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Original article

## Relationship between patients' month of birth and the prevalence of chronic diseases<sup>☆</sup>

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## ARTICLE INFO

## Article history:

Received 17 June 2016

Accepted 20 October 2016

Available online xxx

## Keywords:

Chronic diseases

Month of birth

Prevalence

## ABSTRACT

**Background and objectives:** Patients' month of birth can reflect exposure to certain factors during pregnancy and the first few months of life, which could influence the onset of chronic diseases during adulthood. The aim of this study is to evaluate the association between a patient's month of birth and the presence of chronic diseases in the Spanish population, by analysing the National Health Survey for the year 2006.

**Patients and methods:** We measured the association between 27 common chronic diseases and the month of birth, estimating the odds ratios and confidence intervals at 95%, using multivariate logistical models and adjusting the results for month of birth and potentially confounding variables.

**Results:** The sample population was made up of a total of 29,478 individuals, representing approximately 44.7 million Spanish residents on 1 January 2007. Significant associations were found between the month of birth and several chronic diseases. There is a gender-differentiated risk pattern of developing chronic diseases according to the month of birth, with more significant associations and of greater magnitude being detected among men compared to women.

**Conclusions:** The associations detected might reflect early exposure to environmental factors in the uterus and during the first few months of life. More specific studies are required to gain a more in-depth understanding of these associations.

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### Relación entre el mes de nacimiento y la prevalencia de enfermedades crónicas

## RESUMEN

**Antecedentes y objetivos:** El mes de nacimiento puede reflejar exposiciones a factores durante el embarazo y en los primeros meses de vida que pueden influir en la aparición de enfermedades crónicas en edades adultas. Se pretende evaluar la asociación entre el mes de nacimiento y la presencia de enfermedades crónicas en la población española, analizando la Encuesta Nacional de Salud del año 2006.

**Pacientes y métodos:** Se ha medido la asociación entre 27 enfermedades crónicas comunes con el mes de nacimiento mediante la estimación de *odds ratios* e intervalos de confianza al 95%, con modelos logísticos multivariantes, ajustando el mes de nacimiento y variables potencialmente confusoras.

**Resultados:** El tamaño muestral fue de 29.478 personas, que representaron aproximadamente a 44.7 millones de españoles residentes a 1 de enero de 2007. Se han encontrado asociaciones significativas entre el mes de nacimiento y tener diversas enfermedades crónicas. Hay un patrón de riesgo de presentar enfermedades crónicas según el mes de nacimiento diferenciado por sexos, detectándose más asociaciones significativas y con mayor magnitud en varones que en mujeres.

**Conclusiones:** Las asociaciones detectadas pueden reflejar exposiciones tempranas en el útero y en los primeros meses de vida a factores medioambientales. Son necesarios estudios más específicos para ahondar en estas asociaciones.

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## Palabras clave:

Enfermedades crónicas

Mes de nacimiento

Prevalencia

<sup>☆</sup> Please cite this article as: Quesada JA, Nolasco A. Relación entre el mes de nacimiento y la prevalencia de enfermedades crónicas. Med Clin (Barc). 2017. <http://dx.doi.org/10.1016/j.medcli.2016.10.035>

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## Introduction

The seasonal characteristic of birth has been related to different diseases and health problems, which are manifested both in the early ages and in the adulthood. The month of birth may reflect exposure to various factors during pregnancy and first months of life, which may influence various diseases and health problems in adulthood.

Several studies have linked the month of birth with different autoimmune diseases, such as Crohn's disease at an early age in Danish population,<sup>1</sup> multiple sclerosis in Kuwait,<sup>2</sup> diseases such as rheumatoid arthritis, Crohn's disease, ulcerative colitis and systemic lupus erythematosus in addition to multiple sclerosis in UK,<sup>3</sup> type 1 diabetes in the USA and celiac disease in Italy.<sup>5</sup>

In other studies the month of birth has been associated with various tumors, such as brain tumor in adults in the USA,<sup>6</sup> Hodgkin's lymphoma in the Danish population under 20 years of age,<sup>7</sup> breast tumor in Norwegian women,<sup>8</sup> leukemia, Hodgkin's lymphoma and central nervous system tumors in youngsters in the UK<sup>9</sup> or skin cancer in Italy.<sup>10</sup>

