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Trabajo Original

Epidemiología y dietética

Prevalence of anaemia, risk of haemoconcentration and risk factors during the three trimesters of pregnancy

Prevalencia de anemia y riesgo de hemoconcentración durante los 3 trimestres de embarazo y factores de riesgo

Blanca Ribot[1], Francisco Ruiz-Díez[2], Susana Abajo[2], Gemma March[2], Francesc Fargas[2] and Victoria Arija[1,3,4]

[1]Faculty of Medicine and Health Sciences. Universitat Rovira i Virgili. Tarragona, Spain. [2]Servei d'Atenció a la Salut Sexual i Reproductiva (ASSIR) de Tarragona-Reus. Institut Català de la Salut. Catalunya, Spain. [3]Unitat de Suport a la Recerca Tarragona-Reus. Institut Universitari d'Investigació en Atenció Primària Jordi Gol (IDIAP Jordi Gol). Barcelona. Institut Català de la Salut. Catalunya, Spain. [4]Institut d'Investigació Sanitària Pere Virgili (IISPV). Universitat Rovira i Virgili. Reus, Tarragona. Spain

Abstract

Objective: To evaluate the prevalence of anaemia and the risk of haemoconcentration and its risk factors during all 3 trimesters of pregnancy in women in a Mediterranean area in the south of Europe.

Material and methods: Longitudinal study of 11,259 women whose pregnancies were monitored at primary care centres between 2007 and 2012. The computerised clinical histories of all the pregnancies were used to collect haemoglobin (Hb) data for each trimester. The histories also provided information on the age of the mother, her socioeconomic status, the presence of obesity, tobacco use, type of pregnancy, and number of previous pregnancies and births. Anaemia was defined as Hb < 110 g/L in the 1st and 3rd trimesters of pregnancy and Hb < 105 g/L in the second. The risk of haemoconcentration was defined as Hb > 130 g/L in the 2nd and 3rd trimesters of pregnancy.

Results: The prevalence of anaemia increased from 3.8% in the first trimester to 21.5% in the 3rd trimester. Around 10% of the women had Hb > 130 g/L during the 3rd trimester. Having children previously and/or being younger than 20 increased the chances of anaemia (Adj. OR: 1.4; 95% CI: 1.1-1.9), but being older than 34 increased the chances of Hb > 130 g/L (Adj. OR: 1.3; 95% CI: 1.1-1.5).

Conclusion: The increased prevalence of anaemia is a moderate public health problem. Understanding the factors that influence these problems may help improve the guidelines regarding the use of iron supplements.

Key words:

Risk of haemoconcentration. Anaemia. Risk factors. Prevalence. Pregnancy.

Resumen

Objetivo: valorar la prevalencia de anemia y de riesgo de hemoconcentración y sus factores de riesgo durante los 3 trimestres de embarazo en las mujeres de una zona mediterránea del sur de Europa.

Material y métodos: estudio longitudinal con 11.259 mujeres que realizaron el seguimiento de su embarazo en centros de atención primaria entre el 2007 y 2012. A partir de la historia clínica informatizada se recogieron datos de hemoglobina (Hb) de cada trimestre de gestación, edad de la madre, bajo nivel socioeconómico, presencia de obesidad, hábito tabáquico, tipo de embarazo, número de embarazos y partos previos. Se definió anemia como Hb < 110 g/L para el 1er y 3er trimestre de gestación y como Hb < 105 g/L para el 2º trimestre. Se definió riesgo de hemoconcentración a Hb > 130 g/L en el 2º y 3er trimestre.

Resultados: la prevalencia de anemia aumentó del 3.8% en el primer trimestre al 21.5% en el 3er trimestre. Alrededor de un 10% de las mujeres tuvieron Hb > 130 g/L en el 3er trimestre. Tener hijos previos y/o ser menor de 20 años predispone a tener anemia (adj. OR: 1.4; 95% CI: 1.1-1.9), pero tener más de 34 años predispone a Hb > 130 g/L (adj. OR: 1.3; 95% CI: 1.1-1.5).

