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Medication prescriptions before, during and after pregnancy in Italy: a population-based study

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Abstract

Background. Monitoring medicine prescriptions in pregnancy is an aspect of extreme interest in term of public health.

Methods. A retrospective prevalence study using administrative healthcare databases was performed in order to evaluate medication prescriptions in Italy. A cohort of 274,938 pregnant women (15-49 years) residing in three Italian regions (Emilia-Romagna, Lazio, Puglia), who delivered in 2014-2017, were enrolled. The prevalence of medication use was estimated as the proportion of pregnant women with any medication prescription in each of the following five trimesters: 1 before pregnancy (pre-T), 3 during pregnancy (1st TP, 2nd TP, 3rd TP) and 1 after pregnancy (post-T).

Results. About 80% of enrolled pregnant women received at least one prescription during pregnancy, 36.5% before pregnancy and 50.7% in the post-partum. The most prescribed medicine was folic acid (42%), mostly used in 1st TP (35%). Progesterone use was concentrated in 1st TP (19%) and increased as the number of previous abortions. Pregnancy use of antidiabetics, antihypertensives, and thyroid preparations were 24.1‰, 21.5‰, 101.8‰, respectively.

Conclusions. At the national level, this study confirmed the prescriptive trend observed in other European studies, but a regional variability for all medication groups was found. Further studies are needed in order to identify determinants of medication prescriptions during pregnancy in Italy.

Key words
- medicines
- pregnancy
- drug utilization
- prescription appropriateness
- regional variability

INTRODUCTION

The use of prescription medications during pregnancy is a common event worldwide. The prevalence of pregnant women who used at least one medication is ranging from 27 to 99% in developed countries, with a substantial inter-region variability in the type of medication used depending on the setting [1-4].

There are significant knowledge gaps surrounding the safety, dosage and long-term effects of medications in pregnancy because pregnant women are generally excluded from pre-authorization clinical trials of the majority of pharmacological treatments for conditions that may occur concurrently with pregnancy [5-7].

Pharmacological treatments commonly used in pregnancy are thus often untested in pregnant woman, not optimized in dose, with minimal information on pharmacokinetics and safety profile (especially on long-term outcomes), and prescribed off-label without an adequate information to judge their risks and benefits. This denies women appropriate drug therapies and an inadequate maternal treatment of disease can jeopardize both the mother's and the child's wellbeing [8, 9].

In the absence of available and clear data that can inform treatment choices, the risk-benefit profile of the use of medicines in pregnancy is assessed mostly through post-authorization studies. Currently, observational and/or descriptive studies are often performed on medication use in pregnancy in order to close the knowledge gap in this context [10].

In Italy a prevalence of about 75% of women exposed to at least one prescription medication during pregnancy [11] was reported. However, no recent national

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data about the prevalence of medication use during pregnancy were available in Italy [12] and the information on regional variability in prescription patterns are scarce [13-17]. To fill this important knowledge gap and to better inform clinical practice in Italy, we performed a population-based study aiming to evaluate the maternal medicine prescriptions before, during and after pregnancy across three Italian regions and to investigate the inter-regional variability.

METHODS

A retrospective population study using administrative healthcare databases was performed on a cohort of women aged between 15 and 49 years, who had a delivery (live births and stillbirths) in a Birth Unit from October 1st, 2014 to September 30th, 2017 and who were resident at the time of delivery in one of the following Italian regions: Emilia-Romagna (ER), a region in the North of Italy, Lazio (L), a region of Central Italy, and Puglia (P) in the South of Italy, whose total female residing population of childbearing age (15-49 years) in 2015 was 3.2 million. In the case of more than one delivery during the study period, only the first delivery was included in the study. All pregnant women were identified through the Regional Child-Birth Registry (CeDAP, *Certificato di Assistenza al Parto*) database, after linking the Regional Health Information Systems, containing data on prescriptions of all medicines reimbursed by the National Healthcare Service (NHS) in Italy. Only women covered by the Italian National Healthcare Service at least in one of the five identified trimesters were selected. Voluntary abortions and miscarriages were not included in the study, as this information were not recorded in the CeDAP database [18]. The data from the two different health care databases were combined using a deterministic record-linkage procedure based on anonymized personal identification codes, which is a procedure in line with privacy legislation [19].

