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Baby swimming and respiratory health

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Abstract

Aim—To estimate the effect of baby swimming the first six months of life on respiratory diseases from 6 to 18 months.

Methods—We used data from The Norwegian Mother and Child Cohort Study (MoBa) conducted by the Norwegian Institute of Public Health in children born 1999 – 2005 followed from birth to the age of 18 months (n = 30,870). Health outcomes: lower respiratory tract infections (LRTI), wheeze and otitis media between 6 and 18 months of age. Exposure: baby swimming at age 6 months. The effect of baby swimming was estimated by logistic regression analysis adjusting for potential confounders.

Results—About 25% of the children participated in baby swimming. The prevalence of LRTI was 13.3%, wheeze 40.0% and otitis media 30.4%. Children who were baby swimming were not more likely to have LRTI, to wheeze or to have otitis media. However, children with atopic mothers who attended baby swimming had an increased risk of wheeze, aOR 1.24 (95% CI 1.11, 1.39), but not LRTI or otitis media. This was also the case for children without respiratory diseases before 6 months aOR 1.08 (95%CI 1.02–1.15).

Conclusion—Baby swimming may be related to later wheeze. However, these findings warrant further investigation.

Keywords

Baby swimming; respiratory health

Introduction

It is hypothesised that there may be a causal relationship between environmental exposures from baby swimming in indoor pools and infant respiratory health outcomes. The environmental exposures include volatile chlorination products with possible effects upon lung epithelium and asthma (1–4). However, data are sparse and inconclusive. Bernard et al has, for example, suggested that baby swimming in chlorinated indoor pools may be associated with distal airway alterations predisposing children to the development of asthma and recurrent bronchitis (5). In contrast, another study implies that swimming may protect against the development of otitis media among children aged 1–4 years (6). Previous Norwegian data have

indicated an increased risk of recurrent respiratory tract infections among children taking part in baby swimming if their parents had a history of atopy (7). Due to methodological weaknesses of previous studies, these findings need to be confirmed using a prospective study design.

The Norwegian Mother and Child Cohort Study (MoBa) is a large population based pregnancy cohort study in which 100,000 pregnant women will participate (8) (Protocol, www.fhi.no). Questionnaires are administered at various stages in pregnancy and the mothers and their children are followed prospectively after birth. This study provides a unique opportunity to assess the relationship between baby swimming and respiratory health. We estimated the effect of baby swimming during the first six months of life on respiratory diseases from 6 to 18 months.

Material and methods

Norway has about 4.5 million inhabitants, and approximately 55,000 births a year. The target population of MoBa is all women who give birth in Norway. For practical reasons, the sampling frame comprises pregnant women who attend routine ultrasound examination, which offered to all, and accepted by nearly all pregnant women in Norway. Together with appointments for ultrasound scanning in week 17–18 of pregnancy, the pregnant women receive a postal invitation that includes an informed consent form, the first questionnaire, an information brochure as well as a questionnaire for the father. The first questionnaire asks for data on outcomes of previous pregnancies, medical history before and during pregnancy, medication, occupation, exposures in workplace and at home, life style habits and mental health, while a second questionnaire in week 22 ask for food intake. A third questionnaire is sent at 30 weeks and covers the woman's health status and a variety of environmental exposures during pregnancy. A questionnaire when the child is 6 months has focus on child health and nutrition as well as maternal disorders, well-being and mental health. The questionnaire at 18 months is also focused on the child's health and developmental status.

Pregnancy and birth records in the Medical Birth Registry of Norway (MBRN) are included in the MoBa database (9). The MBRN provide information about pregnancy outcomes, complications in pregnancy and the neonatal period. The objective of MoBa is to test specific etiological hypotheses by estimating the association between exposures and diseases, aiming at prevention (8). The study has been approved by the regional committee for ethics in medical research and the Data Inspectorate.

In the present study, we used data from the first 30,870 children born 1999 – 2005, followed from early pregnancy to the age of 18 months. The present study is based on version three of the quality-assured data files, made available for research in April 2007. Our study population includes all children who had reached 18 months of age whose mother had completed the first pregnancy questionnaire and the questionnaires at six and 18 months ($n=33,192$). Children born before 37 completed weeks of gestation, and children with birth weight <2500 g were excluded from the analysis ($n = 2322$), leaving 30,870 children included in this study.

