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ORIGINAL ARTICLE

Influenza vaccination among caregivers and household contacts of children with congenital heart disease before and during COVID-19 pandemic

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Aim: We aimed to investigate the influenza immunisation status of caregivers and household contacts of children with congenital heart disease (CHD) and potential barriers to vaccine uptake.

Methods: Prospective questionnaire-based survey over two influenza seasons (2019–2020 and 2020–2021) on 161 children with CHD attending a tertiary paediatric cardiology clinic and their families. Logistic regression and factor analysis were performed to identify factors associated with influenza vaccine uptake.

Results: Influenza vaccination coverage of children was 65%, whereas that of their fathers and mothers was 34% and 26%, respectively. Children with unvaccinated siblings represented 43% and those with unvaccinated adults in the household 79% of our study population. No statistically significant differences were found before and during COVID-19 pandemic on vaccine uptake. Logistic regression analysis showed that higher education level, understanding the risk of contracting the disease and vaccination status of the child determined the vaccination status of parents, regardless of their age, age of their child, severity of CHD, beliefs about vaccine safety and efficacy and risk of transmission if not vaccinated. Factor analysis revealed distinct groups among unvaccinated parents (76.3% of the variation in the responses).

Conclusions: Vaccination coverage of caregivers and household contacts of children with CHD is suboptimal. Influenza vaccination campaigns should take into consideration the specific characteristics of parental groups and target interventions accordingly to increase their vaccine uptake and indirectly protect children with CHD.

Key words: caregiver; child; congenital heart disease; household contact; influenza vaccine.

What is already known on this topic

1 Children with congenital heart disease (CHD) are at increased risk of influenza-related morbidity and mortality.
2 Household contacts and caregivers of children with CHD should receive the annual influenza vaccine.
3 Studies investigating influenza vaccination practices of caregivers are lacking.

What this paper adds

1 Vaccination coverage of caregivers and household contacts of children with CHD was suboptimal in our cohort.
2 Influenza vaccination campaigns should target interventions focusing on high-risk groups of parents to increase their vaccine uptake and indirectly protect their vulnerable children.

Influenza infection has a substantial disease burden, especially for high-risk individuals including young children and the elderly being responsible for approximately 250 000 to 500 000 deaths world-wide annually.[1–5] The World Health Organisation reports that world-wide, 20–30% of children are infected with influenza virus every year.[6] The risk of complications due to influenza, including lower respiratory tract infection, hospital admission and death is highly dependent on age and underlying comorbidities.[7,8] Children with congenital heart disease (CHD) are at increased risk of influenza disease complications.[9–11] A recent nationwide cross-sectional retrospective study based on the Kids' Inpatient Database of the USA concluded that the presence of CHD increased the risk of complications and in-hospital mortality in children with influenza infection.[12] The length of hospital stay was also higher, and there were no significant differences in the outcomes between severe and non-severe CHD.[12]

The American Academy of Pediatrics recommends routine influenza immunisation of all children starting at 6 months.[13] Particular emphasis should be given on ensuring that high-risk child and their household contacts and caregivers receive the annual influenza vaccine not only because it protects them from the risks of influenza and associated complications but because it may prevent transmission of the virus to their vulnerable

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children.[14] However, few studies have investigated influenza vaccination rates of high-risk children or their caregivers and have demonstrated suboptimal vaccination coverage in these populations world-wide.[15–20]

In Greece, annual influenza immunisation is currently recommended only for children above 6 months of age belonging to high-risk groups and not for all children.[21] Of note, influenza vaccination of children with CHD as well as their household contacts and caregivers is recommended and fully reimbursed by the National Immunization Schedule on an annual basis. The primary aim of the present study was to estimate influenza immunisation status of caregivers and household contacts of children with CHD and identify potential barriers to vaccine uptake. The secondary aim was to estimate influenza vaccination coverage of children with CHD.