Conclusión: la elevada prevalencia de anemia supone un problema moderado de salud pública. El conocimiento de los factores que pueden influir en dichas prevalencias puede ayudar a adaptar mejor la pauta de suplementación con hierro.

Palabras clave:

Riesgo de hemoconcentración. Anemia. Factores de riesgo. Prevalencia. Embarazo.

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Correspondence:

Victoria Arija. Primary Health Center Sant Père. Camí de Riudoms, 53-55. 43202 Reus, Tarragona. Spain
e-mail: victoria.arija@urv.cat

INTRODUCTION

The World Health Organisation estimates that around 38.2% of pregnant women around the world have anaemia, although the percentage is lower in industrialised regions such as Europe, where it is between 18.7-25.8% (1,2). In the case of Spain, the few studies to have been conducted indicates a rate of about 15-25% (1,3). The negative effect that these high levels can have on the health of both mother and child mean that this pathology is a public health problem.

At the other extreme are high levels of haemoglobin, thus frequently giving the false impression of healthy iron levels and hiding the fact that the plasma volume is increasing a lower rate than expected. This condition affects between 8.7% and 42% of pregnant women in developed countries (4), it is also related to serious problems for both mother and child such as increased risk of pre-eclampsia, premature birth and low birth weight (5-7). Despite these risks, only one study has been conducted on women in southern Europe; this study found a rate of 13% among women in the third trimester of pregnancy (3).

Both conditions, anaemia and haemoconcentration, vary in their prevalence depending on the trimester of pregnancy and may also be influenced by socio-demographic characteristics such as the mother's age (8,9), the number of children she has had previously (8), the length of time between pregnancies (10), multiple pregnancies (11), the ingestion of iron supplements during pregnancy (10,12), socioeconomic status, illiteracy, obesity and even the mother's origins (8,11,13,14).

In the light of these considerations, we decided to evaluate a broad sample of the population to determine the prevalence of anaemia, the risk of haemoconcentration and the associated risk factors during the 3 trimesters of pregnancy in women from the Mediterranean area of southern Europe.

MATERIALS AND METHODS

Longitudinal study of all the women whose pregnancies were monitored by the Sexual and Reproductive Health Care Service (ASSIR) in Tarragona and Reus (Spain), between 2007 and 2012.

The ASSIR is part of the Catalan Health Institute (ICS) and is a support service provided by specialists whose aim is to promote and coordinate comprehensive sexual and reproductive healthcare for pregnant women. The service belongs to the Catalan public health network and it provides services to almost all women.

The ICS began to computerise the clinical records of its patients in 2006 by assigning each one a Personal Identification Code (PIC). Furthermore, pregnant women are assigned a unique identification code for each pregnancy so that each can be monitored individually.

The ICS recommends that non-anaemic pregnant women take a daily dose of 40 mg of iron from the start of the second trimester. For pregnant women with anaemia, this is increased to 80 mg of iron 1 or 2 times a day depending on the severity of the condition.

Our study includes all the pregnant women monitored by the ASSIR between 2007 and 2012. Fasting blood samples were extracted at the primary care centers between 8 a.m. and 9 a.m. by the primary care nurses and transported on ice to the central laboratory for analyses in as short a time-lapse as possible. The complete hematological profile was performed using Coulter autoanalyser.

In total the study analysed the blood of 11,259 women: 9,488 were analysed in the first trimester, 9,411 in the second, and 9,433 in the third. Seven thousand and six hundred women were analysed in all three trimesters of pregnancy.

DATA COLLECTION

The computerised clinical histories of each pregnancy were used to collect data on the age of the mother, socioeconomic status, the presence of obesity, tobacco use during pregnancy, the type of pregnancy (simple or multiple) and the number of previous pregnancies and births. However, there were no data on the extent to which the women complied with the recommendations regarding the use of iron supplements.

