

Swimming pool attendance, respiratory symptoms and infections in the first year of life

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Abstract We evaluated the relationship between indoor and outdoor swimming pool attendance and respiratory symptoms and infections during the first year of life. A population-based mother–child cohort study was conducted in four Spanish areas (INMA project). Study subjects were recruited at pregnancy, followed to delivery and 14 months after birth. Information on swimming pool attendance and health manifestations during the first year of life was collected at 14 months: low respiratory tract infection (LRTI), persistent cough, wheezing, atopic eczema and otitis. Odds ratios and 95 % confidence interval (OR 95 %CI) were calculated by logistic regression adjusting for confounders. Among the 2,205 babies included, 37 % reported having LRTI, 37 % wheezing, 16 % persistent cough, 22 % atopic eczema, 33 % otitis and 50 % attended swimming pools during the first year of life. Around 40 % went to outdoor

pools in summer with a median cumulative duration of 7.5 h/year, and 20 % attended indoor pools with a median cumulative duration of 18 h/year. Pool attendance differed by area, season of birth and sociodemographic characteristics, and was not associated with LRTI, wheezing, persistent cough, atopic eczema or otitis. Adjusted OR of wheezing and LRTI were, respectively, 1.06 (95 %CI, 0.88–1.28) and 1.09 (0.90–1.31) for babies attending vs. babies not attending pools. Stratification by type of swimming pool, cumulative duration or parental atopy did not modify the results. **Conclusion:** No association was detected between pool attendance and LRTI, wheezing, persistent cough, atopic eczema or otitis during the first year of life in Spain.

Keywords Baby swimming · Birth cohort · Eczema · Otitis · Wheezing

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Introduction

Swimming in pools is a common activity among adults and children, especially during summer in western countries with warm weather [8]. Swimming pools are the environment where children usually learn swimming and where swimming is mostly practiced. Apart from the health benefits related to the physical activity, swimming pool attendance entails a potential risk of water-borne infection [29]. Exposure to air-borne irritants such as chlorine and chlorination by-products has been associated with respiratory impairment in pool workers [26] and there is debate whether it could also affect children. Studies conducted in Belgium have reported that swimming pool attendance, particularly in early childhood, increased the risk of bronchiolitis at 5–6 years [27] and asthma at 10 years of age [2, 4]. However, studies in other European countries have not confirmed the association with childhood asthma [8, 10, 12, 15]. The potential risk of childhood asthma due to swimming pool attendance has relevant public health implications, since asthma is among the most common chronic diseases in children [20] and swimming is one of the most practiced sports in western societies [25], where sedentarism and childhood obesity are increasing [14]. Although further research using prospective birth cohorts is still needed [28], available evidence indicate that the health benefits of swimming during childhood outweigh the potential health risks of chemical contamination [24].

A related but slightly different debate is whether baby swimming (i.e. swimming pool attendance at a very early age, commonly during the first year of life in organized lessons with the parents) is safe and healthy [1, 11, 21, 24]. The health benefits of baby swimming are less clear, since babies are not usually able to swim until the age of 4 years [1]. Benefits for the child development have been proposed [16], although empirical data is not available. The American Academy of Pediatrics is against infant swimming due to a potential risk of drowning [1]. Exposure to pathogens and chemicals could have early health impacts but few studies have evaluated this and evidence is inconclusive. The risk of infections during the first years of life, such as otitis [18, 19, 22, 23], respiratory infections [18, 23, 29] or diarrhoea [23] related to baby swimming has been evaluated in Germany [23], USA [22] and Norway [18, 19] with inconsistent results. The association with early wheezing has been studied in a very large birth cohort in Norway and an increased risk of wheezing at 18 months was found among baby swimmers with atopic mothers [19].

The INMA study (Environment and Childhood; www.proyectoinma.org) is a network of mother–child cohorts in various areas of Spain established to evaluate the role of the environment on fetal development and children's health [13]. Data on swimming pool attendance has been collected at around 14 months in order to prospectively evaluate the link

with future respiratory signs and symptoms in childhood. Here we assess the relationship between indoor and outdoor swimming pool attendance and respiratory symptoms, infections and eczema during the first year of life in Spain.