Methods

Caregivers and household contacts of children with CHD who attended the Paediatric cardiology clinic of University General Hospital of Patras were recruited during two study periods: from October 2019 to December 2019 and from October 2020 to December 2020. University General Hospital of Patras is a large Tertiary Referral centre providing paediatric services for the geographical area of Western Greece. The study was approved by the Research and Ethics Committee of our institution (674/15-10-19). All parents/guardians of the children were informed about the study as well as data confidentiality and were asked to fill out an anonymous questionnaire. The latter included demographic characteristics and data on the type and severity of CHD which was filled in by the attending Paediatric Cardiologist. For the study purposes, we defined mild CHD defects that required only follow-up in the clinic whereas significant CHD defects requiring previous operation or transcatheter intervention and defects in children that awaited operation or have undergone transcatheter correction of their defect and those that were on medication. Parents also provided information about the number of children and adults in the household and their influenza immunisation status. They were also asked about their willingness to get vaccinated in the current influenza season and to denote their attitudes about the safety and the efficacy of the vaccine, the possibility to transmit influenza if they get the disease, the possibility to avoid transmitting influenza if they get vaccinated and their willingness to get vaccinated in the forthcoming influenza period. The answers to the last five questions were coded in a four-grade scale (4 = very high, 3 = moderately high, 2 = low, 1 = very low). During the second period of the study, which coincides with COVID-19 pandemic, they were also asked whether the pandemic has increased their willingness to vaccinate themselves and their children against influenza.

Statistical analysis

For continuous variables, the Students' *t*-test and one way ANOVA were used as appropriate. For normally distributed variables results are expressed as mean ± standard deviation. For discrete variables, the Fisher's exact test was applied. Results are expressed as absolute values and percentages (%). Logistic regression analysis was used to explore the determinants of vaccination acceptance. Factor analysis was also performed to determine groups among the unvaccinated caregivers with common characteristics.[15,22] All analyses were performed with IBM SPSS 25.0 software (IBM Corp, Armonk, NY, USA).

Table 1 Demographic characteristics of the study population ($n = 161$)

Demographic characteristics	
Age	Mean ± SD
Age of the child (years)	6.9 ± 4.5
Age of the mother (years)	38.2 ± 6.2
Age of the father (years)	42.6 ± 6.8
Severity of CHD	*n* (%)
Mild CHD	83 (52%)
Severe CHD	78 (48%)
Level of education (mother)	*n* (%)
<6 years	18 (11%)
7–10 years	8 (5%)
11–13 years	65 (40%)
Higher education	70 (44%)
Level of education (father)	*n* (%)
<6 years	19 (12%)
7–10 years	19 (12%)
11–13 years	64 (40%)
Higher education	59 (36%)

CHD, congenital heart disease.

Table 2 Vaccine coverage of the study population

Vaccine coverage of the study population	*N* (%)
Children vaccinated	104 (65%)
Significant CHD	60/78 (77%)
Mild CHD	46/83 (55%)
Mothers (all children)	55 (34%)
Mothers (children with significant CHD)	28/78 (36%)
Fathers (all children)	42 (26%)
Fathers (children with significant CHD)	23/78 (29%)
Parents	
None	104 (65%)
One	16 (10%)
Both	41 (25%)
Siblings	
No siblings	53 (33%)
At least one sibling vaccinated	59/108 (55%)
Families with no sibling vaccinated	46/108 (43%)
Other adults in the household	
No other adults	90
At least one vaccinated	15/71 (21%)
None vaccinated	56/71 (79%)

CHD, congenital heart disease.

Table 3 Parental attitudes of vaccinated and unvaccinated children

	Vaccinated	Unvaccinated	*P*
Safety	3.58 ± 0.52	2.89 ± 0.84	<0.0001
Efficacy	3.57 ± 0.52	3.11 ± 0.83	<0.0001
Risk of infection	2.89 ± 0.94	2.24 ± 1.10	<0.0001
Risk of transmission	3.62 ± 0.66	3.41 ± 0.76	0.07
Probability of vaccination in the current influenza season	3.48 ± 0.83	2.96 ± 0.85	<0.0001

Questions were coded in a four-grade scale: 4 = very high, 3 = moderately high, 2 = low, 1 = very low.