The start date of pregnancy was estimated by subtracting the gestational age at delivery (defined as number of weeks of amenorrhea, as reported in the CeDAP database*7 days) from the date of delivery. On the basis of these information the following five trimesters were identified:

- the pre-pregnancy trimester (pre-T) defined as 91 days before the start date of pregnancy;
- the I trimester of pregnancy (1st TP) defined as the period between 0 (the start date of pregnancy) and the day 91 following the start date of pregnancy;
- the II trimester of pregnancy (2nd TP) defined as the period between the day 92 and the day 189 from the start date of pregnancy (or date of delivery if the delivery occurred during the 2nd TP, which is within 27 weeks of gestation);
- the III trimester of pregnancy (3rd TP) defined as the period between the day 190 from the start of pregnancy and the date of delivery;
- the post-pregnancy trimester (post-T) defined as the day 91 following the date of delivery.

For each woman enrolled in the study, the sociodemographic characteristics (e.g., age, nationality, education, occupational status), the clinical information related to pregnancy (e.g., gestational age and parity) and pregnancy history of the pregnant women (e.g., previous deliveries, previous cesarean sections, previous abortions) retrieved from the CeDAP database were collected.

The pharmaceutical prescriptions retrieved from the regional Health Information Systems provided in the identified five trimesters were linked. The medicines were classified according to the World Health Organization (WHO) Anatomical Therapeutic Chemical (ATC coding) classification system [20]. The use of some pharmacotherapy categories was investigated: vitamin B12 and folic acid (B03B), progestins (G03D) as medications indicated in pregnancy, antidiabetic drugs (A10), antihypertensive drugs (C02) and preparations for thyroid therapy (H03) as medications indicated for the treatment of chronic diseases. Medication dispensing records with missing information (name of medication, dispensing date) were excluded from the analysis.

The prevalence of overall medication use was estimated as the proportion of pregnant women with any medication prescription in each trimester considered. The prevalence of a specific medicine use was defined as the number of pregnant women receiving a specific medicine prescription per 100 pregnant women in the time frame of interest.

A woman was considered to be a prevalent user if she had received at least one prescription of the relevant medicine during the 3 months before the start date of pregnancy, while those who received a prescription during the pregnancy period were considered as new (incident) users.

RESULTS

A total of 337,437 pregnancies (24% of all deliveries occurred in Italy) were selected and a population of 274,938 pregnant women (81.5% of all selected pregnancies) were identified and included in the analysis (*Table 1*).

The 38% of all pregnant women were residing in Lazio, the 32% in Emilia-Romagna, and the remaining 30% in Puglia. About 33.7% of women were aged between 30 and 34 years old, while the 9.4% of women were at least 40 years old, the 7.7% of which was 45 years old and over. The 15.9% of the pregnant women was of a foreign nationality, with a higher percentage in Emilia-Romagna (29.1%). Almost 125,000 women (45.3% of the selected study population) already had a previous delivery (33.4% of which were cesarean sections). Furthermore, the 22.1% of pregnant women suffered at least one previous abortion (6.2% of these had two abortions and over). The majority of the pregnancies (92.1%) ended at term, while the 7% was a preterm pregnancy. The 1.9% of the deliveries were multiple (≥2 babies).

In all 221,066 pregnant women (80.4% of the selected study population) received at least one drug prescription during pregnancy: 81,807 (79.0%) women were residing in Lazio, 70,414 (79.6%) women in Emilia-Romagna, 68,845 women (83.0%) in Puglia. Furthermore, the 36.5% and 50.7% of all women received at

Table 1
Study cohort characteristics (n=274,899)