Routine blood analyses provided data on the women's haemoglobin levels during each trimester.

DEFINITION OF ANAEMIA AND RISK OF HAEMOCONCENTRATION

Anaemia was defined as Hb < 110 g/L in the 1st and 3rd trimesters and Hb < 1,05 g/L in the second (15).

The risk of haemoconcentration was defined as Hb > 130 g/L in the 2nd and 3rd trimesters (4).

STATISTICAL ANALYSES

Statistical analyses were carried out using the SPSS Statistics software package version 20.0. The variables were distributed in a standard manner and are presented as the mean and the standard deviation (SD). The qualitative variables are presented as percentages.

Pearson's chi-squared test was used to compare the categorical variables.

Dummy variables were created for different age groups of women so that each age group could be compared with the intermediate age group (20-34 years). Dummy variables were also created for women who had had children previously in order to compare them with first-time mothers.

The magnitude of association between the different risk factors for anaemia (independent variables) and anaemia (dependent variable) was evaluated by means of multiple logistical regression for each trimester, adjusting for: age of the mother (< 20 years, 20-34 years (reference group), > 34 years), parity (first time mother (reference group), 1-2 children, > 3 children); multiple

pregnancy (no, yes); low socioeconomic level (no, yes); obesity (no, yes); tobacco use (no, yes).

The same regression was repeated for haemoconcentration risk.

In all cases the level of significance was set at $p < 0.05$.

RESULTS

Were monitored 13,185 pregnant women by the ASSIR in Tarragona and Reus between 2007 and 2012. Of these, 11,259 underwent blood analyses (Table I). Of the 1,926 women who did not undergo blood analyses, 381 had miscarriages. The remainder (1,545 pregnant women) presented few differences with respect to the women who underwent blood analyses, the main differences being a larger percentage of first-time mothers (47% *vs.* 43%) and a lower number with obesity (10% *vs.* 13%).

Of the 11,259 who underwent blood tests, 67.5% (n = 7,600) did so during all three trimesters. Sixteen point six per cent of the women did not undergo blood tests in each trimester due to miscarriage or premature birth. Apart from the miscarriages and the number of women with more than two previous births (8.8% *vs.* 4.0%), there are no significant differences between those women who had blood tests in each trimester and those who did not.

Table I shows the main characteristics of the pregnant women with Hb measured at least in one trimester and of pregnant women with Hb measured at every trimester. The average age was 29.7 years with a range from 13 to 48 years, of whom 22% were smokers and 12.8% were obese. Around 43% of the women were expecting their first child and 0.8% had more than four children (data not shown in the table).The mean average of haemoglobin levels is above the cut-off point of anaemia in all the trimesters.

Table II shows that the prevalence of anaemia was higher in the second ($p = 0.040$) and third trimesters ($p = 0.001$) among the women aged below 20 compared with the older women. The women who smoked have significantly lower levels of anaemia than the non-smokers ($p = < 0.001$ in the second trimester and $p = 0.009$ in the third); likewise the women with more than three children previously present significantly higher levels of anaemia ($p = < 0.001$). In contrast, the risk of haemoconcentration is significantly higher in the third trimester among those women expecting their first child than it is among those who have had children previously ($p = 0.019$).

Tables III and IV show the risk of anaemia and the risk factors of haemoconcentration during each trimester in relation to the different risk factors. Being over 35 years is a protective factor against anaemia, but it also increases the risk of haemoconcentration. Low socioeconomic status seems to have no effect on anaemia or on the risk of haemoconcentration. However, both obesity and tobacco use are associated with a lower risk of anaemia.

In contrast, having had children previously increases the risk of anaemia, and the risk increases with the number of children.