Month of birth has been associated with neurological diseases such as schizophrenia, Alzheimer's disease and epilepsy in the United States,<sup>11</sup> and with schizophrenia in Denmark.<sup>12</sup>

The month of birth has also been associated with breathing problems in Australian schoolchildren,<sup>13</sup> respiratory infections in children under one year of age in the USA<sup>14</sup> or bronchial asthma in children in Taiwan.<sup>15</sup>

In other studies it has been associated with reproductive capacity and fertility.<sup>16,17</sup> Recently, Boland et al. reported new associations between the month of birth and diseases of various types not found to date, such as cardiovascular conditions, early development and vitamin D deficiency.<sup>18</sup> It has also been related to physical measures in Chinese adults, such as body mass index (BMI) and waist circumference.<sup>19</sup>

Some studies the month of birth is associated with mortality characteristics, such as in Salib and Cortina-Borja's study, who studied the risk of suicide in England and Wales,<sup>20</sup> the risk of cardiovascular mortality in Lithuania,<sup>21</sup> life expectancy in Denmark<sup>22</sup> and longevity in USA.<sup>23</sup>

These authors have proposed several explanations for these associations. For example, early exposure to environmental factors during pregnancy and in the first months of life may influence the development of certain diseases in adults, as is the case of seasonality of infections as a risk factor for developing autoimmune diseases, early exposures to ultraviolet radiation, or for influencing life expectancy and longevity through associations with cardiovascular disease.

The potential influence of environmental and sociodemographic factors during pregnancy and in the first months of life, so that they can condition the development of certain diseases in adults, justifies the analysis of these potential associations in different environmental conditions of different geographic areas.

In Spain very few studies have been found that relate the month of birth with health problems. One of them is a study that related the height of adult males with the month of birth,<sup>24</sup> associating the potential effect of environmental factors in the early stages of life. Month of birth has also been associated with allergy problems.<sup>25</sup> However, Vellisca et al. reported no association between the month of birth and anorexia nervosa.<sup>26</sup>

Given the low number of studies on this issue in Spain, the aim of this study is to evaluate the association between the month of birth and chronic diseases and long-term health problems in the Spanish population, based on the data provided from the National Health Survey (NHS) for the year 2006.<sup>27</sup>

## Methods

Descriptive cross-sectional study to analyze the relationship between NHS responses in 2006 in Spanish population over 16 years of age, on chronic diseases and health problems, and the seasonality of the respondent's month of birth.

We chose the NHS of year 2006 because its data helped to obtain the respondent's month of birth.

The dependent variables have been obtained from the responses to the questions (included in block B of the NHS, called Health Status): (15.b) Have you suffered or are you suffering from any of these diseases or health problems?, and (15.c) Has any doctor told you that you suffer from it?, encoding as "Yes" the affirmative answers in both questions and "No" in the rest, thus obtaining a list of 27 chronic diseases or long-term health problems, diagnosed by a doctor in a dichotomous way (Yes/No). The variable "global chronicity" has also been evaluated as suffering from any of these 27 chronic diseases (Yes/No). The explanatory variable "month of birth" was obtained from the date of birth of the respondent, with 12 categories.

We have considered all potential confounding variables measured in the survey: physical variables such as the age group (0–39 years, 40–64 years and over 64 years) and BMI (underweight: <18.5 kg/m<sup>2</sup>, normal weight: 18.5–25 kg/m<sup>2</sup>, overweight: 25–30 kg/m<sup>2</sup> and obesity: >30 kg/m<sup>2</sup>); Variables of life habits such as smoking (never, ex-smoker, smoker), regular physical activity (No, Yes) and daily hours of sleep ( $\leq 6$ , 7–9,  $\geq 10$ ); geographical variables such as the area of residence (North: Galicia, Asturias, Cantabria, Basque Country, Navarre, Aragon, Catalonia; Center: Castilla-Leon, Rioja, Extremadura, Madrid, Castilla-La Mancha; South: Andalusia, Murcia, Valencian Community, Ceuta, Melilla; Islands: Balearic Islands, Canary Islands) and the size of the municipality of residence according to the number of inhabitants (>100,000, 50–100,000, 20–50,000 and <20,000). The tests were performed by sex.