Patients and methods

Design and population

A mother–child cohort study was set up in four Spanish areas following a common protocol to constitute the INMA—Infancia y Medio Ambiente [Environment and Childhood] Project [13]. Study subjects in Asturias, Gipuzkoa, Sabadell and Valencia were recruited at 12th-week of gestation and followed until delivery. Eligibility criteria for recruitment were maternal age 16 years or older, singleton pregnancy, planning to deliver at the study hospitals, being able to communicate in either of the official languages, and not having followed an assisted reproduction program [13]. The study sample was representative of the target population in terms of prenatal care attendance in the public health system (used by more than 80 % of the pregnant women), but the educational level was higher than the target population average. Recruitment period ranged from November 2003 in Valencia to February 2008 in Gipuzkoa [13], including 494 subjects in Asturias, 638 in Gipuzkoa, 657 in Sabadell and 827 in Valencia. From the initial sample at recruitment, 2,503 women (95.7 %) were followed until delivery. Follow up at 14 months was performed among 477 subjects in Asturias (96.6 %), 575 in Gipuzkoa (90.1 %), 582 in Sabadell (88.6 %) and 708 in Valencia (85.6 %). The study was approved by the Ethical Committees of the participating centres, and all subjects gave written consent for themselves and their children to participate.

Questionnaires and variables

Personal information was collected through interviews at recruitment (week 12 of pregnancy). Birth data was collected at delivery (birth weight, date and sex). A follow up was conducted at 12–14 months after delivery in Gipuzkoa, Sabadell and Valencia and 2.4 years after birth in Asturias (Table 1). This will be referred as the 14-month follow up.

Swimming pool data Swimming pool attendance was ascertained in the 14-month interview with the question “Do you bring your child to the swimming pool? (yes, no)”. Among those who answered positively, a following question asked for the frequency (days per month) and duration (minutes per day).

Since exposure to air-borne irritants differs between outdoor and indoor pools [8, 29], frequency and duration were asked separately for indoor and outdoor pools, in summer and the rest of the year. The minutes spent in outdoor, indoor and both

Table 1 Characteristics of the cohort, prevalence of signs and symptoms and swimming pool attendance. *N*=2,205

	Asturias		Guipuzkoa		Sabadell		Valencia		Total	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Total population	418	19.0	541	24.5	546	24.8	700	31.7	2,205	100
Age (years), median (min–max)	2.4	1.6–4.2	1.2	1.1–4.1	1.2	1.1–1.5	1.0	0.9–1.8	1.2	1.0–4.2
Sex, male	217	48.1	270	50.2	263	48.3	331	47.3	1065	48.4
Preterm	19	4.6	18	3.4	15	2.8	36	5.1	88	4.0
SGA	29	7.2	42	7.9	55	10.2	80	11.4	206	9.5
Born in winter	102	24.4	148	27.5	145	26.6	203	29.0	598	27.2
Older siblings	191	45.7	301	44.4	234	42.9	304	43.4	969	43.9
Pet contact	115	27.5	88	16.3	183	33.5	327	46.7	713	32.4
Breastfeed >24 weeks	106	27.2	272	53.1	272	51.2	296	43.1	946	44.6
Day care	214	51.2	255	47.1	170	31.2	146	21.0	785	35.7
Maternal characteristics										
Age >35 years	110	26.3	100	18.5	95	17.4	109	15.6	414	18.8
Ethnicity, not White	9	2.1	7	1.3	14	2.6	47	6.7	77	3.5
Education, University	161	38.5	269	49.8	172	31.7	175	25.0	777	35.5
Social class, I+II	95	22.7	162	29.9	114	20.9	116	16.6	487	22.1
Smoking ^a	104	26.5	100	19.5	137	25.7	215	31.2	556	26.1
Asthma	31	7.4	33	6.1	45	8.3	51	7.3	160	7.3
Paternal asthma	35	8.4	39	7.2	37	6.8	36	5.1	147	6.7
Symptoms during the first year of life										
LRTI	174	43.8	211	39.0	218	40.5	202	28.9	805	37.0
Wheezing	233	58.2	193	35.7	197	37.3	179	25.6	802	36.9
Persistent cough	67	17.5	123	22.9	90	17.3	54	7.7	334	15.6
Atopic eczema	142	37.8	88	16.3	119	22.8	117	16.8	466	21.9
Otitis	175	43.5	194	36.0	187	35.0	171	24.4	727	33.4
Pool attendance	164	39.2	257	47.5	360	65.9	325	46.4	1,106	50.2

SGA small for gestational age, LRTI low respiratory tract infection

^a Smoking when the baby was 14 months

types of swimming pools (total) during the first year of life were calculated. Minutes spent in summer were multiplied by 3 months, and minutes spent during the rest of the year were multiplied by 9 months. Missing data in indoor or outdoor pool attendance was imputed zero to construct the “total” variable. These three variables (outdoor, indoor and total swimming pool attendance) were grouped in three categories: 0 min, above 0 min and below the median, above the median.

