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Parental socioeconomic and psychological determinants of the 2009 pandemic influenza A(H1N1) vaccine uptake in children

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ABSTRACT

Background: Before COVID-19, the previous pandemic was caused by influenza A(H1N1)pdm09 virus in 2009. Identification of factors behind parental decisions to have their child vaccinated against pandemic influenza could be helpful in planning of other pandemic vaccination programmes. We investigated the association of parental socioeconomic and psychosocial factors with uptake of the pandemic influenza vaccine in children in 2009–2010.

Methods: This study was conducted within a prospective birth-cohort study (STEPS Study), where children born in 2008–2010 are followed from pregnancy to adulthood. Demographic and socioeconomic factors of parents were collected through questionnaires and vaccination data from electronic registers. Before and after the birth of the child, the mother's and father's individual and relational psychosocial well-being, i.e. depressive symptoms, dissatisfaction with the relationship, experienced social and emotional loneliness, and maternal anxiety during pregnancy, were measured by validated questionnaires (BDI-II, RDAS, PRAQ, and UCLA).

Results: Of 1020 children aged 6–20 months at the beginning of pandemic influenza vaccinations, 820 (80%) received and 200 (20%) did not receive the vaccine against influenza A(H1N1)pdm09. All measures of parents' psychosocial well-being were similar between vaccinated and non-vaccinated children. Children of younger mothers had a higher risk of not receiving the influenza A(H1N1)pdm09 vaccine than children of older mothers (OR 2.59, 95% CI 1.52–4.43, for mothers < 27.7 years compared to ≥ 33.6 years of age). Children of mothers with lower educational level had an increased risk of not receiving the vaccine (OR 1.46, 95% CI 1.00–2.14).

Conclusions: Mother's younger age and lower education level were associated with an increased risk for the child not to receive the 2009 pandemic influenza vaccine, but individual or relational psychosocial well-being of parents was not associated with children's vaccination. Our findings suggest that young and poorly educated mothers should receive targeted support in order to promote children's vaccinations during a pandemic.

1. Introduction

Vaccinations are one of the greatest public health advances and one of the most cost-effective ways to prevent diseases in children. Despite the many benefits of vaccinations to individuals and at the population level, vaccine hesitancy exists around the world, and World Health Organization (WHO) has identified it as one of the most significant global health threats [1]. Other reasons for families not to vaccinate their children include structural barriers such as the inability to take time off work, inconvenience or inaccessibility of vaccination, and social and cultural habits and norms [2–4].

The decision to vaccinate a young child is made by the parents and may be influenced by many factors, including recommenda-

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tions of health care professionals, national legislation, and opinions of relatives, peers, and public persons, among other factors [3]. In addition to reliable sources of information, there is currently a wealth of misleading information about vaccines on the Internet, which can confuse parents and influence their decision-making [4,5]. Even though the source may be perceived as unreliable at the time of retrieving the information, people may later remember the message but not the source, and the perception of unreliability is lost [6]. The decision-making is a multi-factorial cognitive process and can be especially difficult for those with psychological stress or mental disorders [7]. Based on previous studies, the socioeconomic background of the family, and especially of the mother, increases the risk of not vaccinating the child [8–10]. Parents with lower education levels and unemployed parents are more likely than others to have a negative attitude towards both vaccines included in the national immunization programme and other vaccines. More data are needed on the impact of psychological and socioeconomic factors on parental vaccination decisions.

In 2009, a novel influenza A(H1N1) virus spread quickly around the globe as a pandemic. Vaccines were developed rapidly and population-level vaccinations began as soon as possible [11]. A monovalent, adjuvanted influenza A(H1N1)pdm09 vaccine was used in Finland for children and adults, wit high coverage in children [12,13]. In this study, our aim was to examine associations of parental psychological and socioeconomic factors with the vaccination of young children against the pandemic influenza in 2009–2010 within a birth cohort study. We hypothesized that socioeconomic factors, parental depressive symptoms, loneliness, pregnancy-related anxiety, and poor relationship satisfaction influence parental decisions to have their child vaccinated against the 2009 pandemic influenza.

2. Methods

This study was conducted within the prospective birth-cohort study, the Steps to the Healthy Development and Well-being of Children (the STEPS Study). In the Hospital District of Southwest Finland, 9936 children were born between January 2008 and April 2010. Of these children, 1805 children were recruited to the STEPS Study during the first trimester of pregnancy or shortly after birth. No selection criteria other than language (Finnish or Swedish speaking family) were used [14].