		L		ER		P		Overall	
		All pregnant women		All pregnant women		All pregnant women		All pregnant women	
		103,556		88,440		82,942		274,938	
		n	%	n	%	n	%	n	%
Age group	≤24	7,169	6.9	7,576	8.6	9,404	11.3	**24,149**	**8.8**
	25-29	19,266	18.6	19,459	22.0	18,647	22.5	**57,372**	**20.9**
	30-34	34,783	33.6	29,761	33.6	28,178	34.0	**92,722**	**33.7**
	35-39	30,684	29.6	23,588	26.7	20,585	24.8	**74,857**	**27.2**
	≥40	11,654	11.3	8,056	9.1	6,128	7.4	**25,838**	**9.4**
	≥45	*1,038*	*8.9*	*564*	*7.0*	*396*	*6.0*	***1,998***	***7.7***
Level of education	none/elementary school (≤ 5 years)	8,761	8.5	2,106	2.4	1,213	1.5	**12,080**	**4.4**
	middle school (8 years)	21,566	20.8	18,925	21.4	25,673	31.0	**66,164**	**24.1**
	high school (12-13 years)	47,561	45.9	38,220	43.2	36,161	43.6	**121,942**	**44.4**
	bachelor degree/post-degree (>13 years)	25,602	24.7	29,189	33.0	19,895	24.0	**74,686**	**27.2**
	Missing	*66*	*0.1*	*0*	*0*	*0*	*0*	***66***	***0.0***
Nationality	Italian	89,780	86.7	62,828	70.9	78,572	94.7	**231,180**	**84.1**
	Foreign	13,776	13.3	25,612	29.1	4,370	5.3	**43,758**	**15.9**
Gestational age	preterm delivery (<37 weeks)	7,726	7.5	5,815	6.6	5,738	6.9	**19,279**	**7.0**
	term delivery (37-41 weeks)	94,643	91.4	81,482	93.2	76,960	93.1	**253,085**	**92.1**
	post-term delivery (>41 weeks)	1,187	1.1	1,143	0.2	244	0.0	**2,574**	**0.9**
Previous deliveries	No	61,655	59.5	45,732	51.7	42,975	51.8	**150,362**	**54.7**
	Yes	41,901	40.5	42,708	48.3	39,967	48.2	**124,576**	**45.3**
	Cesarean section	*15,448*	*36.9*	*10,206*	*23.9*	*15,921*	*39.8*	***41,575***	***33.4***
Previous abortions	0	79,575	76.8	66,261	74.9	68,308	82.4	**214,144**	**77.9**
	1	17,434	16.8	15,764	17.8	10,479	12.6	**43,677**	**15.9**
	2+	6,547	6.3	6,415	7.3	4,155	5.0	**17,117**	**6.2**
Parity	1	101,404	97.9	86,845	98.2	81,424	98.2	**269,673**	**98.1**
	2+	2,152	2.1	1,595	1.8	1,518	1.8	**5,265**	**1.9**

L: Lazio; ER: Emilia-Romagna; P: Puglia.

least one drug prescription in the pre-T and in post-T respectively. The number of women receiving at least one drug prescription showed an increasing trend with increasing age in all the pregnancy trimesters and in the considered pre-T and post-T, even if in lower percentage for all age groups (*Table 1S, available online as Supplementary material*). The medicines belonging to the category of drugs for blood and hematopoietic organs (ATC B) were the most prescribed medications during pregnancy, with a peak of prevalence of 39.2% in the 1st TP, followed by antimicrobials for systemic use (ATC J) with a peak of 22.4% in the 2nd TP and by medicines belonging to the category of drugs for genitourinary system and sex hormones (ATC G) with a peak of prevalence of 19.8% in the 1st TP (*Figure 1*).

About 10% of the overall pregnant women included in the study population was prescribed exclusively with vitamins, minerals, and antianemic preparations purchased also as over the counter (OTC) medications.

Among the top 30 medicines most prescribed during pregnancy, 9 drugs were antimicrobials for systemic use (J), 6 were drugs for blood and blood-forming organs (B), 4 were drugs for alimentary tract and metabolism (A), 3 were drugs for genitourinary system and sex hormones (G) and 3 were drugs for to systemic hormonal preparations, excluding sex hormones and insulins (H) (*Table 2*).

The most prescribed medication during pregnancy was folic acid with an overall percentage of 41.9% of women receiving at least one prescription, ranging from the maximum of 35.0% in the 1st TP to the minimum of 11.4% in the 3rd TP; only the 6% of women received