Symptoms and signs The 14-month questionnaire included the following questions: “During the first year of life, how many wheezing episodes have your child had?”, “Has any doctor said that your child had a chest infection?”, “Has your child had cough for more than 3 weeks?”, “Has your child suffered from atopic eczema?” and “How many ear infection has your child had?”. Babies were classified as having or not having wheezing, low respiratory tract infections (LRTI), persistent cough, atopic eczema or otitis during the first year of life.

Covariates Number of siblings, maternal and paternal asthma (yes, no), maternal education (primary or less, secondary, high), social class (I, II managers/technicians, III, IV skilled manual/non-manual, V, VI semi-skilled, unskilled), ethnicity (white, other) and maternal age were ascertained in the interview at recruitment in the 12th week of pregnancy. Maternal social class was coded from the longest held job during the pregnancy, using the 4-digit Spanish classification [17], which is closely related to the International Standard Classification of Occupations (ISCO 88). Birthweights below the tenth percentile for gestational age according to national growth curves [7] were defined as small for gestational age (SGA). Deliveries before 37 weeks of gestation were defined as preterm births. Date, season of birth and sex were collected at delivery. Maternal smoking at 1 year (yes, no), breast feeding (0, 1 to 24 weeks, >24 weeks), pet contact (yes, no) and day care attendance (yes, no) were collected in the interview at 14 months after delivery.

Statistical analysis

Babies with missing data for ever pool attendance or all the outcomes evaluated were excluded and the final population was 2,205. Sex, preterm delivery and small for gestational age status, season of birth, maternal age, ethnicity, education, social class and asthma, and paternal asthma were compared between the analysed sample and the excluded subjects ($N=298$). Excluded infants were similar in terms of paternal or maternal asthma, but tended to be from disadvantaged social classes, younger mothers, preterm, SGA, not white and born in winter. A descriptive analysis and multivariate logistic regression analyses were performed with the statistical package STATA 11 to estimate adjusted odds ratios (OR) and 95 % confidence intervals (CIs) of manifestations associated with swimming pool attendance. Sensitivity analyses were performed in different subsets to check for the stability of results.

Results

Among the 2,205 babies included, 37 % had LRTI, 37 % had wheezed, 16 % had persistent cough, 22 % had atopic eczema and 33 % had otitis. Overall, 50 % of infants attended pools during the first year of life, ranging from 39 % (Asturias) to 66 % (Sabadell; Table 1). The 14-month follow up showed that 50.2 % of babies ($N=1,106$) attended swimming pools, 17 % ($N=372$) attended indoor pools, 39 % ($N=865$) went to outdoor pools in summer and 7.5 % attended both types of pools and 34 (1.5 %) had missing data on both indoor and outdoor attendance (Table 2, Fig. 1). Among those attending outdoor pools, median attendance was 5 days per month during 20 min in summer. Outdoor pool attendance the rest of the year was anecdotic (0.6 %). Among those attending indoor pools, median attendance was 4 days per month during 30 min, both in summer and the rest of the year. The median cumulative duration of total pool attendance during the first year of life was 12 h (interquartile range=3.5–30), among babies attending pools. Classification of babies in categories of cumulative minutes of pool attendance is shown in Fig. 1. Sabadell had the highest levels of total (indoor and outdoor) pool attendance, while Asturias had the lowest, due to lower outdoor pool attendance.

Both indoor and total swimming pool attendance differed by cohort, season of birth and social class (Fig. 2). Being older, white, born at term or with proper weight were positively associated with total pool attendance. Long breast feeding and day care attendance were only related to indoor pool attendance. Maternal or paternal asthma were not associated with baby pool attendance.