We performed a descriptive study of the explanatory variables by calculating frequency tables, separating by sex and for the total. We designed a prevalence chart on suffering from "any chronic disease" by sex, according to the month of birth, with its 95% confidence intervals.

To measure the association between the 27 specific chronic diseases and the "global chronicity" with the month of birth, odds ratios (OR) were estimated by using multivariate logistic models, including the month of birth and all potential confounding variables. The significance level for ORs has been set at 0.01. Goodness of fit indicators have been calculated for each model, such as the model log-likelihood, the Nagelkerke's pseudo-*R*<sup>2</sup>, and the log-likelihood provided by the "month of birth" variable to the adjusted model along with the associated *p* value.

In order to obtain representative estimates of the Spanish population, we have taken into account the complex sampling using as a weighting factor the elevation factor of the survey divided by its mean, obtaining weights centered on its mean.<sup>28</sup>

The testing was performed with the SPSS<sup>®</sup> v18 statistical program and the R v.3.2.3 program using the RStudio v.0.99 interface.

## Results

The sample size of the survey was 29,478 subjects, who accounted for approximately 44.7 million Spanish residents on 1 January 2007,<sup>29</sup> 14,459 (49.1%) were men and 15,019 (50.9%) were women. The average age of the respondents was 46.0 years (SD 18.5), ranging from 16 to 104 years of age.

As a general characteristic, the Spanish population in 2007 was 19.4% over 65 years of age, 15.1% were obese, 29.5% were smokers

**Table 1**  
Number and frequencies of respondents in levels of explanatory variables and month of birth, by sex. Chi square test.

	Male		Female		Total	
	n	%	n	%	n	%
<i>Age, years</i>						
0–39	6323	43.7	5921	39.4	12,244	41.5
40–64	5696	39.4	5820	38.7	11,516	39.1
>64	2440	16.9	3278	21.8	5718	19.4
<i>BMI (kg/m<sup>2</sup>)</i>						
<18.5 (low weight)	97	0.7	453	3.4	550	2.0
18.5–25 (normal weight)	5458	40.1	6996	52.7	12,454	46.3
25–30 (overweight)	5985	44.0	3840	28.9	9825	36.5
>30 (obesity)	2071	15.2	1981	14.9	4052	15.1
<i>Smoking</i>						
Never	5281	36.5	9450	62.9	14,731	50.0
Ex-smoker	4069	28.1	1983	13.2	6052	20.5
Smoker	5109	35.3	3587	23.9	8696	29.5
<i>Regular physical exercise</i>						
No	5129	36.4	6215	42.4	11,344	39.4
Yes	8978	63.6	8439	57.6	17,417	60.6
<i>Hours of sleep</i>						
≤6	3096	21.6	3885	26.1	6981	23.9
7–9	10,327	72.1	10,032	67.3	20,359	69.7
≥10	898	6.3	987	6.6	1885	6.5
<i>National area of residence</i>						
North	5065	35.0	5321	35.4	10,386	35.2
Center	3840	26.6	4023	26.8	7863	26.7
South	4571	31.6	4685	31.2	9256	31.4
Islands	982	6.8	990	6.6	1972	6.7
<i>Size of residence municipality, population</i>						
>100,000	6393	44.2	6468	43.1	12,861	43.6
50–100,000	1367	9.5	1443	9.6	2810	9.5
20–50,000	2067	14.3	2196	14.6	4263	14.5
<20,000	4631	32.0	4912	32.7	9543	32.4
<i>Month of birth</i>						
January	1426	9.9	1333	8.9	2759	9.4
February	1203	8.3	1148	7.6	2351	8.0
March	1229	8.5	1348	9.0	2577	8.7
April	1281	8.9	1272	8.5	2553	8.7
May	1313	9.1	1290	8.6	2603	8.8
June	1122	7.8	1191	7.9	2313	7.8
July	1164	8.1	1265	8.4	2429	8.2
August	1204	8.3	1225	8.2	2429	8.2
September	1152	8.0	1258	8.4	2410	8.2
October	1150	8.0	1242	8.3	2392	8.1
November	1069	7.4	1232	8.2	2301	7.8
December	1146	7.9	1215	8.1	2361	8.0