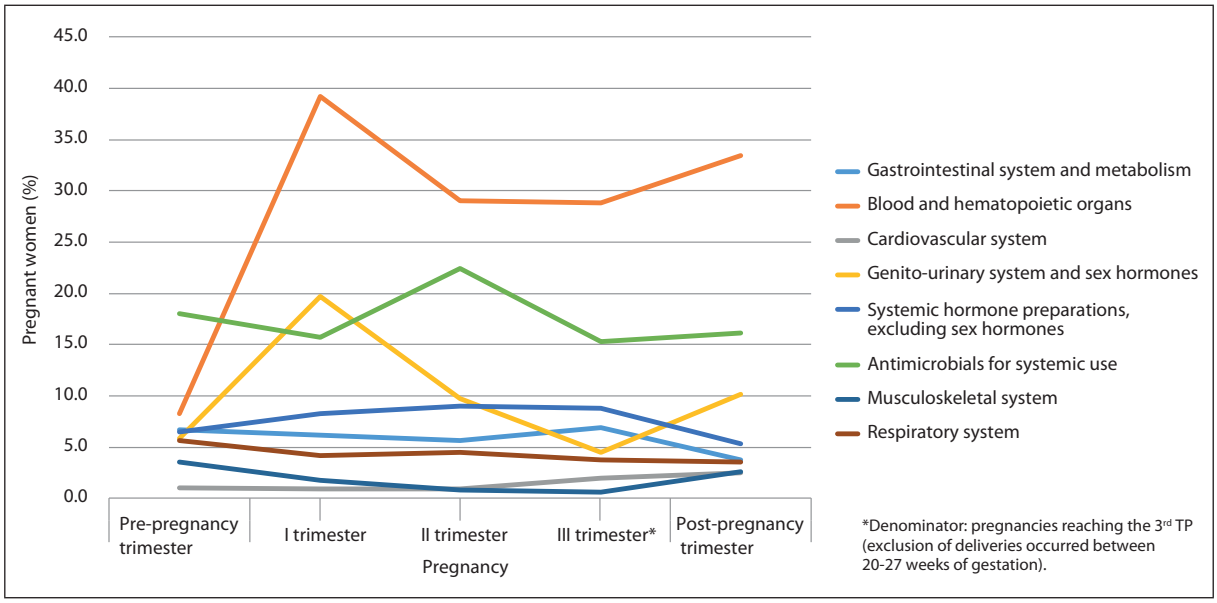

Figure 1
Medication prescription trends per ATC (I level) before, during and after pregnancy.

at least one prescription in the pre-T. Some regional variability was found in 1st TP (ER-39.4%; A-35.6%; L-30.7%) and in pre-T (ER-7.1%; L-6.7%; A-4.7%), when the use of folic acid was most recommended [21-23].

The antimicrobial for systemic use were the second most prescribed medication group during pregnancy, with a peak (22.4%) of prescription rate observed in the 2nd TP increasing with maternal age: 17.8% in women under 35 years of age, 27.9% in women between 35 and 39 years, and 33.0% in women 40 years old and over (*Figure 2*). Azithromycin and amoxicillin/clavulanic acid were the most prescribed agents (*Table 2*).

The progesterone and hydroxyprogesterone, medicines both mainly prescribed for the treatment of woman at risk of miscarriage or preterm delivery, were the second and eleventh most prescribed drugs during pregnancy in the selected study population, with an overall percentage of women receiving a prescription during pregnancy of 22.3% and 5.8%, respectively (*Table 2*). Particularly, the users of progesterone were mainly concentrated in 1st TP with the 18.2% of pregnant women receiving at least one prescription, while the percentage progressively decreased in 2nd TP (7.3%) and in 3rd TP (2.6%). The prescription of progestins during the 1st TP showed an increasing trend in relation to the number of previous abortions, ranging from 18.3% in women with no previous abortion to 28.2% for women with 2 abortions and over, with a different range within each considered Italian region: Δ=4% in Puglia (from 28.2% to 32.2%), Δ=10% in Emilia-Romagna (from 10.1% to 20.1%) and Δ=17% in Lazio (from 16.6% to 33.5%) (*Figure 3*).

The overall distribution of pregnant women with at least one prescription of medications indicated for the treatment of chronic diseases (antidiabetics, antihypertensives and preparations for thyroid therapy) during pregnancy was shown in *Table 3*. The mean prevalence for antidiabetics was 24.1 per 1,000 pregnant women, ranging from a maximum of 26.5 in Lazio to 20.5 in Puglia, 21.5 per 1,000 for anti-hypertensives, ranging from the maximum of 33.6 in Lazio to 11.9 in Puglia, 101.8 per 1,000 for thyroid preparations, with a range from 122.8 in Emilia-Romagna to 71.1 in Puglia.

Comparing to the number of prevalent users, expression of a preconception chronic treatment, Emilia-Romagna had the highest percentage of new users in pregnancy of both antidiabetic drugs and thyroid preparations, respectively 83.5% and 63.4%, while Puglia had the lowest percentage, respectively 68.1% and 44.5%. The Lazio had the highest percentage of new users in pregnancy of anti-hypertensive drugs (81.5%), followed by Puglia (68.1%) and Emilia-Romagna (63.6%).