Having attended swimming pools during the first year of life was not associated with any of the evaluated

Table 2 Frequency and duration of swimming pool attendance at the 14-month follow up, among infants who attended swimming pools; $N=1,071$

	<i>N</i>	Median	Min–max
Outdoor pools in summer			
Frequency (days/month)	874	8	1–70
Duration (min)	867	20	1–420
Min/month	864	150	1–7200
Indoor pools in summer			
Frequency (days/month)	136	4	1–30
Duration (min)	134	30	5–180
Min/month	134	120	5–1800
Indoor pools during the rest of the year			
Frequency (days/month)	261	4	1–40
Duration (min)	260	30	5–120
Min/month	260	160	1–720
Cumulative duration, hours/year ^a			
Indoor pools	372	18	0.15–144
Outdoor pools	864	7.5	0.25–360
Total ^b	1071	12	0.25–468

^a Estimated assuming that swimming pool attendance occurred in the 12 months of the year (with 3 months of summer)

^b Missing data in indoor or outdoor attendance was considered 0 in the total cumulative duration variable. Among the 1,106 babies who answered having attended pools, 1,071 (98.5 %) reported data on indoor or outdoor attendance

manifestations (Table 3). When cumulative duration and type of swimming pool was considered, a dose–response pattern appeared for specific outcomes. The OR of LRTI increased for indoor attendance in the intermediate category of exposure (1.30; 95 %CI=0.87, 1.96) and decreased in the most exposed infants (0.71; 95 %CI=0.52, 0.96). A similar pattern was found for LRTI and total pool attendance, persistent cough for indoor, outdoor and total pool attendance, and eczema for outdoor and total pool attendance. However, confidence intervals were very wide and none of them reached statistical significance. Total, indoor and outdoor pool attendance was similarly associated to all the evaluated signs and symptoms. Crude models gave similar results and are not shown.

Several sensitivity analyses were performed, stratifying the analysis by potential effect modifiers (maternal asthma, maternal/paternal atopy, age younger than 1.5 years, season of birth and cohort) and results remained similar (Table 4). As shown in Fig. 1, several babies had missing data on specific type of swimming pool attendance. In a further sensitivity analysis, missing data was imputed to both zero values and the maximum exposure level and in both cases the results did not change (results not shown). For example, the OR of wheezing among those with >18 h in indoor pools compared to those without swimming in indoor pools was 0.83 (95 %CI=0.59, 1.15) when missing data was imputed

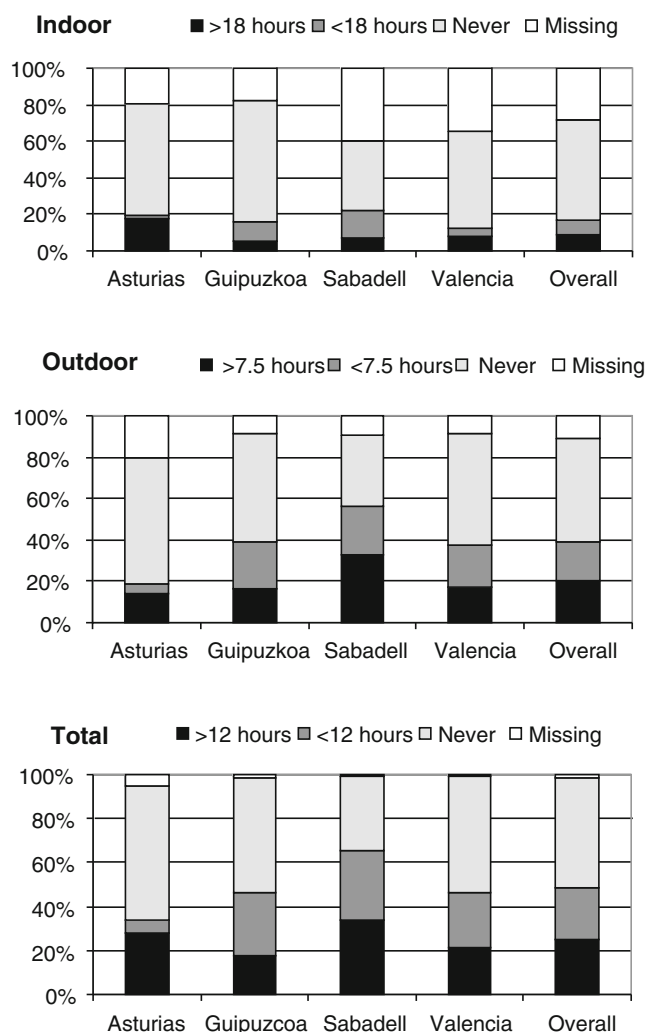


Fig. 1 Cumulative swimming pool attendance during the first 14 months of life in indoor, outdoor or both types of pools. $N=2,205$. Missing data in indoor or outdoor attendance was considered 0 in the “total” variable. Thirty-four babies (1.5 %) had missing data on both indoor and outdoor attendance, although answered to have ever attended a pool