Table I. General and haematological characteristics of the pregnant women

	Mothers with Hb measured in at least one trimester (n = 11,259)		Mothers with Hb measured at every trimester (n = 7,600)	
	Mean ± SD or n (%)	**% of data missing**	**Mean ± SD or n (%)**	**% of data missing**
Age of mother (years):	29.7 ± 5.7	-	30.0 ± 5.4	-
< 20	465 (4.1%)	-	256 (3.4%)	-
20-34	8,443 (75.0%)	-	5,762 (75.8%)	-
≥ 35	2,351 (20.8%)	-	1,582 (20.8%)	-
Obesity	1,438 (12.8%)	-	930 (12.2%)	-
Low socioeconomic status	200 (1.8%)	-	106 (1.4%)	-
Multiple pregnancy	63 (0.6%)	5.9%	47 (0.4%)	1.1%
Previous births (n)	0.8 ± 1.0	1.5%	0.8 ± 0.9	1.1%
First-time mother:	4,813 (42.7%)	1.5%	3,308 (44.0%)	-
1-2	5,664 (50.3%)	1.5%	3,907 (52%)	-
≥ 3	616 (5.6%)	1.5%	303 (4%)	-
Previous pregnancies (n)	2.2 ± 1.3	1.5%	2.2 ± 1.2	1.1%
Smoker	2,325 (22.0%)	6.1%	1,717 (23.4%)	3.5%
Haemoglobin (g/L):				
1st Trimester	126.3 ± 9.1	18.4%	126.3 ± 9.0	-
2nd Trimester	114.1 ± 8.9	16.4%	114.1 ± 8.7	-
3rd Trimester	117.0 ± 10.0	16.1%	117.4 ± 9.8	-

Table II. Prevalence of anaemia and risk of haemoconcentration in the 3 trimesters of pregnancy in relation to risk factors

	Anaemia						Risk of haemoconcentration			
	1T		2T		3T		2T		3T	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Overall presence	3.8	3.4-4.2	13.1	12.7-14.1	21.5	20.7-22.3	5.8	5.3-6.3	9.9	9.3-10.5
Age of mother (years):										
< 20	4.8 [a]	2.5-7.7	16.7 [a]	12.9-20.5	28.5 [a]	24.1-32.9	2.2 [a]	0.7-3.7	5.3 [a]	3.1-7.5
20-34	3.7 [a]	3.3-4.1	12.9 [b]	12.1-13.7	21.7 [b]	20.7-22.7	3.4 [a]	3.0-3.8	9.9 [b]	9.2-10.6
≥ 35	4.1 [a]	3.2-5.0	13.2 [b]	11.7-14.7	19.7 [c]	17.9-21.5	2.9 [a]	2.2-3.6	10.8 [b]	9.4-12.2
Low socioeconomic status:										
No	3.8 [a]	3.4-4.2	13.0 [a]	12.3-13.7	21.4 [a]	20.6-22.2	3.3 [a]	2.9-3.7	10.0 [a]	9.4-10.6
Yes	6.5 [a]	2.4-10.6	14.6 [a]	9.1-2.1	28.7 [b]	22.0-35.4	1.3 [a]	0.0-3.1	6.9 [a]	3.1-10.7
Obesity:										
No	3.9 [a]	3.5-4.3	13.5 [a]	12.8-14.2	21.5 [a]	20.6-22.4	3.0 [a]	2.6-3.4	10.1 [a]	9.5-10.7
Yes	3.4 [a]	2.4-4.4	9.9 [b]	8.2-11.6	21.5 [a]	19.1-23.9	5.2 [a]	3.9-6.5	8.8 [a]	7.2-10.4
Smoker:										
No	4.1 [a]	3.6-4.6	13.7 [a]	12.9-14.5	22.3 [a]	21.3-23.3	3.1 [a]	2.7-3.5	10.0 [a]	9.3-10.7
Yes	2.5 [b]	1.8-3.2	10.5 [a]	9.2-10.5	19.5 [b]	17.7-21.3	3.8 [b]	3.0-4.6	9.6 [a]	8.3-10.9
Parity (number of children):										
First-time mother	3.0 [a]	2.5-3.5	12.8 [a]	11.8-13.8	17.5 [a]	16.3-18.7	3.9 [a]	3.3-4.5	12.8 [a]	11.8-13.8
1-2	4.1 [b]	3.5-4.7	12.7 [a]	11.8-13.6	24.1 [b]	22.9-25.3	2.9 [b]	2.4-3.4	7.7 [b]	6.9-8.5
≥ 3	7.9 [c]	5.4-10.4	18.4 [b]	15.0-21.8	29.0 [c]	25.0-33.0	2.5 [a,b]	1.1-3.9	6.7 [b]	4.5-8.9
Type of pregnancy:										
Single	3.7 [a]	3.3-4.1	12.7 [a]	12.0-13.4	21.6 [a]	20.8-22.4	3.2 [a]	2.8-3.6	9.8 [a]	9.2-10.4
Multiple	5.5 [a]	0.0-11.5	27.1 [b]	15.8-38.4	18.9 [a]	8.4-29.4	1.7 [a]	0.0-5.0	13.2 [a]	4.1-22.3