Nifedipine (calcium channel blocker) and methyldopa (centrally acting antiadrenergic agent) were the most prescribed medications in the category of antihypertensives, ranking among the top 30 most prescribed medications, in line with the choice of antihypertensives compatible with pregnancy [24-26], while the most prescribed medicine among preparations for thyroid therapy was levothyroxine sodium, a thyroid preparation indicated in the treatment of hypothyroidism, which was the sixth most prescribed drugs in pregnancy with a prevalence of 10% in pregnancy. No antidiabetic drug was found among the top 30 most prescribed medications during pregnancy (*Table 2*).

DISCUSSION

Between 2014 and 2017 in Italy an overall of 80.4% of women received at least one medication prescription during pregnancy period, ranging from the 83% of Puglia region to the 79,0% of Lazio region.

The prevalence of overall medication prescription throughout the study period varied by trimester and by cohort demographic characteristics, showing the same clear change pattern across all the trimesters in all the

Table 2
The most prescribed 30 medications during pregnancy: analysis by pregnancy trimester

	ATC	Drug	Pregnancy		1st TP		2nd TP		3rd TP*	
			n	%	n	%	n	%	n	%
1	B03BB01	folic acid	115,086	41.9	96,103	35.0	51,974	18.9	30,895	11.2
2	G03DA04	progesterone	61,274	22.3	49,944	18.2	20,081	7.3	7,246	2.6
3	B03AA07	ferrous sulfate	59,498	21.6	7,138	2.6	27,524	10.0	42,426	15.4
4	J01FA10	azithromycin	36,413	13.2	10,729	3.9	23,049	8.4	4,679	1.7
5	J01CR02	amoxicillin/clavulanic acid	33,689	12.3	11,270	4.1	13,418	4.9	12,910	4.7
6	H03AA01	levothyroxine sodium	27,614	10.0	15,807	5.7	20,585	7.5	18,200	6.6
7	J01XX01	fosfomycin	25,892	9.4	7,645	2.8	12,292	4.5	9,234	3.4
8	J01CA04	amoxicillin	20,279	7.4	5,706	2.1	9,610	3.5	6,797	2.5
9	R03BA01	beclometasone	18,790	6.8	5,789	2.1	8,054	2.9	6,647	2.4
10	B01AB05	enoxaparin	16,151	5.9	5,715	2.1	7,181	2.6	13,497	4.9
11	G03DA03	hydroxyprogesterone	15,809	5.8	7,157	2.6	9,029	3.3	5,419	2.0
12	B01AC06	acetylsalicylic acid	10,876	4.0	7,560	2.7	6,965	2.5	2,998	1.1
13	H02AB01	betamethasone	8,217	3.0	2,149	0.8	2,028	0.7	4,546	1.7
14	A02BX13	alginic acid	7,877	2.9	2,940	1.1	3,544	1.3	3,824	1.4
15	H02AB07	prednisone	6,874	2.5	5,290	1.9	2,423	0.9	1,625	0.6
16	J01DD08	cefixime	6,418	2.3	2,155	0.8	2,421	0.9	2,254	0.8
17	J01CA01	ampicillin	5,252	1.9	967	0.4	2,179	0.8	2,376	0.9
18	G03CA03	estradiol	5,046	1.8	5,032	1.8	292	0.1	27	0.0
19	A02AD02	magaldrate	4,979	1.8	2,148	0.8	1,738	0.6	1,824	0.7
20	B01AB06	nadroparin	4,559	1.7	2,120	0.8	2,222	0.8	3,417	1.2
21	J01FA09	clarithromycin	3,958	1.4	1,823	0.7	1,094	0.4	1,184	0.4
22	A11CC05	colecalciferol	3,890	1.4	1,819	0.7	1,728	0.6	1,690	0.6
23	M01AE03	ketoprofen	3,477	1.3	1,959	0.7	1,073	0.4	879	0.3
24	R03AC02	salbutamol	3,439	1.3	1,444	0.5	1,476	0.5	1,137	0.4
25	B03AA01	ferrous glycine sulfate	3,231	1.2	363	0.1	1,626	0.6	2,173	0.8
26	J06BB01	anti-D (rh) immunoglobulin	3,178	1.2	220	0.1	1,016	0.4	2,104	0.8
27	C08CA05	nifedipine	2,701	1.0	340	0.1	837	0.3	2,326	0.8
28	A02BC02	pantoprazole	2,601	0.9	1,756	0.6	693	0.3	701	0.3
29	C02AB01	methyldopa (levorotatory)	2,496	0.9	539	0.2	937	0.3	2,137	0.8
30	J02AC01	fluconazole	2,433	0.9	1,437	0.5	653	0.2	427	0.2