(35.3% male and 23.9% female), 60.6% practiced regular physical activity (63.6% men and 57.6% women), 69.7% slept 7–9 hours a day, 43.6% lived in municipalities with over 100,000 inhabitants and 32.4% below 20,000 inhabitants. Concerning the number of births per month of the year, in men the lowest number was in November, with 7.4%, and the highest in January, with 9.9%. In women, it was February with 7.6% and March with 9.0%, respectively (Table 1).

The prevalence of diseases or health problems differed by gender, with the highest prevalence among men being high blood pressure, with 18.6%, followed by chronic low back pain, with 16.3%; Among women, osteoarthritis, arthritis or rheumatism with 27.5%, followed by chronic neck pain, with 27.1%, finding 6 diseases that exceed 10% prevalence in men, and 10 in women (Tables 2 and 3). Fig. 1 shows the prevalence of “any chronic disease” by sex and per month of birth.

Tables 2 and 3 summarize the indicators of goodness of fit and estimated ORs of the months of birth for every disease, adjusted for all variables, for men and women, respectively, and with the prevalences listed from highest to lowest. In the OR estimation,

January was used as the reference category, and we scored the ORs with high and low risks at the significance level of 0.01.

When adjusting the logistic models for each health problem, a significant association was found between the month of birth and 10 chronic diseases in men and 8 in women, showing different patterns and magnitudes of association by gender.

In men, no significant association was found between the month of birth and 17 diseases: diabetes, hemorrhoids, chronic constipation, osteoporosis, high blood pressure, high cholesterol, chronic neck pain, prostate problems, chronic migraines, stomach ulcer, varicose veins in legs, chronic bronchitis, myocardial infarction, urinary incontinence, malignant tumors, anemia and embolism. It has been detected that in a few months of birth there is a low risk for 3 diseases: chronic low back pain, allergy and some chronic disease, March being the month with the lowest risk of suffering from chronic low back pain, with an OR of 0.56. There are a few months of birth with a significant risk of suffering from 4 diseases: osteoarthritis, other heart diseases, asthma and thyroid problems, being September the month with the highest risk of thyroid problems, with an OR of 2.92. There are 3 diseases in which there are months of birth of high risk and others with low significant risk, such as depression, skin problems and cataracts (Table 1).

In women, no significant association has been found with 19 diseases: some chronic disease, depression, chronic low back pain, varicose veins in legs, allergy, anemia, hemorrhoids, cataracts, osteoporosis, thyroid problems, skin problems, other heart diseases, diabetes, asthma, stomach ulcer, chronic bronchitis, malignant tumors, myocardial infarction and embolism. Some months of birth show a lower risk for 2 diseases: chronic migraine and problems of the menopausal period, with November being at a lower risk for menopausal problems, with an OR of 0.54. There have been months of birth with a significant high risk in 5 diseases: osteoarthritis, chronic neck pain, high blood pressure, high cholesterol and constipation, being June the month at a highest risk for urinary incontinence, with an OR of 1.53. Urinary incontinence is the only condition in which months of birth at high-risk and others at low-risk have been detected (Table 2).

## Discussion

In this study we have evidenced a significant association between the month of birth and the occurrence of various chronic diseases and long-term health problems in the general Spanish population through the NHS tests in 2006.

This paper is not intended to establish a causality between the month of birth and the occurrence of these chronic diseases in adulthood, but to evidence these associations in order to be able to construct hypotheses in future papers and take it into account in studies on the prevalence of chronic diseases as a potential confounding factor.

The patterns reported differed clearly by sex, presenting associations of the month of birth with more diseases and with more magnitude in men than in women.