Health outcomes

The three main health outcomes of the present study were maternal reports of lower respiratory tract infections (LRTI), wheeze and otitis media between 6 and 18 months of age. Lower respiratory tract infections (LRTI) included RS-virus, bronchiolitis, bronchitis or pneumonia, wheeze was defined as an episode of chest congestion or whistling in the chest, and otitis media as at least one episode. All outcomes were dichotomized into yes versus no. All children with the actual health outcomes between 6 and up to 18 months were categorized as having the disease.

Exposure

The main exposure was maternal reports of their children's participation in baby swimming at age 6 months. The question was: "Does your child participate in baby swimming?", The children were categorized into baby swimming (yes) *versus* no baby swimming (no) based on the answers.

Covariates

We adjusted for the following covariates: maternal age, maternal atopy, maternal education, maternal smoking during pregnancy, parental smoking post partum, parity, the child's season of birth, birth weight, gender, breast feeding, and day care attendance. The selection of covariates was based on the literature and prior knowledge to factors that may influence the health outcomes. The covariates were categorized as follows: maternal atopy was defined as ever having hay fever, atopic eczema, or asthma (yes *versus* no) before pregnancy, maternal education (number of years of education completed: ≤ 12 , >12 – <16 , and ≥ 16 , with an extra category "other" for women not giving number of years but marked in a box for "other"), maternal smoking in pregnancy (smoking more than one cigarette per day or occasional smoking), obtained from the first pregnancy questionnaire (yes *versus* no), parental smoking post partum (0–3 months after birth) (yes *versus* no), parity (0, 1 or more than 1 previous pregnancy with a duration of more than 20 weeks), the child's season of birth classified according to the infant's birth month, and categorized into four seasons: spring (March–May), summer (June–August), fall (September–November), winter (December–February), breastfeeding at 6 months of age (yes *versus* no), birth weight and maternal age were included as continuous variables, and day care attendance: nanny/private or kindergarten from 0–18 months compared to no attendance. Information regarding the child's gender, birth weight and month of birth were obtained from the Norwegian Medical Birth Registry (9). Illness before 6 months of age was any episode of LRTI (yes *versus* no) and any episode of otitis media (yes *versus* no). Wheeze was not queried before 6 months of age.

Statistical analysis

First, we described the prevalence of baby swimming by the characteristics of the mothers and the children. The incidence proportion of lower respiratory tract infections (LRTI), wheeze and otitis media was then estimated by baby swimming and the different covariates. We used logistic regression analysis to estimate the association between baby swimming and LRTI, wheeze and otitis media. The results are presented as crude (c) and adjusted odds ratios (aOR) with 95% confidence intervals (95%CI). To test the hypothesis that children of mothers with a history of atopy are more likely to develop respiratory diseases in relation to baby swimming, we investigated the effect of baby swimming in two strata: mothers with and without atopy. In addition, we checked for interaction by performing analysis including an interaction term between maternal atopy and baby swimming, and all covariates in the analyses.

Data were analyzed using Stata 9.2 (Stata Corporation, College Station, Texas).

For regression analyses, we used the binreg command with the odds ratio option. This is a generalized linear model with logit-link for binary data.

The number of missing was in general low, not exceeding 2.3 % for the questions on health outcomes, and being 0.6 % for the question on baby swimming at 6 months. Thus missing are not included in analyses.

Results

Participation in baby swimming was common, about 25%. The prevalence of baby swimming was also almost similar among children with and without maternal history of atopy (26.6% *versus* 25.2%). The incidence proportion of lower respiratory tract infections (LRTI), wheeze and otitis media in children from 6 to 18 months based on the questionnaire at 18 months was respectively 13.3%, 40.0%, and 30.4%. Among those reporting LRTI 77.9% reported wheeze, whereas 37.0% of those with otitis media reported wheeze. The history of maternal atopy was 25.7%.

Table 1 shows how maternal and background characteristics, and illness first 6 months of life influence the probability of swimming at 6 months. Mothers who took their children to baby swimming in the age period 0–6 months were less likely to report respiratory diseases in their children aged 0–6 months. Furthermore, they were less likely to smoke, but more likely to breastfeed at 6 months. These mothers also had longer education. The prevalence of baby swimming was also higher among first born children (Table 1).