In this study we included children who were at least 6 months of age, and thus eligible for influenza vaccination, on October 1, 2009. The monovalent, adjuvanted influenza A(H1N1) vaccine (Pandemrix, GSK) arrived in Finland on October 12, 2009, and vaccinations were started right after that with a programme of one dose to all individuals from 6 months of age (half of an adult dose for children, ca. 1.9 mg of hemagglutinin). One dose of a seasonal trivalent influenza vaccine was recommended to children from 6 to 35 months of age at the same time as the pandemic vaccine, and a second dose of seasonal vaccine 1 month later to children who had never before received an influenza vaccine. Data on the administration of the influenza A (H1N1)pdm09 vaccine and seasonal trivalent influenza vaccine to the study children between October 1, 2009, and August 31, 2010, were collected from the electronic registers of regional well-baby clinics, where the children received their vaccines as part of the national immunization programme. Demographic, socioeconomic, and other background data including chronic diseases of parents were collected by questionnaires on recruitment. Data on pregnancy and birth were retrieved from the National Birth Registry.

The Ministry of Social Affairs and Health and the Ethics Committee of the Hospital District of Southwest Finland approved the study. Parents of participating children gave their written, informed consent. The study complies with the Declaration of Helsinki.

2.1. Psychological measures

Mothers' and fathers' depressive symptoms were measured with Beck's Depression Inventory (BDI) at gestational week 20, satisfaction with a relationship with A Revision of the Dyadic Adjustment Scale (RDAS) at gestational week 20 and at child's age of 4 months, pregnancy-related anxiety with the Pregnancy-Related Anxiety Scale (PRAQ) at gestational week 20, and social and emotional loneliness with UCLA loneliness scale at gestational week 20 and at child's age of 8 months. Parents of children recruited after birth received only the 4 and 8 month questionnaires.

BDI is a widely used measure for the assessment of depression. This measure can be used to screen for depression, assess severity, and monitor treatment [15]. The Finnish version of BDI-II includes 21 sections, each scored according to the severity of the depressive symptoms. Test symptom surveys are well suited for screening [16]. RDAS is an effective measure for assessing satisfaction with a relationship. The test consists of three areas with a total of 14 points. These three areas include dyadic consensus, dyadic satisfaction, and dyadic cohesion [17]. The PRAQ is a widely used scale to identify maternal anxiety during pregnancy. The test contains 40 items and 10 domains [18]. The loneliness experienced by the parents was examined with a Finnish version of the UCLA loneliness scale, which has been validated with Finnish data [19]. The measure includes factors of social loneliness (SC) and emotional loneliness (EM). Both factors include six statements by which the frequency and amount of feelings of loneliness are assessed [20].

2.2. Statistical analyses

Exposure variables were compared between children who did or did not receive the influenza A(H1N1)pdm09 vaccine. Categorical variables were compared with the Chi-squared test. Parents' psychological indicators and other continuous variables were compared using the T-test (mother's age, RDAS) or Wilcoxon rank-sum test (BDI, SC, EM, and PRAQ, because of the exception of normal distribution).

Latent variables were formed from all measured psychological variables for time points of 20 weeks of gestation (RDAS, BDI, SC, EM, and PRAQ) and 8 months of age of the child (SC and EM). The latent variables were made separately for mothers and fathers by standardizing the original variables and averaging these variables. The association between latent variables and the vaccination of the child against influenza A(H1N1)pdm09 was examined with the Wilcoxon rank-sum test.

The association between background, socioeconomic, and psychological factors and the vaccination of the child against influenza A(H1N1)pdm09 was analyzed by logistic regression using SAS's "LOGISTIC" procedure. For the regression analysis, the age of the mother was categorized using the median and quartiles (<27.7 years; 27.7–30.6 years; 30.7–33.5 years; and $\geq$ 33.6 years). The choice of the model started with a full model that included the background and socioeconomic factors (Table 1) and psychological variables (Table 2), taking into account the correlations between the variables. Maternal and paternal psychological factors and primary and higher education were strongly correlated with each other. A high educational level was defined as a polytechnic or master's degree or higher. Psychological factors were also tested in the models one at a time with the background and socioeconomic variables. However, psychological factors were not statistically significant in the model and the model selection criteria (Akaike information criterion and Bayesian information criterion) and the plausibility quotient following the test were used to select

Table 1
Characteristics of the study children and their parents by children's vaccination against influenza A(H1N1)pdm09.