For diseases and health problems, no studies have been found directly comparable with the results of this paper. Brenner et al. found spikes in subjects born in the months of January and February and valleys in July and August for the risk of specifically presenting gliomas and meningiomas in USA<sup>6</sup>; Kristoffersen and Hartveit found association between breast tumor and women born in the first half of the year<sup>8</sup>; Van Laar et al. found spikes in February in Hodgkin's tumors in the United Kingdom,<sup>9</sup> and La Rosa et al. found a high risk of skin cancer in February–April in Italy.<sup>10</sup> However, in our study no association was found to have malignant tumors in any sex.

**Table 2**  
Number and prevalence of every health problem. Odds ratios of every health problem in the months of birth, adjusted for all variables. Male.

Male (n = 14,459)	n	P (%)	MLL	R <sup>2</sup> (%)	BMLL	p	J	F	M	A	M	J	J	A	S	O	N	D
Any chronic condition	9138	63.2	15.031	22.9	46.7	<0.001	1	1.08	0.93	<b>0.78</b>	1.14	1.01	1.09	1.12	<b>0.78</b>	1.12	0.83	0.98
High blood pressure	2685	18.6	10.207	28.1	17.7	0.088	1	0.99	0.95	1.09	1.16	1.29	0.98	1.03	0.82	1.08	1.01	0.99
Chronic low back pain	2352	16.3	11.422	6.3	40.9	<0.001	1	<b>0.70</b>	0.82	<b>0.56</b>	0.96	<b>0.78</b>	<b>0.69</b>	<b>0.89</b>	<b>0.74</b>	<b>0.78</b>	0.83	0.83
High cholesterol	2218	15.3	10.249	15.5	9.6	0.569	1	1.03	0.98	0.90	0.91	0.98	0.98	1.11	1.10	1.09	0.95	0.86
Osteoarthritis, arthritis or rheumatism	1913	13.2	8305	25.1	25.0	0.009	1	0.94	1.20	0.95	1.04	0.85	1.39	1.01	0.97	1.22	1.11	1.31
Chronic neck pain	1854	12.8	9699	6.7	19.2	0.057	1	0.75	0.83	0.80	0.98	0.90	0.87	0.82	1.08	0.97	0.91	1.11
Chronic allergies	1528	10.6	8887	3.9	27.4	0.004	1	1.17	1.00	1.01	1.01	0.93	1.23	1.15	0.79	1.15	1.06	<b>0.71</b>
Depression, anxiety	1177	8.1	6973	5.6	49.8	<0.001	1	1.01	0.73	1.16	1.53	<b>0.66</b>	1.23	1.23	1.02	1.05	1.19	1.54
Prostate problems	1016	7.0	4481	36.5	14.9	0.188	1	1.19	0.90	0.86	0.82	0.99	0.73	1.00	1.00	1.32	0.91	0.87
Migraine or headache	941	6.5	6314	1.0	12.7	0.314	1	1.15	0.96	0.91	1.07	0.85	1.05	1.07	0.94	1.35	0.92	1.19
Stomach or duodenal ulcer	922	6.4	5763	10.6	9.9	0.543	1	0.88	0.69	0.79	0.96	0.74	0.72	0.91	0.80	0.77	0.76	0.85
Diabetes	911	6.3	5130	19.1	22.9	0.018	1	1.22	0.81	0.70	0.92	0.99	0.94	0.68	0.73	0.86	1.20	0.93
Hemorrhoids	863	6.0	5667	6.9	23.2	0.016	1	0.91	1.17	1.12	1.23	1.03	1.11	0.65	0.92	1.46	1.05	0.96
Chronic skin problems	811	5.6	5636	3.9	42.8	<0.001	1	1.29	1.12	1.18	1.10	1.14	1.29	0.94	<b>0.62</b>	0.96	1.87	1.47
Cataracts	776	5.4	3877	30.3	43.9	<0.001	1	1.45	1.55	1.31	1.20	1.50	0.79	0.88	1.11	0.88	<b>0.57</b>	1.60
Varicose veins in legs	751	5.2	4938	10.4	15.8	0.149	1	1.14	1.06	0.95	1.02	1.03	0.78	0.68	0.94	1.01	1.33	1.14
Chronic bronchitis	734	5.1	4622	11.8	13.9	0.240	1	1.32	1.13	1.26	1.05	1.42	1.16	1.34	1.44	0.88	1.32	0.92
Other heart conditions	719	5.0	4336	19.0	31.6	0.001	1	1.79	1.15	0.92	1.40	1.78	1.05	0.98	1.33	0.97	1.52	1.58
Asthma	730	5.0	5129	4.1	48.3	<0.001	1	1.13	1.50	1.82	1.62	1.28	1.80	1.96	1.58	1.44	0.62	1.08
Myocardial infarction	461	3.2	3059	18.8	7.1	0.791	1	1.24	1.28	1.07	0.85	1.10	1.05	0.83	0.94	1.19	0.87	1.10
Urinary incontinence	424	2.9	3000	21.3	17.8	0.087	1	1.24	0.78	0.93	1.14	1.18	0.83	0.82	1.37	1.50	1.01	1.31
Chronic constipation	377	2.6	2744	13.6	23.3	0.016	1	0.90	0.42	0.71	0.54	0.63	0.71	0.54	0.86	0.84	1.16	0.91
Malignant tumors	288	2.0	2221	12.9	12.8	0.304	1	0.99	1.36	1.42	0.76	1.54	1.07	1.81	1.58	1.56	1.46	1.26
Anemia	250	1.7	2167	6.5	15.5	0.162	1	0.87	0.83	0.76	0.79	1.25	0.96	0.79	1.52	0.48	0.88	1.10
Embolism	181	1.3	1611	14.3	23.8	0.014	1	0.94	0.97	0.55	0.90	1.02	1.52	0.66	0.88	0.83	0.41	1.80
Osteoporosis	182	1.3	1665	15.6	23.8	0.014	1	3.30	1.51	1.41	1.75	1.44	2.24	3.10	2.47	2.19	3.12	2.95
Thyroid problems	126	0.9	1345	8.2	26.4	0.006	1	2.72	0.25	1.43	1.55	2.80	0.62	1.89	2.92	2.18	2.38	1.96