The cumulative proportion of LRTI, wheeze and otitis media by baby swimming and the characteristics of the mothers and their children showed that children who took part in baby swimming were not more likely to have LRTI (13.0 *versus* 13.4%), to wheeze (40.5 *versus* 39.8%) or to have otitis media (30.1 *versus* 30.5%). Children of mothers with a history of atopy were more likely to develop respiratory diseases than those without. We performed stratified analysis in children with and without maternal atopy. Table 2 shows the incidence proportion of LRTI, wheeze and otitis media by baby swimming and the characteristics of the mothers in the two strata: mothers with and without atopy. The main finding was that the incidence proportion of wheeze was higher in children who took part in baby swimming if their mothers were atopic, whereas the risk of LRTI and otitis media was not higher. The pattern of distribution of the other variables by LRTI, wheeze and otitis media was almost similar in the two strata (Table 2). The incidence of LRTI, wheeze and otitis media were higher in boys than girls. Smoking in pregnancy increased the incidence, whereas breastfeeding reduced the incidence of all health outcomes.

Table 3 describes the association between baby swimming and LRTI, wheeze and otitis media adjusting for the potential confounding factors in the two strata: mothers with and without atopy. Children of atopic mothers, who participated in baby swimming, had an increased risk of wheeze. In addition to stratification, we also performed analyses where we included an interaction term of maternal atopy and baby swimming in the analysis. There was a significant interaction between baby swimming and maternal atopy for wheeze ($p=0.004$).

We also performed an overall stratified analysis in children with and without respiratory diseases before 6 months. Children without respiratory diseases before 6 months of age had an increased risk of wheeze, aOR 1.08 (1.02–1.15), if they took part in baby swimming, whereas children with respiratory diseases before age 6 months had no increased risk of any of the health outcomes. Among children of atopic mothers without respiratory diseases before 6 months the risk increased to aOR 1.24 (1.11–1.39) for wheeze. Furthermore, in a sample of children ($n = 20\,204$), where we also had information from the father, the risk of wheeze was aOR 1.11 (1.00–1.23) if the mother or the father had atopy.

Discussion

The results of the present study suggest that some children have an increased risk of wheeze if they take part in baby swimming during infancy. However the risk of LRTI or otitis media was not increased.

In this analysis we have followed women through pregnancy and their off-springs in a large population-based pregnancy cohort study from birth up to age 18 months. Thus we have information on exposures, outcomes and potential confounding factors from early pregnancy through infancy. The strength of the present study is consequently that we can ensure that the actual exposure precedes the health outcomes. However, we can not exclude that some parents may have stopped baby swimming with their children due to the occurrence of early infant respiratory diseases. The exposure measure in this study was participating in baby swimming at 6 months, and we do not know how well this represents exposure to chlorinated pools before 6 months of age, as some children may have stopped swimming before queried, and thus being categorized as non-swimmers, while other may just have started. Our analysis showed that among those reporting respiratory diseases from age 0 to 6 months about 20% took part in baby swimming compared to about 26% among those with no respiratory diseases in this age period. We can thus not rule out that our result are influenced by “a healthy worker” effect e.g. that children with early infant respiratory diseases have stopped baby swimming before age 6 months. If that is the case, infant baby swimming could have an impact upon infant respiratory diseases, despite the lack of associations in this study. This is supported by the finding that children without respiratory diseases before six months of age had an increased risk of wheeze if they took part in baby swimming. Parents with a history of atopy may be more likely to report respiratory diseases in their children. This kind of differential misclassification should, however, not influence our results, if not atopic parents taking their children to baby swimming are more focused in observing symptoms like wheezing in their children