to 0 and 0.96 (0.79, 1.17) when missing data was imputed to >18 h. Finally, to explore a possible selection bias due to health conditions, we used data from one of the cohorts (Sabadell) that had information on health manifestations at 6 months of age. In this subsample ($N=530$), LTRI, wheezing, persistent cough, eczema or otitis by 6 months were not related to pool attendance at 14 months (Fig. 2). After excluding babies with any of these signs or symptoms by 6 months, no significant association was detected between pool attendance and any manifestation at 14 months (Table 4).

Discussion

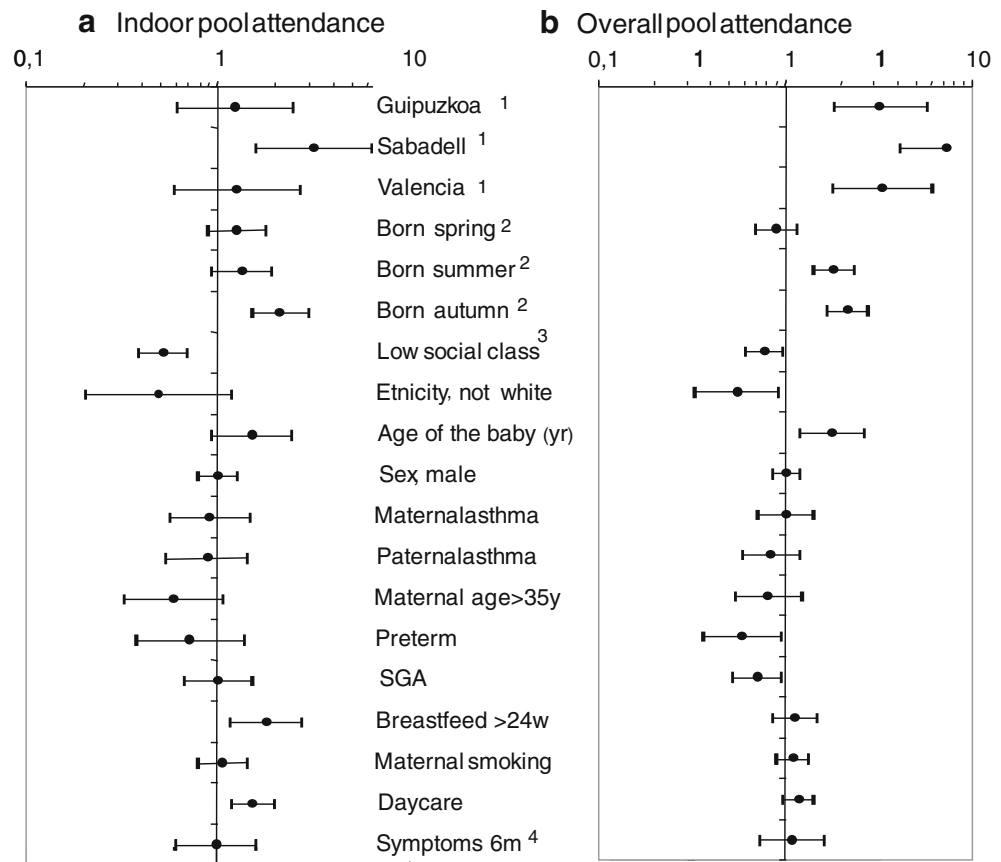
Prevalence of swimming pool attendance during the first year of life in this Spanish population was around 50 %,

with a median cumulative duration of 12 h (IQR=3.5–30). Around 40 % went to outdoor pools in summer with a median cumulative duration of 7.5 h/year, and 20 % attended indoor pools with a median cumulative duration of 18 h/year. No association was detected between attending swimming pools and having LTRI, wheezing, persistent cough, atopic eczema or otitis during the first year of life.