MLL: model log-likelihood; BMLL: birth month log-likelihood; P: prevalence; p: BMLL p value; R<sup>2</sup>: Nagelkerke's R<sup>2</sup>.

Data in bold: significant high risk; Data in italics: low significant risk.

Torrey et al.<sup>11</sup> found high risk of epilepsy in subjects born in the winter months and less risk in those born in September, and risk of Parkinson's disease in subjects born in spring. Sorensen et al.<sup>12</sup> found higher risk of schizophrenia in subjects born in autumn. In our study, there are spikes in May and December in the pattern of risk of depression, anxiety or other mental disorders in men, and lower risk in June, and no significant risk in women.

Boland et al.<sup>18</sup> found in their work high-risk spikes of presenting asthma in subjects born in August and September, in agreement with our results in males, although in our study spring and summer appear to be more risky, and in women there is no significant association. These authors also found low risk of having hypertension in October; However, in this study, July has been reported as at high-risk for women, and no association in males. These authors also

**Table 3**  
Number and prevalence of every health problem. Odds ratios of every health problem in the months of birth, adjusted for all variables. Female.

Female (n = 15,018)	n	P (%)	MLL	R <sup>2</sup> (%)	BMLL	p	J	F	M	A	M	J	J	A	S	O	N	D
Any chronic condition	11,457	76.3	12.529	20.0	23.6	0.015	1	0.87	0.97	0.95	0.82	0.86	0.99	0.89	0.77	0.99	0.73	0.76
Osteoarthritis, arthritis or rheumatism	4133	27.5	10.834	38.1	26.7	0.005	1	1.24	1.34	0.97	1.00	1.23	1.30	1.25	1.10	0.98	0.96	1.20
Chronic neck pain	4067	27.1	14.279	8.3	41.2	<0.001	1	0.96	1.08	1.15	0.93	0.87	1.37	1.16	0.93	0.89	0.90	1.02
Chronic low back pain	3800	25.3	13.806	8.5	18.1	0.079	1	0.97	0.91	1.12	0.87	0.93	1.16	1.02	0.92	0.87	0.93	0.95
High blood pressure	3389	22.6	9834	34.3	28.9	0.002	1	0.94	1.09	0.96	0.82	0.80	1.27	1.04	1.11	1.01	0.81	1.11
Varicose veins in legs	2907	19.4	11.713	10.5	4.5	0.951	1	1.07	1.16	1.13	1.04	1.12	1.12	1.08	1.15	1.00	1.14	1.14
Depression, anxiety	2875	19.1	11.633	11.1	20.2	0.043	1	1.06	0.94	1.02	1.09	0.88	1.29	1.11	0.87	0.98	1.01	0.94