We found no association between baby swimming and LRTI or otitis media in children of parents with atopy. Baby swimming was, however, associated with wheeze in children with a parental history of atopy. The prevalence of wheeze is high in this study. One explanation for this could be that “chest congestion” is included as wheeze. Infant wheeze is an unspecific health outcome, representing both transient wheezing caused by common infectious episodes, and more persistent wheezing in children with susceptible airways more likely to develop chronic respiratory disease such as asthma (10). Estimates of wheeze could also result in bias due to a skewed maternal awareness of symptoms, for example in different educational levels, and by maternal interpretation of the term wheeze (11). However, the pattern of responses in relation to wheeze is similar as those for LRTI and otitis media, supporting that reports of wheeze may reflect real respiratory symptoms. Infants with susceptible airways due to their genetic background may be more prone to develop respiratory symptoms such as chest congestion or whistling in the chest as a result of exposures to physical, chemical and biological factors by baby swimming (12). This may explain why exposing babies to airway irritants, for example volatile chlorination products of indoor pools, may affect lung epithelium differently in children with and without parental atopy. It is also plausible that children with episodes of wheeze continued to swim, whereas those with LRTI and otitis media stopped baby swimming before age 6 months due to the greater seriousness of these diseases, which would result in less misclassification of swimming-exposure due to wheezing.

The results of previous studies on the effect of baby swimming on childhood respiratory health have been inconclusive (6;7;12;13). A recent cross-sectional study of 341 children aged 10–13 years, among whom 43 had followed an infant swimming program showed that infant swimming was associated with airway changes (12). This was, however, a small study with limited statistical power, and it is not clear to what extent the results may be biased and confounded. A higher proportion of the exposed children (14%) had, for example, a backyard pool compared to the non-exposed (3%). The cumulative incidence of indoor pool attendance during childhood was also much higher among those who where baby swimming. Thus it is difficult to distinguish between infant swimming and further swimming during early childhood including current swimming at age 10 to 13 years in the study population. The results of another study measuring the effect of current swimming pool attendance in 57 children have indicated

that repeated exposure to chlorination by-products in the air of indoor swimming pools has an adverse effect on the Clara cell (CC16) function in children, such that the anti-inflammatory role of CC16 in the lung could be diminished (12). A previous cross-sectional study of school children from our institute demonstrated that baby swimming increased the risk of recurrent respiratory tract infections among children of parents with atopy (7). We underlined, however, in that study that the finding needed to be confirmed using a longitudinal study design. The results of another new study showed that babies who did not participate in baby swimming had a lower rate of infections (14). However, the main limitation of this study was that they at age 6 retrospectively asked for the age of first pool attendance, and the main exposure was baby swimming first year of life. The health outcomes such as airway infections, otitis media and diarrhea were also related to first year of life. Thus we can not rule out whether the exposure precedes the health outcomes, and regarding causal inference, the results must be interpreted with caution (14).

In conclusion, our results suggest that early baby swimming may be related to wheeze up to age 18 months. However, these findings warrant further investigation.

We underline, that our study only clarifies the effect of baby swimming before age 6 months on respiratory diseases from 6 months up to age 18 months. A possible longitudinal effect of infant and early childhood swimming on later respiratory diseases needs further investigation.

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Prevalence and crude (c) and adjusted (a) odds ratios (OR) with 95% confidence intervals (95% CI) of swimming at 6 months according to lower respiratory infections and otitis media 0–6 months, and covariates for 30,870 children born 1999–2005 in The Norwegian Mother and Child Study.

Table 1

		%	cOR	Baby swimming (Yes)	
				aOR**	95%CI
LRTI 0–6	No	25,9	1	1	
	Yes	20,5	0,71*	0,95	0,83, 1,10
Otitis Media 0–6	No	25,9	1	1	
	Yes	20,0	0,74*	0,91	0,79, 1,05
Maternal atopy	No	25,2	1	1	
	Yes	26,6	1,08*	0,99	0,93, 1,06
Sex	Male	25,9	1	1	
	Female	25,2	0,97	0,96	0,91, 1,02
Maternal smoking in pregnancy	No	26,3	1	1	
	Yes	18,6	0,64*	0,84	0,75, 0,94
Parental smoking after birth	No	27,4	1	1	
	Yes	21,6	0,73*	0,85	0,79, 0,91
Season born	Winter	19,0	1	1	
	Spring	28,4	1,69*	1,82	1,689, 1,97
	Summer	27,4	1,60*	1,71	1,57, 1,86
	Fall	27,0	1,57*	1,64	1,51, 1,79
Breastfeeding at 6 months	No	21,0	1	1	

		Baby swimming (Yes)		
	%	cOR	aOR**	95%CI
Maternal education (years)	Yes	26,6	1,36*	1,33 1,23, 1,44
	≤12	20,2	1	1
	>12 –<16	28,2	1,55*	1,43 1,34, 1,53
	≥16	31,1	1,78*	1,64 1,51, 1,78
	Other	27,8	1,52*	1,47 1,209, 1,81
Parity	0	38,2	1	1
	1	18,1	0,36*	0,32, 0,37
	>1	11,4	0,21*	0,19, 0,23

* p<0.05

** Adjusted for maternal age, maternal educational level, maternal atopy, parity, gender, birth weight, season born, breastfeeding, maternal smoking in pregnancy, and parental postnatal smoking.