Occasional swimming pool attendance was common among this population, especially in outdoor pools during summer. This pattern dominated by outdoor pool attendance in summer was previously described among Spanish children¹ and differs from that observed in northern European countries. In Germany, 30 % of babies attended pools occasionally during the first year of life and another 30 % practiced baby swimming regularly [23]. In Norway, the prevalence of baby swimming was 25 % during the early 2000s [19], with a frequency of attendance of at least once a week [18]. In consequence, the population in this study could have been less exposed to the swimming pool environment compared to previous studies, especially to indoor pools [18, 19, 23]. In the studied areas, as happens globally, the vast majority of swimming pools are disinfected by chlorine-based products [9]. In a previous work in one of the studied areas (Sabadell), 7 out of 9 indoor swimming pools in the municipality were chlorinated and 95 % of children at 10 to 12 years of age had attended only chlorinated pools in the last year [8]. Regarding levels of exposure to irritant disinfection by-products in swimming pools, trichloramine concentrations in swimming pools air have only been reported in the same studied area. The median level in the seven indoor chlorinated pools in this area measured during summer-time was $0.160 \text{ mg} \cdot \text{m}^{-3}$ [8], what is below the maximum recommended level by the WHO [29] and similar to a recent study in the Netherlands (0.21 mg/m^3) [15].

We found no association between attending swimming pools (indoors or outdoors) and the presence of the evaluated manifestations during the first year of life. This lack of association is consistent with previous studies that assessed the risk of otitis [18, 19, 22, 23], respiratory infections [18, 19, 23] or wheezing [19] with indoor pool attendance during the first year of life. The first two studies were performed among 2,862 and 2,192 babies in Norway [18] and Germany [23] respectively, where data were collected retrospectively when children were 6 years old. The other Norwegian study used a very large birth cohort ($N=30,870$) and prospectively measured baby swimming at 6 months and later manifestations (LTRI, otitis and wheeze from 6 to 18 months) [19]. Following the hypothesis that infants with susceptible airways due to their genetic background may be more prone to develop respiratory symptoms as a result of baby swimming [4], several studies on swimming and respiratory manifestations later in childhood have evaluated a possible effect modification by atopic status with inconsistent results [3–6, 8, 10], although atopy has been defined differently between studies. In the first study in

Fig. 2 Determinants of swimming pool attendance during the first 14 months of life. Odds ratios and 95 % confidence intervals of indoor swimming pool attendance (**a**) and overall swimming pool attendance (**b**; yes vs. no). *N*=2,205. ¹ Compared to Asturias. ² Compared to born in winter. ³ Low social class (semi-skilled and unskilled) compared to high social class (managers and technicians). *SGA* small for gestational age. ⁴ Data available only for Sabadell (*N*=513) OR in **a** adjusted by cohort, season of birth and age. OR in **b** adjusted by cohort, season of birth, social class, ethnicity and age



Norwegian babies, an increased risk of otitis and respiratory infections associated with baby swimming was found among infants with atopic mothers, defined by questionnaire [18].

However, in the second Norwegian study, swimming increased the risk of wheezing among babies with atopic mothers but not the risk of otitis or respiratory infections

Table 3 Odds ratio (95 % confidence interval) of signs and symptoms by swimming pool attendance at the 14 month-follow up; *N*=2,205

	Pool attendance ^a	Indoor pools ^b		Outdoor pools ^b		Total ^b	
	Yes	>0–18 h	>18 h	>0–7.5 h	>7.5 h	>0–12 h	>12 h
<i>N</i>	1,106	175	197	415	449	526	545
Wheezing	1.06	1.08	0.76	1.08	1.08	1.16	0.92
<i>N</i> =2,163	(0.88, 1.28)	(0.70, 1.66)	(0.56, 1.03)	(0.84, 1.40)	(0.84, 1.38)	(0.91, 1.46)	(0.73, 1.16)
LRTI	1.09	1.30	0.71	1.15	1.11	1.25	0.96
<i>N</i> =2,093	(0.90, 1.31)	(0.87, 1.96)	(0.52, 0.96)	(0.90, 1.48)	(0.87, 1.42)	(0.99, 1.57)	(0.76, 1.21)
Persistent cough	1.01	1.21	0.89	1.23	0.91	1.25	0.85
<i>N</i> =2,134	(0.79, 1.30)	(0.71, 2.03)	(0.60, 1.34)	(0.89, 1.70)	(0.65, 1.27)	(0.93, 1.68)	(0.62, 1.16)
Eczema	1.07	1.04	1.08	1.28	0.91	1.17	1.03
<i>N</i> =2,128	(0.86, 1.32)	(0.62, 1.73)	(0.78, 1.51)	(0.96, 1.70)	(0.68, 1.22)	(0.89, 1.54)	(0.79, 1.33)
Otitis	1.00	1.08	1.05	1.05	0.84	1.11	0.91
<i>N</i> =2,167	(0.83, 1.21)	(0.71, 1.63)	(0.79, 1.41)	(0.82, 1.35)	(0.66, 1.08)	(0.88, 1.40)	(0.72, 1.14)