ATC: Anatomical Therapeutic Chemical Classification system.
TP: trimester during pregnancy.
*Denominator: pregnancies reaching the 3rd TP (exclusion of deliveries occurred between 20-27 weeks of gestation).

regions considered. In general, we found a more intense medication use during the 1st TP (59.1%) in all regions (Puglia: 63.7%, Emilia-Romagna: 59.6%, Lazio: 55.0%) and an increase in overall prescription rate with the maternal age until a maximum of 86.9% in pregnant women of 40 years and over (Puglia: 89.3%, Lazio: 86.9%, Emilia-Romagna: 85.1%).

The peak of prevalence in the 1st TP was mainly due to a potentially higher demand for medication treatment indicated in early pregnancy (such as iron preparations, folic acid, vitamins and progestins). The prevalence of folic acid use was very low during the preconception period (6.2%) and highest after pregnancy confirmation within the 1st TP (35.0%), probably because women do not plan their pregnancy or do not request a preconception medical visit [27] (*Figure 2*).

Although the real consumption of folic acid in this study was probably underestimated because of non-reimbursed OTC medications and vitamin supplements [28], a noteworthy low prescription rate and regional variability was found in both pre-T and 1st TP periods, showing a national and regional clinical practice far from the recommendations of national and international clinical guidelines on the prevention of neural tube defects, that recommend a daily supplementation with 0.4 mg of folic acid in women who is planning to

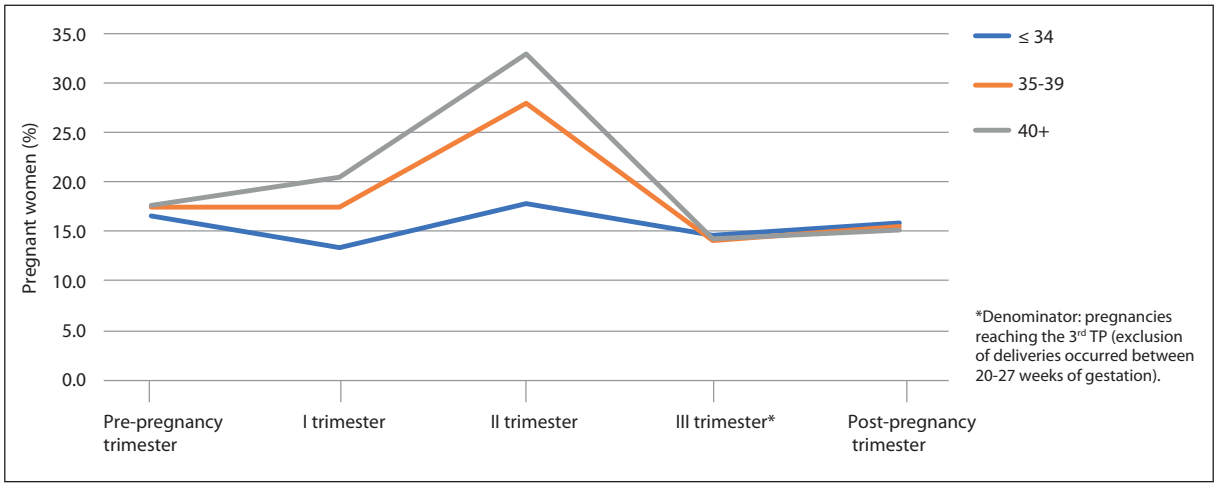

Figure 2
Prescription trends of antibiotics for systemic use before, during and after pregnancy.

become pregnant at least one month before the conception and until 12 weeks of gestation, in order to reduce the risk of neural tube defects and other congenital anomalies in their infants [21-23].

As regard to progestins, a proportion of 22.3% of women was exposed to progesterone during pregnancy, mainly concentrated in the 1st TP (18.2%), probably in an attempt to prevent an early pregnancy loss (*Figure 3*). The prescriptive trends were in line with the number of previous abortions reported in the maternal pregnancy history for all regions, even if different variations were found within each region. In particular, a high prescription prevalence of progestins were observed in Puglia region, which has almost 30% of women receiving one or more prescriptions regardless of the number of previous maternal abortions.