Anaemia: Hb < 110 g/L in 1st and 3rd trimester and Hb < 105 g/L in the 2nd trimester; risk of haemoconcentration: Hb > 130 g/L in 2nd and 3rd trimester.
[a,b,c]Mean values within the same column with a different letter in superscript indicates that they are significantly different (p < 0.05).

Women with multiple pregnancies are predisposed to presenting with anaemia, although this finding only appears in the second trimester.

DISCUSSION

The present study shows that in addition to the increased presence of anaemia as pregnancy advances, the risk of haemoconcentration is also a problem for public health and affects around 10% of women in the final stages of pregnancy. This percentage raises the importance of studying the real risks of high haemoglobin levels on the health of both mother and child. Furthermore, it has been seen that under the age of 20 or having had children previously can increase the chances of anaemia and that being over the age of 34 increases the risk of haemoconcentration.

The pregnant women in the study were all of the women attended by the ASSIR service, which is a public health network used, according to the Agència de Salut Pública (Catalan Public Health Agency), by about 70% of pregnant women in Catalonia (16). Both the age of the women and the number of previous births is similar to that recorded in the overall population of Catalonia (16), although the percentage of multiple births is slightly lower than the overall Catalan population (0.6% *vs.* 4.2%) (16) possibly because

Table III. Multiple logistical regression of the principal risk factors for anaemia*