Migraine or headache	2578	17.2	11.648	4.0	26.6	0.005	1	<b>0.72</b>	0.89	0.86	<b>0.74</b>	<b>0.67</b>	0.93	1.00	<b>0.79</b>	0.85	<b>0.78</b>	0.82
High cholesterol	2424	16.1	9816	16.7	34.5	<0.001	1	1.05	1.00	1.19	1.00	1.03	1.11	0.84	1.02	1.51	1.01	0.82
Chronic allergies	2043	13.6	10.489	1.4	16.1	0.136	1	1.09	1.23	0.94	1.31	1.14	1.15	1.04	1.16	0.93	1.01	1.14
Anemia	1733	11.5	9115	1.9	16.9	0.109	1	1.09	1.33	1.09	1.01	0.91	1.23	1.15	1.10	1.19	0.88	1.12
Hemorrhoids	1373	9.1	7476	5.7	14.4	0.212	1	1.15	1.06	0.90	1.06	1.02	1.33	1.08	1.03	1.02	1.10	0.80
Cataracts	1306	8.7	4581	35.3	18.2	0.078	1	1.16	1.00	1.10	0.85	1.09	1.61	1.10	1.06	0.84	0.97	0.92
Chronic constipation	1300	8.7	7139	5.1	28.0	0.003	1	1.06	1.40	0.88	1.23	1.16	1.40	1.34	1.32	1.14	1.52	0.89
Osteoporosis	1239	8.2	5665	25.7	14.4	0.214	1	1.16	1.53	1.40	1.39	1.52	1.56	1.42	1.43	1.46	1.11	1.43
Thyroid problems	1032	6.9	6332	5.9	10.0	0.528	1	1.23	1.32	1.13	1.16	1.23	1.38	1.05	1.31	0.99	1.01	1.12
Menopause problems	1038	6.9	5658	16.7	25.1	0.009	1	0.95	0.75	<b>0.64</b>	0.89	<b>0.65</b>	0.93	0.82	<b>0.67</b>	0.74	<b>0.54</b>	<b>0.67</b>
Chronic skin problems	979	6.5	6217	1.9	11.4	0.410	1	1.01	0.85	0.91	0.87	1.25	1.07	1.01	0.96	0.79	0.94	0.84
Other heart conditions	898	6.0	4732	14.7	13.3	0.273	1	0.68	1.00	0.80	1.12	0.92	1.07	0.95	0.86	0.90	0.68	0.96
Diabetes	905	6.0	4323	19.2	6.8	0.819	1	0.91	1.12	1.22	1.12	0.83	0.98	0.94	1.08	1.15	0.99	1.16
Asthma	878	5.8	5645	2.4	16.6	0.119	1	1.15	1.22	1.17	1.10	1.19	1.21	1.07	1.16	0.71	0.87	1.34
Stomach or duodenal ulcer	725	4.8	4548	6.8	14.6	0.199	1	0.91	0.71	1.24	1.00	0.81	1.18	1.06	1.09	0.77	0.91	1.03
Urinary incontinence	721	4.8	3911	16.4	26.7	0.005	1	1.07	0.95	0.96	0.67	1.53	0.93	0.83	0.87	0.78	0.77	<b>0.63</b>
Chronic bronchitis	670	4.5	4267	6.0	21.0	0.033	1	1.08	0.87	1.24	0.81	1.15	1.02	1.17	1.11	0.68	0.82	1.49
Malignant tumors	447	3.0	3087	9.5	12.8	0.307	1	1.25	1.26	1.52	0.78	1.07	0.97	0.82	1.21	1.06	0.91	0.95
Myocardial infarction	216	1.4	1411	16.8	15.5	0.162	1	0.64	0.91	0.80	0.48	0.69	1.07	0.57	0.87	0.51	1.49	1.12
Embolism	183	1.2	1308	13.7	17.7	0.088	1	1.49	1.37	1.32	1.17	1.19	1.06	1.35	0.28	0.70	1.14	1.97

MLL: model log-likelihood; BMLL: birth month log-likelihood; P: prevalence; p: BMLL p value; R<sup>2</sup>: Nagelkerke's R<sup>2</sup>.