Results

Over the two influenza periods, a total of 161 questionnaires were completed (97 in the first period and 64 in the second). All parents contacted agreed to participate. The parents recruited in the second study period were not the same as the year before. The demographics of the study population are presented in Table 1 whereas vaccination coverage of the study population is shown in Table 2. The percentage of vaccination of children with CHD in the first period was 66/97 (68%) and in the second period was 46/64 (72%). The difference was not statistically significant (Fisher's exact test: 0.7266). Although the percentage of vaccination of the children was quite high the relevant parental percentage was quite low. The vaccination rate of the mothers was 30/97 (31%) in the first period and 24/64 (25%) in the second, whereas that of the fathers was 26/92 (27%) and 16/64 (25%), respectively. The differences were not statistically significant between the two study periods (Fisher's exact test 0.3992 and 0.7157, respectively). The percentage of unvaccinated adults in the household was 79%. With regards to children, the percentage of children with mild CHD that were vaccinated was 46/83 (55%), whereas the percentage of children with significant CHD that were vaccinated was 60/78 (77%). The difference was statistically significant (Fisher's exact test: 0.0048). When caregivers were asked whether the COVID-19 pandemic influenced positively their intention to get vaccinated against influenza they stated that it did so in 4/64 (6%) the vaccination of the child, in 6/64 (9%) the vaccination of the mother and in 6/64 (9%) the vaccination of the father.

Parental attitudes of vaccinated and non-vaccinated children are shown in Table 3. The reasons for non-vaccination of the child or the parents are listed in Table 4. Parental attitudes about vaccination according to their vaccination status are presented in Table 5. The results show that parents who believed in safety and efficacy of the vaccine and those who were afraid of influenza infection were more likely to have been vaccinated and also to get vaccinated in the current season. However, their beliefs about the risk of transmission did not differ between the three categories of paternal vaccination status.

Logistic regression analysis showed that higher education level (OR 2.49; 95% CI 1.37–4.51), understanding the risk of acquiring the disease (OR 1.76; 95% CI 1.01–3.08) and vaccination status of the child (OR 11.84; 95% CI 3.01–46.6) determined vaccination status of mothers, regardless of their age, age of their child, CHD severity and their beliefs about safety and efficacy of the vaccine and the risk of transmission if they do not get vaccinated. Similarly, higher education level (OR 3.02; 95% CI 1.31–6.95), understanding the risk of acquiring the disease (OR 3.86; 95% CI 1.48–10.06) and vaccination status of the child (OR 17.19; 95% CI 3.97–74.4) determined vaccination status of the fathers, irrespective of the effect of other parameters.

Factor analysis (Table 6) revealed four distinct groups among unvaccinated mothers and three groups among unvaccinated fathers that shared similar characteristics. In mothers, the first group consisted of participants who believed in the safety and

Table 4 Reasons for non-vaccination

Reasons for non-vaccination	
Child (unvaccinated 57 children)	*n* (%)
I did not know it was needed and did not ask	8 (14%)
I asked but I was told that it is not necessary	12 (21%)
I was told I need to vaccinate the child but	
I believe that the vaccines are not effective	2 (3.5%)
I am afraid of the side effects	1 (1.8%)
The child is allergic to the vaccine	0 (0%)
Financial reasons	2 (3.5%)
I did not have time/forgot	3 (0.5%)
I am not at all interested in this subject	29 (51%)
Mothers (unvaccinated 131 mothers)	*n* (%)
I did not know it was needed and I did not ask	28 (21%)
I asked but I was told that it is not necessary	16 (12%)
I was told I need to get vaccinated but	
I believe that the vaccines are not effective	6 (5%)
I am afraid of the side effects	16 (12%)
I am allergic to the vaccine	0 (0%)
Financial reasons	1 (0.8%)
I did not have time/forgot	17 (13%)
I am not at all interested in this subject	72 (55%)
Fathers (unvaccinated 119 fathers)	*n* (%)
I did not know it was needed and I did not ask	29 (24%)
I asked but I was told that it is not necessary	19 (16%)
I was told I need to get vaccinated but	
I believe that the vaccines are not effective	3 (2.5%)
I am afraid of the side effects	12 (10%)
I am allergic to the vaccine	0 (0%)
Financial reasons	5 (4%)
I did not have time/forgot	18 (15%)
I am not at all interested in this subject	33 (28%)