Incidence proportions (%) of lower respiratory tract infections (LRTI), wheeze and otitis media from age 6–18 months in different strata of characteristics, in children with and without atopic mothers (n= 30,870) among children born 1999– 2005 in The Norwegian Mother and Child Study.

Table 2

	Maternal atopy = No (n= 22,951)				Maternal atopy = Yes (n= 7,919)			
	LRTI %	Wheeze %	Otitis Media %		LRTI %	Wheeze %	Otitis Media %	
Overall	12,6	38,3	29,9		15,4	45,0	31,9	
Baby swimming 0–6 months								
No	12,7	38,4	29,9		15,4	44,1	32,1	
Yes	12,2	38,1	29,5		15,4	47,3	31,9	
Sex								
Male	14,5	41,8	31,8		17,4	50,1	34,6	
Female	10,5	34,6	27,8		13,2	39,7	29,1	
Maternal smoking in pregnancy								
No	12,4	37,9	29,8		15,1	44,5	31,8	
Yes	14,5	41,4	30,7		17,6	49,1	33,7	
Parental smoking after birth								
No	12,2	37,7	29,9		15,2	44,3	31,5	
Yes	13,5	40,5	29,8		15,1	47,6	33,2	
Season born								
Winter	11,5	34,0	30,2		14,4	41,9	30,8	
Spring	11,3	37,1	28,4		14,8	41,7	30,5	
Summer	14,7	41,5	29,6		16,8	49,2	31,7	
Fall	13,0	40,6	31,6		15,4	47,1	34,9	
Breastfeeding (months)								
< 6	13,2	40,8	30,7		17,4	48,6	34,3	
≥ 6	12,4	37,7	29,7		14,9	44,2	31,4	
Maternal education (years)								
≤12	12,3	37,8	29,8		16,0	45,9	32,8	
>12 – <16	12,6	39,4	29,6		15,0	46,4	31,9	
≥16	13,3	37,1	30,8		15,8	40,7	30,1	

	Maternal atopy = No (n= 22,951)				Maternal atopy = Yes (n= 7,919)			
	LRTI %	Wheeze %	Otitis Media %		LRTI %	Wheeze %	Otitis Media %	
Parity	Other	12,9	35,1	28,9	6,5	36,0	32,9	
	0	10,9	35,0	28,1	13,6	42,9	29,7	
	1	13,9	41,7	31,3	17,1	48,9	34,8	
	>1	13,6	38,8	30,8	16,7	43,1	32,6	

Table 3

Incidence proportions and adjusted* odds ratios (aOR) with 95% confidence intervals (95%CI) for wheeze, lower respiratory tract infections (LRTI) and otitis media between 6 and 18 months of age in strata of maternal atopy, according to baby swimming 0 – 6 months for 30,870 children born 1999 – 2005 in the Norwegian Mother and Child Cohort.

Maternal atopy		LRTI			Wheeze			Otitis Media		
		%	aOR	95%CI	%	aOR	95%CI	%	aOR	95%CI
No (n = 22,951)	Baby swimming	No	12,7	1	38,4	1		29,9	1	
		Yes	12,2	1,00	38,1	1,02	0,95, 1,10	29,5	1,04	0,96, 1,12
Yes (n = 7,919)	Baby swimming	No	15,4	1	44,1	1		32,1	1	
		Yes	15,4	1,14	47,3	1,24	1,11, 1,39	31,9	1,06	0,94, 1,20

* Adjusted for maternal age, maternal educational level, parity, sex, birth weight, season born, breastfeeding, maternal smoking in pregnancy, parental smoking after birth, and respiratory diseases before 6 months of age.