	Women with Hb measured at least in one trimester (n = 10,596)		Women with Hb measured at every trimester (n = 7,517)	
	OR (95% CI)	Adj. OR (95% CI)	OR (95% CI)	Adj. OR (95% CI)
1st Trimester				
Age of mother (years):				
20-34	1	1	1	1
< 20	1.4 (0.7-2.6)	1.5 (0.8-2.9)	1.5 (0.7-3.1)	1.7 (0.8-3.6)
≥ 35	0.7 (0.6-0.9)	0.7 (0.5-0.9)	0.8 (0.7-1.1)	0.7 (0.6-0.9)
Low socioeconomic status (no, yes)	1.9 (0.9-3.7)	1.7 (0.8-3.4)	1.6 (0.7-3.7)	1.4 (0.6-3.4)
Obesity (no, yes)	0.9 (0.7-1.3)	0.7 (0.5-1.0)	0.9 (0.6-1.3)	0.7 (0.5-1.1)
Smoker (no, yes)	1.1 (0.9-1.4)	0.7 (0.5-0.9)	0.7 (0.5-0.9)	0.7 (0.5-0.9)
Parity (number of children):				
First-time mother	1	1	1	1
1-2	1.3 (1.0-1.6)	1.3 (1.0-1.7)	1.4 (1.1-1.8)	1.5 (1.1-1.9)
≥ 3	2.6 (1.7-3.9)	3.1 (1.9-4.9)	3.2 (2.1-5.1)	4.1 (2.5-6.8)
Multiple pregnancy (no, yes)	1.5 (0.4-4.9)	2.7 (0.8-8.7)	1.8 (0.6-5.9)	3.0 (0.9-9.8)
2nd Trimester				
Age of mother (years):				
20-34	1	1	1	1
< 20	1.2 (0.8-1.7)	1.1 (0.8-1.7)	1.4 (0.9-2.2)	1.3 (0.9-2.1)
≥ 35	0.8 (0.7-0.9)	0.7 (0.6-0.8)	0.8 (0.7-0.9)	0.7 (0.6-0.9)
Low socioeconomic status (no, yes)	1.2 (0.8-1.8)	1.0 (0.6-1.7)	1.3 (0.8-2.3)	1.2 (0.7-2.1)
Obesity (no, yes)	0.7 (0.6-0.9)	0.6 (0.5-0.8)	0.7 (0.5-0.9)	0.6 (0.5-0.8)
Smoker (no, yes)	0.7 (0.6-0.9)	0.7 (0.6-0.9)	0.7 (0.6-0.9)	0.7 (0.6-0.8)
Parity (number of children):				
First-time mother	1	1	1	1
1-2	1.0 (0.9-1.1)	1.0 (0.9-1.2)	1.0 (0.9-1.2)	1.1 (0.9-1.3)
≥ 3	1.6 (1.2-2.0)	1.7 (1.3-2.3)	1.4 (1.1-2.0)	1.6 (1.1-2.4)
Multiple pregnancy (no, yes)	2.6 (1.5-4.6)	2.7 (1.4-5.4)	2.4 (1.2-4.7)	2.6 (1.2-5.5)
3rd Trimester				
Age of mother (years):				
20-34	1	1	1	1
< 20	1.3 (0.9-1.7)	1.4 (1.1-1.9)	1.5 (1.1-2.2)	1.7 (1.2-2.5)
≥ 35	0.7 (0.7-0.8)	0.7 (0.6-0.8)	0.7 (0.7-0.8)	0.7 (0.6-0.8)
Low socioeconomic status (no, yes)	1.5 (1.1-2.1)	1.3 (0.9-1.8)	1.6 (1.0-2.4)	1.4 (0.9-2.2)
Obesity (no, yes)	1.0 (0.8-1.1)	0.9 (0.8-1.1)	0.9 (0.8-1.1)	0.9 (0.7-1.1)
Smoker (no, yes)	0.8 (0.7-0.9)	0.8 (0.7-0.9)	0.9 (0.8-0.9)	0.9 (0.7-0.9)
Parity (number of children):				
First-time mother	1	1	1	1
1-2	1.5 (1.3-1.7)	1.6 (1.5-1.8)	1.5 (1.3-1.7)	1.7 (1.5-1.9)
≥ 3	1.9 (1.5-2.4)	2.2 (1.7-2.8)	1.9 (1.5-2.6)	2.4 (1.8-3.3)
Multiple pregnancy (no, yes)	0.8 (0.4-1.7)	0.8 (0.3-2.0)	0.5 (0.2-1.2)	0.8 (0.3-1.9)

**Anaemia: Hb < 110 g/L in the 1st and 3rd trimester and Hb < 105 g/L in the 2nd trimester.*
Adj. OR: adjusted Odds ratio. Adjusted for age of the mother (< 20 years, 20-34 years [reference group], > 34 years).

Table IV. Multiple logistical regression of the principal risk factors for haemoconcentration*