Models adjusted for: Wheezing: cohort, sex, day-care, breast feeding, maternal asthma, social class. LRTI: cohort, sex, day-care, maternal asthma and age. Persistent cough: cohort, social class, day care, parental studies. Eczema: cohort, sex, maternal asthma. Otitis: cohort, day-care, maternal asthma

LRTI low tract respiratory infection

^a Compared to “no” (*N*=1,099)

^b Compared to 0 h (*N*=1,199 for indoor pools and *N*=1,099 for outdoor pools and total)

Table 4 Sensitivity analysis

	Wheezing		LRTI		Persistent cough		Eczema		Otitis	
	OR (95 %CI)	N	OR (95 %CI)	N	OR (95 %CI)	N	OR (95 %CI)	N	OR (95 %CI)	N
Final model	1.06 (0.88,1.28)	2163	1.09 (0.90,1.31)	2093	1.01 (0.79,1.30)	2134	1.07 (0.86,1.32)	2128	1.00 (0.83,1.21)	2167
Mothers with asthma	1.39 (0.70,2.78)	157	0.99 (0.49,2.00)	151	0.98 (0.38,2.53)	153	0.87 (0.42,1.81)	158	1.41 (0.71,2.80)	158
Maternal or paternal atopy ^a	1.15 (0.86,1.53)	912	1.13 (0.85,1.50)	885	0.94 (0.64,1.38)	896	0.98 (0.71,1.35)	898	1.00 (0.75,1.32)	915
High social class (I, II)	0.99 (0.65,1.51)	472	1.29 (0.87,1.91)	477	0.93 (0.55,1.54)	466	1.08 (0.69,1.68)	469	0.90 (0.60,1.34)	475
Low social class (IV, V)	1.05 (0.81,1.36)	1112	1.15 (0.89,1.48)	1115	1.09 (0.78,1.54)	1097	1.08 (0.79,1.47)	1089	1.11 (0.86,1.44)	1112
Excluding Asturias	1.08 (0.88,1.33)	1765	1.17 (0.95,1.43)	1773	1.03 (0.78,1.36)	1754	1.04 (0.81,1.32)	1752	0.93 (0.76,1.15)	1767
Infants <1.5 years	1.03 (0.83,1.27)	1696	1.15 (0.93,1.41)	1706	1.01 (0.77,1.34)	1684	1.02 (0.79,1.31)	1687	0.94 (0.76,1.16)	1703
Born in winter or spring	1.23 (0.94,1.61)	1063	1.25 (0.96,1.63)	1075	1.11 (0.79,1.58)	1048	1.03 (0.76,1.39)	1046	0.93 (0.71,1.21)	1066
Born in summer or autumn	0.90 (0.68,1.18)	1098	0.94 (0.72,1.22)	1097	0.93 (0.64,1.34)	1085	1.21 (0.88,1.68)	1082	1.17 (0.89,1.55)	1090
Imputing zero to missing outcomes	1.07 (0.88,1.29)	2192	1.08 (0.90,1.30)	2121	1.01 (0.79,1.30)	2201	1.04 (0.84,1.29)	2201	1.00 (0.83,1.20)	2197
Without symptoms at 6 months ^b	1.44 (0.73,2.85)	302	0.65 (0.35,1.18)	302	1.04 (0.45,2.43)	299	1.33 (0.53,3.36)	300	1.18 (0.67,2.08)	301
Asturias	0.99 (0.65,1.51)	400	0.88 (0.57,1.37)	373	0.93 (0.53,1.65)	383	1.20 (0.78,1.84)	376	1.32 (0.87,1.99)	402
Guipuzkoa	0.86 (0.61,1.23)	541	1.32 (0.93,1.87)	541	0.92 (0.61,1.39)	536	0.76 (0.47,1.21)	536	0.96 (0.67,1.37)	539
Sabadell	1.28 (0.87,1.90)	526	0.86 (0.59,1.25)	536	1.42 (0.85,2.37)	518	0.91 (0.59,1.40)	521	1.00 (0.68,1.47)	533
Valencia	1.01 (0.71,1.45)	699	1.30 (0.93,1.83)	699	0.82 (0.46,1.45)	699	1.53 (1.02,2.28)	694	0.85 (0.60,1.21)	695