	Children, No. (%)[a]		
Characteristic	Vaccinated (n = 820)	Not vaccinated (n = 200)	*P* value[b]
Child			
Male sex	425 (52)	112 (56)	0.29
Prematurity (<37 weeks)	49 (6)	10 (5)	0.60
At least one sibling	424 (52)	93 (47)	0.19
Mother			
In a relationship when child born	760 (96)	178 (93)	0.12
Basic education at least high school	617 (77)	117 (60)	<0.0001
Highly educated	481 (60)	87 (45)	<0.0001
Chronic condition[c]	383 (48)	92 (48)	0.96
Father			
Basic education at least high school	421 (54)	84 (64)	0.047
Highly educated	347 (44)	63 (35)	0.027
Household income > 3000 €/month	367 (46)	62 (32)	0.0006

[a] Percentages were calculated from those with data available.
[b] Chi-squared test.
[c] Includes mild conditions such as allergies.

Table 2
Psychological indicators of mother and father at 20 weeks of pregnancy and at child's age of 4 and 8 months by children's vaccination against influenza A(H1N1)pdm09.[a]

Psychological indicators and time of measurement	No. with data	Vaccinated children (n = 820)	Not vaccinated children (n = 200)	*P* value[b]
Gestational week 20				
RDAS, mother	739	31 (6.4)	31 (6.3)	0.91
RDAS, father	683	31 (5.8)	31 (6.3)	0.89
BDI, mother	771	8 (5, 12)	9 (6, 13)	0.15
BDI, father	694	2 (0, 5)	2 (0, 5)	0.95
SC, mother	771	9 (8, 11)	9 (8, 12)	0.33
SC, father	693	9 (7, 11)	9 (8, 12)	0.15
EM, mother	773	8 (7, 10)	9 (8, 10)	0.15
EM, father	701	9 (8, 11)	9 (8, 11)	0.39
PRAQ, mother	787	37 (32, 42)	37 (31, 43)	0.80
PRAQ, father	710	20 (16, 22)	20 (16, 23)	0.17
Latent variable, mother	788	−0.094 (-0.49, 0.34)	0.0039 (-0.43, 0.39)	0.37
Latent variable, father	711	−0.079 (-0.50, 0.39)	−0.049 (-0.47, 0.43)	0.62
Child's age 4 months				
RDAS, mother	474	31 (6.4)	32 (7.6)	0.61
RDAS, father	426	31 (6.2)	31 (6.4)	0.52
Child's age 8 months				
SC, mother	597	9 (8, 12)	10 (8, 12)	0.40
SC, father	545	9 (7, 11)	9 (7, 12)	0.21
EM, mother	584	8 (7, 10)	9 (8, 11)	0.13
EM, father	543	9 (7, 10)	9 (7, 11)	0.44
Latent variable, mother	606	−0.21 (-0.71, 0.47)	−0.051 (-0.59, 0.51)	0.22
Latent variable, father	549	−0.13 (-0.68, 0.43)	0.055 (-0.87, 0.80)	0.32

Abbreviations: BDI, Beck's Depression Inventory; EM, emotional loneliness; PRAQ, Pregnancy Related Anxiety Scale; RDAS, A Revision of the Dyadic Adjustment Scale; SC, social loneliness.
[a] Data are presented as mean (standard deviation) or median (quartiles Q1, Q3). Latent variables were made by standardizing the original variables and averaging these variables.
[b] T-test or Wilcoxon rank-sum test as appropriate.

the model in Fig. 1. Child's sex, premature birth (<37 gestational weeks), household siblings, mother's age, household monthly income (< 1000 €; 1000–1999 €; 2000–2999 €; 3000–3999 €; and ≥ 4000 €), and mother's and father's education were included in the final model as explanatory variables. The level of significance was set at *P*-value < 0.05. Analyses were made with the SAS software, version 9.4 for Windows (SAS Institute Inc).

3. Results

Of the 1805 children in the STEPS Study, 1020 were at least 6 months of age by October 1, 2009, and were included in this study (age range, 6–20 months). Of these children, 869 were recruited during the first trimester of pregnancy and 151 after birth. Administration of pandemic vaccines to the study children began on October 23, 2009, and 90% of vaccinations were carried out by November 18, 2009. During the study period, 820 (80.4%) children received the influenza A(H1N1)pdm09 vaccine and 200 (19.6%) children did not receive it. At least one dose of the seasonal influenza vaccine was received by 331 (40%) of 820 children who received the pandemic vaccine and by 14 (7%) of 200 children who did not receive the pandemic vaccine (*P* <.0001).