	Women with Hb measured at least in one trimester (n = 10,596)		Women with Hb measured at every trimester (n = 7,517)	
	OR (95% CI)	Adj. OR (95% CI)	OR (95% CI)	Adj. OR (95% CI)
2nd Trimester				
Age of mother (years):				
20-34	1	1	1	1
< 20	0.9 (0.4-1.9)	0.8 (0.4-2.0)	0.4 (0.1-1.7)	0.4 (0.1-1.7)
≥ 35	0.8 (0.7-1.1)	0.9 (0.7-.1.1)	0.8 (0.6-1.1)	0.9 (0.7-1.2)
Low socioeconomic status (no, yes)	0.4 (0.1-1.5)	0.4 (0.1-1.6)	No cases	No cases
Obesity (no, yes)	1.8 (1.3-2.4)	1.8 (1.3-2.5)	1.9 (1.4-2.7)	2.1 (1.5-3.0)
Smoker (no, yes)	1.2 (0.9-1.6)	1.1 (0.8-1.4)	1.2 (0.9-1.6)	0.9 (0.7-1.3)
Parity (number of children):				
First-time mother	1	1	1	1
1-2	0.7 (0.6-0.9)	0.7 (0.6-0.9)	0.7 (0.5-0.9)	0.6 (0.5-0.9)
≥ 3	0.6 (0.3-1.1)	0.6 (0.3-1.1)	0.3 (0.1-0.9)	0.3 (0.1-0.9)
Multiple pregnancy (no, yes)	0.5 (0.1-3.7)	0.7 (0.1-5.1)	No cases	No cases
3rd Trimester				
Age of mother (years):				
20-34	1	1	1	1
< 20	0.8 (0.5-1.4)	0.7 (0.4-1.2)	0.5 (0.2-1.1)	0.4 (0.2-0.9)
≥ 35	1.1 (0.9-1.3)	1.3 (1.1-1.5)	1.1 (0.9-1.3)	1.3 (1.1-1.5)
Low socioeconomic status (no, yes)	0.7 (0.4-1.2)	0.7 (0.4-1.4)	0.7 (0.3-1.5)	0.8 (0.6-1.1)
Obesity (no, yes)	0.9 (07.7-1.1)	0.9 (0.7-1.2)	0.8 (0.6-1.0)	0.8 (0.6-1.1)
Smoker (no, yes)	0.9 (0.8-1.1)	0.9 (0.7-1.1)	0.9 (0.8-1.1)	0.9 (0.7-1.0)
Parity (number of children)				
First-time mother:	1	1	1	1
1-2	0.6 (0.5-0.7)	0.5 (0.4-0.6)	0.6 (0.5-0.7)	0.5 (0.5-0.6)
≥ 3	0.5 (0.3-0.7)	0.4 (0.2-0.6)	0.6 (0.4-0.9)	0.5 (0.3-0.8)
Multiple pregnancy (no, yes)	1.4 (0.6-3.1)	1.2 (0.5-3.0)	1.3 (0.5-3.0)	0.9 (0.3-2.7)

**Risk of haemoconcentration: Hb >130 g/L in the 2nd and 3rd trimester.*
Adj. OR: adjusted Odds ratio. Adjusted for age of the mother (< 20 years, 20-34 years [reference group], > 34 years).

higher-risk pregnancies are referred to specialised centres or are monitored by private clinics. This is a possible limitation to the study; however, we have compared the women who were monitored throughout their pregnancies with those who were referred to other centres and clinics and we have found no differences between the groups in terms of risk factors for anaemia or risk of haemoconcentration.

The ASSIR service carries out regular blood tests of all pregnant women during each trimester, regardless of whether they are suspected of having an iron deficiency, which means that the levels of anaemia have been accurately determined. All the blood samples were analysed at the Camp de Tarragona Clinical Laboratory, which is the leading laboratory in the province of Tarragona and which complies with the International Standard ISO 9001:2000. Anaemia was determined by taking in account the different degrees of haemodilution in each trimester of pregnancy (15).

The vast majority of cases of anaemia are caused by iron deficiency (17). For this reason, the ASSIR recommends regular 40 mg iron supplements from the second trimester for all pregnant women without anaemia and iron supplements of 80 mg, 1 or 2 times a day for those who do have anaemia. This ensures that the iron supplements fully meet the needs of each pregnant woman.