Odds ratio, 95 % confidence interval (OR, 95 %CI) of respiratory outcomes for attending vs. not attending swimming pools in the final model and subgroups of the study population. High social class includes managers and technicians. Low social class includes semi-skilled and unskilled

LRTI low respiratory tract infection, SGA small for gestational age

^a Father or mother with allergic asthma, atopic dermatitis, eczema or allergic rhinitis

^b Infants without wheezing, LRTI, persistent cough, eczema or otitis at 6 months. Data available only for Sabadell

[19]. In our study, stratification by self-reported parental atopic status did not modify the results. Pool attendance increased the risk of wheezing and otitis among the 160 babies with asthmatic mothers but this was not statistically significant. This risk was not further increased among the 929 babies with the father or mother with allergic asthma, atopic dermatitis, eczema or allergic rhinitis. Therefore, uncertainty remains regarding the existence of an increased risk of respiratory effects by pool attendance among babies with parental atopy.

Baby swimming was more common among socioeconomically favoured families, as reported in Norwegian babies [19] and among older children in Spain [8] or UK [10]. In that sense, the prevalence of swimming pool attendance described in our study population could have been overestimated, since our final analysed population was slightly selected with higher socioeconomic status. Another limitation of this study is that both exposure and effects refer to the same period of time (from birth to the 14-month follow up). Disorders could have occurred either before, after or simultaneously to pool attendance. The lack of association in this and previous studies may indicate that babies attending pools during the first year of life are not at higher risk of having otitis, LRTI or wheezing. However, if infants who started attending pools and developed some health problem had stopped baby swimming before the study interview, the results could have been biased. The slightly higher association in the intermediate cumulative duration of pool attendance that disappears in the highest category would be in favour of this effect. However, none of the associations reached statistical significance. To further explore this, we used data from one of the four cohorts that collected information on respiratory manifestations at 6 months of age and confirmed that there was also no association between pool attendance at 14 months and LRTI, wheezing or persistent cough before 6 months. Although this data suggest that pool attendance at 14 months was not influenced by early disorders, we cannot completely rule out a potential selection bias, which would dilute a real association between baby swimming and these manifestations. The unclear temporality of exposure-outcome events and the challenge in measuring them during the first year of life even in a birth cohort was previously highlighted by Nystad et al. [19] and should be better addressed in future studies.

This is the first study evaluating health effects of swimming pool attendance during the first year of life in a southern European country. It has a large and population-based sample from different regions in Spain that allowed distinguishing indoor and outdoor pool attendance patterns. As in previous studies [18, 19, 22, 23], information on signs and symptoms and swimming pool attendance was collected through questionnaire, what could lead to some exposure and outcome misclassification. However, we could collect data at around 1 year of age, leading to less misclassification and recall bias than some of the previous studies with data

collected retrospectively during childhood [18, 22, 23]. Several maternal and environmental factors that can affect the evaluated outcomes were considered in the study, such as breastfeeding, day care attendance or tobacco smoke, but further adjustment by medication during pregnancy or air pollution was not carried out. Future follow-ups in this cohort are planned to evaluate the impact of early swimming pool attendance in respiratory health later during childhood. Respiratory and atopic manifestations as well as swimming pool attendance will be evaluated at 4 years of age [13]. Furthermore, physical activity will be also evaluated at different follow ups during childhood, which will allow considering this potential confounder and overcoming this limitation in previous studies [8].

To summarize, approximately 20 % of Spanish babies attended indoor pools during the first year of life and 40 % attended outdoor pools. No association was found between outdoor or indoor pool attendance and LRTI, wheezing, cough, eczema or otitis during the first year of life.

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