The use of progestins, in particular in the prevention of non-recurrent miscarriage, is worthy of attention because the appropriateness of the clinical use in terms of efficacy is still widely debated. In 2009 the World Health Organization (WHO) recommended not to prescribe progestogens for preventing miscarriages. In 2015 the American College of Obstetricians and Gynecologists (ACOG) Guideline stated that conclusive evidence supporting progestins use to avoid early pregnancy loss is lacking and that women who have experienced at least three prior pregnancy losses may benefit from progesterone therapy in the first trimester [29]. This recommendation is supported by the results of recent large randomized clinical trials, which reported no evidence of efficacy for these medications [30-32]. On the other hand, recent systematic reviews, concerning the efficacy of progesterone use in the treatment of miscarriage and in the prevention of preterm birth, suggest a probable efficacy, even in the early stages of pregnancy [33-36]. The use of progestins remains controversial and conclusive evidence supporting their use in lowering the risk of miscarriages is still lacking. The

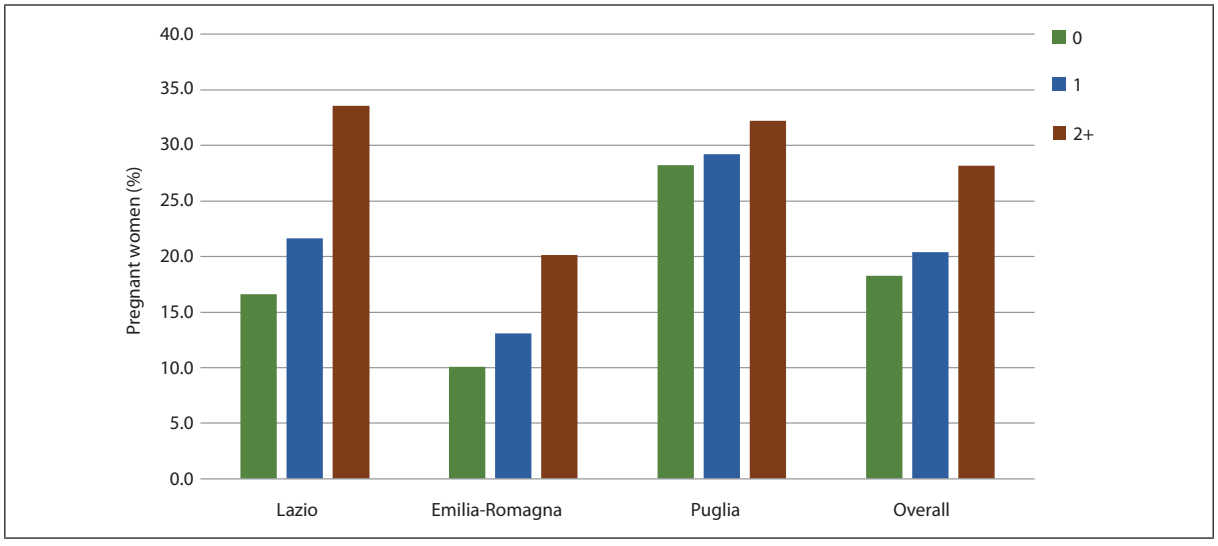

Figure 3
Progestin prescription trends during first trimester of pregnancy per region and number of previous abortions.

persistence of this inappropriate prescriptive habit in Italy makes the monitoring of medication prescriptions in this therapeutic area necessary in order to avoid inappropriate use.

In our study antimicrobials for systemic use were the second most prescribed medications during pregnancy (peak of 22,4% in the 2nd TP), even if the observed rate is lower than other European countries (27-40%) [37-40]. Given the growing problem of bacterial resistance, the use of antibiotics during pregnancy would require more attention in terms of appropriate use [41]. Therefore, there is an urgent need to understand the motivation for the peak of antibiotic prescription rate in the 2nd TP.

As regard medications for chronic diseases, regional differences were found in prescription of antidiabetics, antihypertensives and thyroid preparations, with the highest regional variability observed for antihypertensive therapy (Lazio: 33.6 per 1,000 pregnant women; Emilia-Romagna: 16.4; Puglia: 11.9) (*Table 3*).

A decrease in the rate of prevalent users of antidiabetic and antihypertensive drugs during pregnancy (in particular in the II and III trimesters) was observed in all regions. Furthermore, nearly half of the women suspended the antihypertensive therapy before pregnancy and this could be a reason of concern for the health consequences for mothers and foetus. On the contrary, new users in pregnancy increased, covering 60-80% of women who received prescriptions of these drugs during pregnancy.