The levels of anaemia found in the present study are similar to those found across Europe by the World Health Organisation (1)

and also to those found by other European studies (17,18), which confirms that iron deficiency is high, even in developed countries. However, both Stevens et al. and the WHO state that their data only show the mean values for the entire pregnancy, which made it impossible for those studies to observe how the level of anaemia increased, an aspect that we have improved in the present study.

By the same token, there is little information regarding the prevalence of high levels of haemoglobin during pregnancy in Europe. A recent study conducted in Holland estimates that around 15% of the women analysed had excessive haemoglobin levels (19), which is a similar figure to that found in southern Europe by our own research group (3).

In addition to already well-documented effects of anaemia on the health of mother and child (5,12), more recently, evidence has also been emerging regarding the harmful effects of high haemoglobin levels during pregnancy, including increased oxidative stress and preeclampsia in the mother (6,20) and the increased likelihood of premature birth and low birthweight (5,6), although more studies are needed to confirm these findings. It is important to understand the risk factors in specific populations for both anaemia and haemoconcentration because some risk factors can be more significant depending on the population type (8,19). Our results indicate that being under the age of 20 and previously having had children increases the likelihood of anaemia, whereas being over the age of 34 increases the chances of having haemoconcentration.

With regard to the age of the mother, it is well known that women under the age of 20 are at greater risk of presenting with anaemia during pregnancy because they are still growing themselves (8,19). In contrast, as other authors have found, we observed that the risk of anaemia decreased as the women got older, with the lowest risk being found in pregnant women over the age of 34 (8,9). However, pregnant women over 34 were around 30% more likely to develop haemoconcentration than younger women. As far as we know, only two other studies have looked this relationship and neither one was able to establish a connection (19,21). One of the studies was carried out by our research group and described the risk factors associated with the risk of haemoconcentration in a sample of 217 women (21). However, the sample was not large enough to study this effect in different age groups. It is not known by which mechanism age may be related to the risk of haemoconcentration.

With regard to previous children, the general finding seems to be that the more children a woman has had previously, the greater the risk of presenting with anaemia (8,19,22) and, consequently, the lower the risk of haemoconcentration (19). This may be because the more pregnancies a woman has, the shorter the period between each one, which in turn limits the time she has to recover her iron levels.

Another factor that may increase the chances of anaemia is low socioeconomic status (14,23) because this may lead to poor diet due to lack of financial resources. However, in our sample we found no relation between low socioeconomic status and anaemia, thus coinciding with Gaillard et al., who also found no such relation during the third trimester of pregnancy in a sample of European women. This may be because levels of malnutrition in developed countries are not as high as in developing countries and because the widespread use of iron supplements may correct iron deficiency in women with low socioeconomic status.

The body mass index of pregnant women is also associated with anaemia (24). In the present study, as in other studies, we observed that obese women were less likely to have anaemia, although this was not statistically significant in any trimester (24,25) and that they were more likely to have haemoconcentration (19).

According to our results, tobacco use seemed to reduce anaemia; however, this is an inaccurate finding because although smokers present higher levels of haemoglobin, this is nether functional nor does it transport iron because it is joined with carbon monoxide (26). Consequently, in addition to the already established negative health effects of smoking, tobacco use may also hide an iron deficiency because of the increased levels of non-functional haemoglobin, which in turn may mean that a pregnant woman is not treated with the correct dose of iron supplements.

One of the limitations to our study is that the data are from computerised clinical histories and that we have been unable to evaluate risk factors such as the time between births. Some authors assert that when this is less than two years, women do not have time to recover their iron reserves (10,22).

To conclude, the present study confirms that around 1 in 5 women reach the third trimester of pregnancy with anaemia and around 10% have the risk of haemoconcentration. Risk factors for anaemia and the risk of haemoconcentration are the age of the mother and the number of previous children. Tobacco use may hide a possible iron deficiency.

Understanding these risk factors highlights the need to implement health policies that focus more on risk groups in order to treat both insufficient and excessive iron levels during pregnancy and to adapt iron supplements accordingly.

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