Table 5 Parental attitudes according to their vaccination status

Parental attitudes according to vaccination of the parents				
	Number of parents vaccinated			
	0	1	2	*P*
Safety[†]	3.22 ± 0.78	3.53 ± 0.62	3.59 ± 0.50	0.012
Efficacy[‡]	3.31 ± 0.74	3.47 ± 0.51	3.65 ± 0.48	0.031
Risk of infection[§]	2.45 ± 1.01	2.89 ± 1.02	3.14 ± 0.80	0.002
Risk of transmission of the disease[¶]	3.48 ± 0.72	3.72 ± 0.58	3.55 ± 0.70	0.243
Probability of vaccination in the current period[††]	2.98 ± 0.89	3.89 ± 0.32	3.89 ± 0.39	<0.0001

[†]Safety: 0 versus 2, $P = 0.018$.

[‡]Efficacy: 0 versus 2, $P = 0.025$.

[§]Risk of infection: 0 versus 2, $P = 0.002$.

[¶]Risk of transmission: non-significant differences.

[††]Probability of future vaccination: 0 versus 2, $P < 0.0001$, 0 versus 1, $P < 0.0001$.

Questions were coded in a four-grade scale: 4 = very high, 3 = moderately high, 2 = low, 1 = very low. One way ANOVA post hoc tests.

necessity of the vaccine, had vaccinated their child, but was told that the seasonal flu vaccine was not necessary for them. The second group consisted of mothers of older age, with older children, less educated and not convinced about vaccine safety and necessity. The third group included participants with older children, with less severe disease, who had not vaccinated their children or themselves because they were told that the vaccine was not necessary. The last group consisted of highly educated mothers who were worried about vaccine safety. These four groups could explain the 76.3% of variability in the questionnaire response. In fathers, the first group consisted of those who believed in vaccine safety and necessity, had vaccinated their child, but they were told that the vaccine was not necessary for them. The second group included fathers of older children, who did not vaccinate their child or themselves because they were not convinced about vaccine safety and necessity. The last group consisted of fathers who believed in vaccine safety, did not vaccinate their child and reported that they were unaware about the necessity of getting the vaccine themselves.

Discussion

In this study, we assessed the influenza vaccination status of parents, siblings and other household contacts of children with CHD attending our Paediatric Cardiology outpatient clinic, and we identified factors associated with suboptimal vaccination coverage. To the best of our knowledge, this is the first study of this kind in caregivers and household contacts of children with CHD. The results of this study show that a significant percentage of children with CHD get vaccinated against influenza and that the percentage is higher in those with significant CHD. Moreover,

Table 6 Factor analysis

	Mothers				Fathers		
	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3
Child's age	—	0.646	0.423	0.335	0.610	0.802	—
Disease severity	0.382	—	−0.304	—	—	—	−0.695
Child vaccinated	0.545	—	−0.546	—	0.574	−0.556	−0.349
Other parent unvaccinated	0.328	0.328	0.486	—	—	0.662	0.570
Parent's age	—	0.563	—	—	—	—	—
Parent's education	—	−0.429	—	0.682	—	—	—
Safety	0.796	−0.416	—	−0.647	0.829	−0.689	0.388
Efficacy	0.566	—	—	—	0.689	—	—
Risk of infection	0.747	—	—	—	0.945	—	—
Risk of disease transmission	0.361	−0.600	—	—	—	−0.642	—
Did not know/ask	—	—	—	—	—	—	0.416
Was told it is not necessary	0.524	—	0.652	—	0.407	—	—
% of variance explained	25.3	20.6	16.2	14.2	35	25.1	15.7

†Exploratory dichotomous factor analysis (promax oblique rotation and least squares extraction method).

Only parameters with a factor loading >0.300 are shown.

