm, low birthweight and LGA; interaction with prenatal care provider included for gestational hypertensive disorders)

Models #3– Models #2 + gestational age at 1st visit + number of visits

Models #4 – Models #2 + weight gain (except for pre-labor caesarean) + smoking in 3rd trimester (only for SGA) + gestational hypertensive disorders (except for LGA) + gestational diabetes (except caesarean in labor, preterm, low birthweight, SGA)

[a] within pre-pregnancy smokers; [b] versus adequate weight gain; [c] excluding women with pre-pregnancy diabetes; [d] excluding women with pre-pregnancy hypertension

in Models 1 and 2) to control for self-selection to prenatal care provider and similar results were found (data not shown). We conducted several sensitivity analyses to assure the strength of our results. This study therefore seems to be a robust alternative to randomized and quasi-randomized experiments.

Interpretation

Women opting for out-of-pocket private services (disregarding the public offer) show, in general, better social profile and are more likely to plan pregnancy, adopt healthy lifestyles and to be aware of the risk of complications [27, 28]. Prenatal care in Portugal is available at all primary healthcare centers, which are at relatively short distance from residence and each woman is entitled to free care. Thus, the decision to use alternative care seems to be related to the perception of quality or the access to specialized care [12]. Because public prenatal care for low-risk women is offered by general practitioners, private settings are a possible route to access an obstetrician. The observed apparent protection provided by private providers may therefore be a result of differences in women's attitudes and expectations, which we could not fully attenuate by adjusting for social profile and pregnancy planning. This may also explain the higher rates of caesarean deliveries before the onset of labor, which are, as previously described for this cohort, also associated with cultural background [16].

Our results may also be explained by the early initiation of care or the higher number of visits in private settings. However, adjusting for these characteristics did not change the results and we would expect to see the same differences independently of the risk profile, and not only in low-risk pregnancies. Additionally, no data supports the theory that privately-insured women have better results based on the number of visits [29].

We can hypothesize that public providers disregarded preventable adverse health behaviors in alleged low-risk women. Differences were found for weight gain and gestational diabetes and not for smoking. This may reflect the widely-recognized risk of smoking, justifying more efforts regarding smoking cessation [30]. We cannot assess whether the differences in prenatal outcomes reflect time constraints, providers' skills or nonexistent clinical guidelines. However, no national guidelines exist on weight gain and IOM recommendations have only recently started to be adopted. Despite the higher likelihood that public care users will gain excessive weight or have impaired glucose metabolism, macrosomia (or excessive fetal growth) was not different. This might reflect either early diagnosis and/or timely treatment, based on the existing referral system to hospitals with perinatal support [31].

High-risk women appeared to have a similar and probably more standardized clinical approach, regardless of the care setting. Health behaviors were possibly addressed more carefully in women with another risk factor than in apparently low-risk ones. Also, other non-behavioral risk factors may contribute to adverse outcomes. Unfortunately, we could not assess the effect of the quality of care, which would be of particular interest as the minimization of risk was not mediated by the amount of care. Differences between public and private providers in prenatal care components do not seem to reflect effectiveness, but rather increased medicalization of care provided by private providers to wealthier and healthier women, which may not always be necessary.

Conclusion

Most public prenatal care users experienced similar outcomes to those from private care. Public care seems to solve the major problems effectively, but only attenuates part of their users' increased social and clinical risk. To further overcome inequalities in birth outcomes, prevention strategies need to incorporate special attention to low-risk women, as well as those at higher risk of problems.

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Conflict of interest The authors report no conflict of interest.

Ethical standard The birth cohort study was approved by the ethics committee from the University of Porto Medical School/Hospital S. João (27th April 2005) and a written signed consent form, designed according to the Declaration of Helsinki, was required for all women.

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