Data in bold: significant high risk; Data in italics: low significant risk.

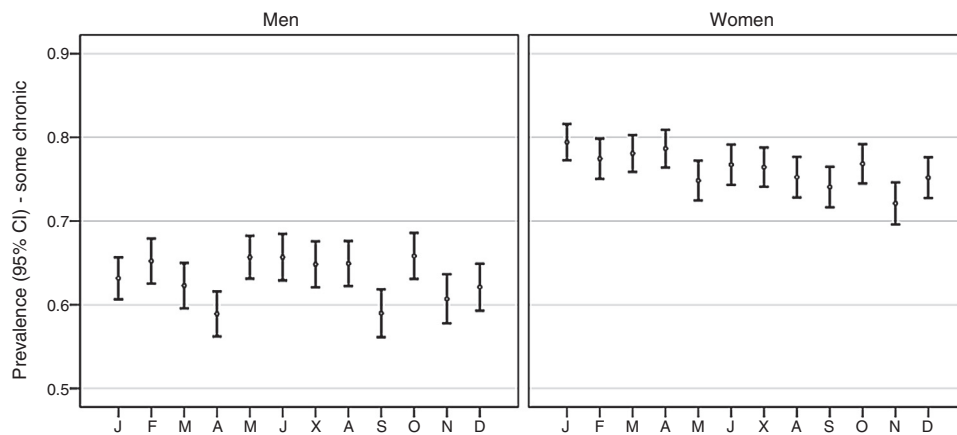


Fig. 1. Prevalence of "some chronic disease" by sex and per month of birth.

detected a high risk of respiratory diseases in October; however, in our study no association has been detected.

In the study by Kahn et al.<sup>4</sup>, individuals born in the months of April to July show a high risk of type 1 diabetes, and lower risk in subjects born from November to February in the USA. But only in the states at high latitudes, finding no association in southern states, revealing differential geographic patterns. In our study, no significant risk was detected in men or women.

Although the magnitude of the risks detected is not excessive, it is noteworthy that in men, the significant risks of having thyroid problems have a magnitude over 2.50, up to 2.90. The lowest risk of chronic low back pain has been detected in March, with an OR of 0.56. In women the risks are more moderate, spiking at 1.53 in June for urinary incontinence, and 0.54 in November for menopausal problems.

The month of birth may behave as an indicator of periods of early exposure to various factors, such as exposure to ultraviolet rays, vitamin D, temperature, seasonal exposure to viruses and allergies, etc., which may affect the development of the uterus and neonate in their first months of life. The fact that they are seasonal factors that may vary in different geographical regions might explain the variability of the results of different studies that have measured these associations. The differentiation of patterns by sex found that there may be a different vulnerability in men and women to these early exposure factors.

The limitations of this paper are those of a transversal study to be able to establish causality. Although the risk factor evaluated, such as the month of birth, is prior to the measured health outcome, this study has not been intended to establish a causal relationship between this factor and the health outcome, but rather to establish associations to construct future hypotheses and to take into account the month of birth as a potential confounding factor in future prevalence studies. Another limitation may be the lack of control of confounding variables to suffer from these diseases analyzed, although physical variables, life habits and geography have been taken into account. Another potential limitation is that all variables are self-reported, but responses with medical diagnosis have been taken into account. One strength of this study is being a national survey, accounting for the entire Spanish population, and the complex sample design was taken into account in the testing.

In conclusion, significant associations have been found between suffering from different chronic diseases in the Spanish population and the month of birth, to a greater extent in men than in women, which may reflect early exposure to environmental factors in the uterus and in the first months of life. More specific studies are required to delve into these associations.

## Funding

This research has received no specific grant from any funding agency.

## Conflict of interest

The authors report no conflict of interest.

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