Table 1 presents background and socioeconomic factors by influenza A(H1N1)pdm09 vaccination status. The mean age [standard deviation, SD] of vaccinated and non-vaccinated children was similar at the beginning of the study period (1.0 [0.29] and 1.0 [0.27] years, respectively). The mothers of the children who did not receive the A(H1N1)pdm09 vaccine were younger (mean [SD] age at the time of childbirth, 29.3 [4.9] years) than the moth-

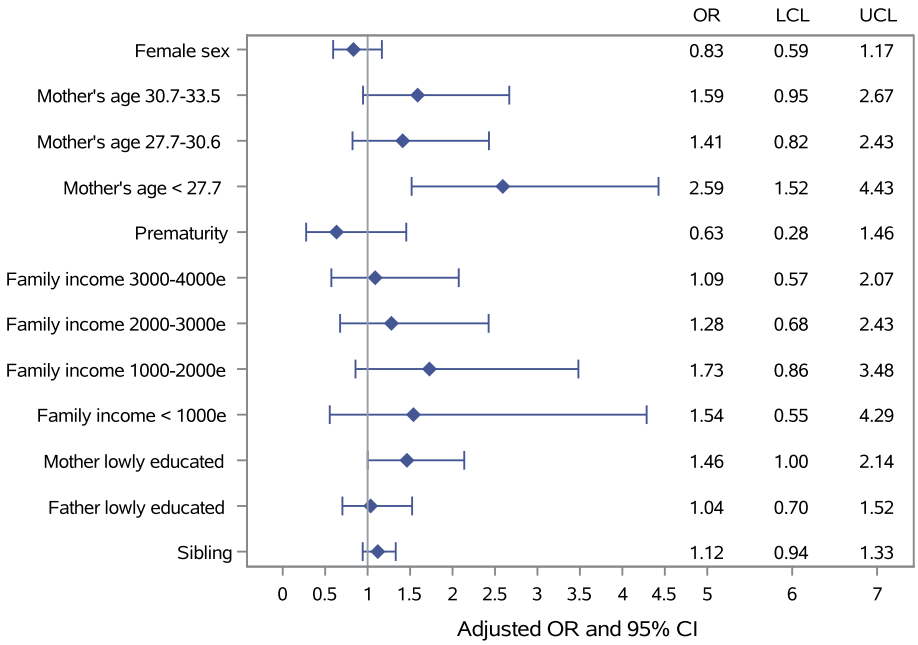

Fig. 1. Association between background and socioeconomic factors and the child not receiving the vaccine against influenza A(H1N1)pdm09. The diamonds represent adjusted odds ratios (OR) and the whiskers 95% confidence intervals (CI) analyzed by logistic regression analysis. LCL indicates lower limit and UCL upper limit of the 95% CI.

ers of children who did receive the vaccine (30.9 [4.9] years, P <.001). The mothers of the children who did not receive the A (H1N1)pdm09 vaccine had a lower education level, and the household income was lower compared to the children who did receive the vaccine. There were no significant differences in univariate comparisons between groups in measures of individual and relational psychosocial well-being of parents before the birth of the child or at child's ages 4 and 8 months (Table 2).

In the logistic models, psychological factors had no significant association with the vaccination of the child against the influenza A(H1N1)pdm09 and they were left out of the final model, results of which are presented in Fig. 1. Children of younger mothers had a higher risk of not receiving the A(H1N1)pdm09 vaccine than children of older mothers (odds ratio [OR], 2.59; 95% confidence interval [CI], 1.52–4.43, for mothers in the lowest age quartile [<27.7 years] compared to the mothers in the highest age quartile [≥33.6 years]). The children of mothers with a low education level had a higher risk of not receiving the vaccine than those with a high level of maternal education (OR, 1.46; 95% CI, 1.00–2.14).

4. Discussion

In this birth-cohort study, younger age and lower education level of the mother were associated with a higher probability of the child not receiving the pandemic influenza vaccine, whereas depressive symptoms, loneliness, pregnancy-related anxiety, or poor relationship satisfaction of parents did not have an effect on the vaccination of the child. The 2009 influenza pandemic caused by the influenza A(H1N1)pdm09 virus was the latest pandemic before COVID-19. Our results on the reasons behind the rejection of recommended pandemic influenza vaccine for children should be considered when tackling vaccine hesitancy during the implementation of pediatric COVID-19 vaccination programmes.