The increase proportion of the new users in pregnancy for antidiabetic or antihypertensive therapy, even with regional differences, may indicate an increasing number of women firstly diagnosed at their first prenatal medical visit with a chronic disease (such as diabetes mellitus or hypertension) or an incidence of some pregnancy-related acute problems (such as gestational diabetes, hypertension or preeclampsia) [42, 43], while the proportion of new user of thyroid preparations seems to suggest an increasing number of pregnant women being diagnosed with subclinical hypothyroidism in pregnancy, requiring a thyroid hormone replacement therapy, as recommended by clinical national and international guidelines on management of thyroid disease during pregnancy and the postpartum [44, 45] (*Table 2S, available online as Supplementary material*).

Generally, the overall rate of medication prescriptions, as well as the prescription patterns, observed in our large cohort of Italian pregnant women are generally comparable with medication prescriptive trends observed in other European population-based studies [46] reporting rates of 69.2-79.1% in the Netherlands, 85.2-96% in Germany and 89.9% in French population [47-49].

The strength of our study is the availability of the medication prescription data in pregnancy from three different Italian regions, which are representative of all geographical areas (Emilia-Romagna region for the North of Italy, Lazio region for the Centre, and Puglia region for the South). Previous population-based studies conducted in Italy were limited to a single Italian region [13-16]. To our knowledge, this is the largest and most representative population-based study illustrating the medication prescription during pregnancy in Italy.

A limitation of the study is that our data were referred only to prescription of medicines reimbursed by the Italian National Health Service, excluding over-the-counter (OTC) and non-reimbursed medications (i.e. vitamin supplements), that may lead to an underestimation of medication use among the target population. On the other hand, the medication use in the real world could be over-estimated, in case the medicine is dispensed but not actually taken by the pregnant woman. Although several studies based on administrative data consider drug dispensation as a good "*proxy*" measure for medication use [50-51], it cannot be considered a direct measure of real maternal drug exposure rate.

Finally, our administrative databases do not provide information on drug use in pregnancies ended in a miscarriage or induced abortion, as well as no information on therapeutic indications for drug prescribing were

Table 3
New and prevalent users in pregnancy of antidiabetics, antihypertensives and thyroid preparations by region

During pregnancy	Antidiabetics drugs (24.1‰)			Antihypertensive drugs (21.5‰)			Thyroid preparations (101.8‰)		
n per 1,000 pregnant women									
	L	**ER**	**P**	**L**	**ER**	**P**	**L**	**ER**	**P**
New users	19.4	20.7	14.0	27.3	10.4	8.1	62.9	77.8	31.6
Prevalent users	7.2	4.1	6.6	6.2	6.0	3.8	45.5	45.0	39.5
Total	26.5	24.7	20.5	33.6	16.4	11.9	108.4	122.8	71.1
% prevalent and new users									
	L	**ER**	**P**	**L**	**ER**	**P**	**L**	**ER**	**P**
New users	73.0	83.5	68.1	81.5	63.6	68.1	58.0	63.4	44.5
Prevalent users	27.0	16.5	31.9	18.5	36.4	31.9	42.0	36.6	55.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

L: Lazio; ER: Emilia-Romagna; P: Puglia.

available, consequently we were not able to investigate the medication use patterns more in depth. On the other hand, the population-based approach together with a large cohort of pregnant women enrolled, which is geographically representative of the whole Italian context could be considered a very strong point for this study.

CONCLUSIONS

This study showed that pregnancy medication use is very common in Italy. Eight in 10 pregnant women was prescribed with at least one medication, with an increasing trend in the 1st TP, therefore recommending cautious in drug prescribing for women in the childbearing age. The evaluation and monitoring of medicine prescriptions in the preconception period, during pregnancy and after childbirth are aspects of extreme interest in term of public health.

Given the limited information on medication use during pregnancy in Italy, this study could be periodically replicated, even involving more and different regions of the country, with the objectives of monitoring some critical aspects of drug prescribing in pregnancy, as well as to detect and investigate the observed regional variability in the prescription patterns, in order to identify all the determinants of the drug prescriptions, also in terms of appropriateness of use [52].

Authors' contributions

All the authors contributed to the study conception and design. VB, FRP, AP, VS and PS performed data collection and analysis. VB coordinated the analysis and prepared the final version of tables and figures included in the manuscript. FF drafted the first version of the manuscript. RB contributed to interpretation of data. All authors read, commented, revised and approved the final version of the manuscript.

Conflict of interest

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