Our findings on younger maternal age and lower education level as risk factors for the child not receiving the vaccine are consistent with previous research on the importance of parents' socioeconomic background in their decisions on vaccinations [8–10,21,22]. In an adult study, individuals with higher educational levels were more often up-to-date with their tetanus vaccinations compared to those with lower educational levels [23]. In a national immunization survey in the U.S., factors associated with seasonal influenza vaccination of children aged 19–35 months included the primary caregiver being older, married, and more educated [24]. On the contrary, another study reported a negative association between the higher education level of parents and influenza vaccination of children [25]. These findings suggest bidirectional connections between education and vaccine hesitancy. The older age of the mother was associated with the child receiving influenza vaccine in a study conducted among black and Latino children living in inner-city neighborhoods of New York City [26]. Our study was conducted in Finland, which is a society with a high level of universal healthcare, small differences in income between social classes, and the existence of well-developed social welfare support for poor people. In our study, very young mothers were rare, education was quite good also in the group of lower education level, and families with lower income were eligible for the social allowance if needed. Even in this environment, we were able to document associations of lower maternal age and educational level with lower vaccine uptake in children, and a similar trend was seen for lower household income. Father's educational level was not associated with the vaccination of the child in the logistic model.

The impact of psychological factors on vaccination decisions has not been studied in detail before. We used validated questionnaires that comprehensively describe a wide range of psychological factors of the parents such as marital dissatisfaction, depression, social and emotional loneliness, and pregnancy-related anxiety. Questionnaires were conducted for both parents during pregnancy and at the child's ages of 4 and 8 months. Previous research has shown that decision-making can be difficult for persons who have depressive symptoms [7]. It could be assumed that vaccinations are easily missed if the parents have challenges in their personal life or family functioning. However, in our study, parents with questionnaire results that suggest depressive symptoms, emotional or social loneliness, pregnancy-related anxiety, or poor relationship satisfaction had their children vaccinated at

a similar rate to other parents. This is a reassuring finding and suggests that parents with psychological challenges rely on health care recommendations and prioritize their children's well-being.

Our results on factors behind vaccine uptake in children during the 2009 influenza pandemic may be applicable to pediatric vaccinations during the COVID-19 pandemic, but differences between the pandemics need to be observed. Clinical presentation of COVID-19 is mild in most young adults and children [27–29]. Despite the possibility of severe illness or prolonged symptoms, young adults and possibly also parents of young children may not perceive COVID-19 as a high-risk infection and may not give a high priority to vaccination. COVID-19 vaccine acceptance is lower in young adults compared to older people, and worry about side effects has been identified as the main cause behind it [30]. During the 2009 influenza pandemic, some parents felt that possible sequelae of the disease were more acceptable than potential complications from the vaccine, supporting their decision not to have their children vaccinated [31]. This is a worrying aspect and vaccine campaigns should focus on clear communication of the risks and benefits. The AS03-adjuvanted influenza A(H1N1) pdm09 vaccine used in Finland was later recognized to rarely be associated with narcolepsy in children and adolescents [32], but this phenomenon gained media attention first in August 2010, and should not have an effect on our results.

Our results suggest that when childhood pandemic vaccination campaigns are conducted, special attention should be paid to young mothers and to those with lower education levels, even in societies with a generally high level of basic education. Interventions should use methods of demonstrated efficacy to reduce barriers to vaccination and increase confidence [33,34]. Healthcare workers play a key role in increasing confidence in vaccines, and their expertise and knowledge of vaccines must be ensured through training [35–38]. Parents with depressive symptoms, loneliness, or poor relationship satisfaction need support, but according to our study, they do not form a distinct risk group for children missing the opportunity for vaccination. A caveat here is that the COVID-19 pandemic has caused substantial psychological stress, especially to young adults and mothers of children because of lock-down situations, unemployment, school closures, inability to meet friends and relatives, and other societal effects [39,40]. Thus, observations from the era of the 2009 influenza pandemic may not be directly applicable to the COVID-19 pandemic.

The strengths of this study are the unselected population-based cohort and the rigorous use of registry data and validated questionnaires. Limitations include missing psychological questionnaire data because of recruitment of part of the cohort after birth and non-responding participants. We have earlier reported that mothers in the STEPS Study were slightly more educated than mothers who were not recruited, and mothers responding to the questionnaires were on average older and they were more often married, and had higher occupational status than non-responding mothers [14]. As our cohort was from one district only, our inferences may not be directly generalizable to other populations. It should also be noted that our study was not designed to identify the effects of clinical depression or other psychiatric diagnoses of parents on vaccine uptake in children. Finally, part of the youngest study children received the vaccine between 6 and 8 months of age, just before the last survey. However, this should not be a major concern because the surveys reflect psychological well-being over a longer period of time.

5. Conclusion

Our findings suggest that parents' decision to have their child vaccinated against the 2009 pandemic influenza were associated with the family socioeconomic factors, but not with the individual or relational psychosocial well-being of the parents. The mother's young age and lower education level increased the risk for the child to not receive the vaccine. The results of this study can be utilized for better targeting childhood vaccine-related information to parents in pandemic situations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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