parents who believed in the safety and the efficacy of the vaccine, those who were afraid of the risk of infection and those planning to get vaccinated in the current influenza period were more likely to vaccinate their children. Our results differ from those of a previous study in Israel where the rate of influenza vaccination of children with CHD during the previous flu season was 36.6% and the recommendation of the child's physician was the main factor influencing the vaccination rate.[18] Similar findings were reported on vaccine coverage of patients who received a recommendation from their paediatric cardiologist. The authors suggest that parental misinformation about the influenza vaccine is a major contributor to the low rate of vaccination in the population of children with chronic heart disease.[18] However, the authors of this study did not divide the patients based on the severity of their cardiac problems. In addition, in another study examining influenza vaccination rates in adult CHD patients attending a single outpatient clinic the vaccination rate was 43%, which is slightly higher than in the general population with underlying cardiac morbidities, but still well below the ideal percentage.[19] Older patients and those that had not experienced side effects from previous vaccination were more likely to receive it again. Patients who were informed about the benefits of the vaccine by their physician were also more likely to receive it. The authors conclude that educating both the patients about the risk–benefit ratio of vaccination as well as the physicians about their important role in counselling adult CHD patients will likely improve the vaccination rates in this high-risk population. It is worth mentioning at this point that a recent systematic review showed that specific interventions in the field might improve influenza vaccine coverage in children with comorbidities.[20] Multicomponent interventions, targeting also children with non-respiratory comorbidities and greater use of information technologies (i.e. electronic medical records and e-mail or text message reminders) resulted in an average improvement in coverage by 60%.[20]

Although the percentage of vaccination of children in our cohort was high that of the parents was quite low. Even worse and equally worrying was the vaccination rate of other adults who live in the same household, who usually are the grandparents. The percentage of vaccination in this group was 21%. Similarly, the majority (79%) of the other siblings were not vaccinated against the seasonal flu. All the above suboptimal level of vaccination exposes children with CHD to the risk of influenza infection which could have been prevented.[23,24] It is worth mentioning at this point that suboptimal influenza vaccination coverage has been previously reported in household contacts of children with cystic fibrosis (all contacts vaccinated only in 21% of cases),[16] paediatric cancer survivors (only 24.2% of caregivers received regular vaccination)[17] and children with asthma.[15]

The American Academy of Pediatrics supports vaccination of caregivers of children at risk of influenza complications in the paediatric office setting.[13,14] Universal parental influenza vaccination is a subject of debate among US paediatricians.[25] In a prospective observational study conducted over a period of 2 years, the authors found that approximately one-half of US paediatric offices offered seasonal influenza vaccine to the parents and guardians of their patients. The greatest driver for paediatricians to vaccinate parents and guardians was to protect their patients, while the main barriers were concerns over health insurance and malpractice issues.[25]

It is of interest to note that in our study parental attitudes differed according to their vaccination status. Both mothers and fathers were more likely to get vaccinated if they believed in vaccine safety, efficacy and the risk of transmitting the disease if they do not get vaccinated. The same group was more likely to get vaccinated in the current influenza period. Similarly, parents of vaccinated children believed in the safety and the efficacy of the vaccine, the risk of infection if they do not get vaccinated and also were willing to get vaccinated in the current period. We also documented several parental misperceptions regarding influenza vaccination. Of those that did not get vaccinated and did not vaccinate their child several did not know that this was needed and did not ask, several asked their primary care physician but were told it was not necessary, some of them were afraid of the side effects or believed that vaccines are not effective and a significant percentage of them worryingly was not at all interested in the field. The latter highlights either lack of understanding of the severity of influenza disease in children with CHD or failure of the health-care provider to accurately deliver this message to the caregiver and warrants further attention. Of note, only a small percentage of parents reported financial issues as barriers for getting the vaccine. In Greece, as mentioned earlier, the vaccination of high-risk groups as well as their caregivers is free of charge and therefore parents may have it delivered without any cost in the public health sector or even at the pharmacies.

Factor analysis is a useful tool to define groups of responders that share common characteristics in questionnaire-based surveys.[15,22] This analysis revealed four distinct groups among unvaccinated mothers and three groups among unvaccinated fathers that shared similar characteristics. These four groups could explain the 76.3% of variability in the questionnaire responses. These results underline the importance of targeted interventions in the context of influenza vaccination campaign. Extended provision of evidence-based information by primary care paediatricians and paediatric cardiologists is only one step to address this complex issue. Common misconceptions should be continuously addressed and the relevant information should be disseminated to the public in a simple and easy to understand manner focusing on particular parental characteristics as depicted in factor analysis.

We acknowledge that our study has limitations. The most important is that it was geographically restricted to the Region of Western Greece and included a relatively small sample. However, to the best of our knowledge, there are no published data regarding influenza vaccination status of caregivers of children with CHD. Second, it is possible that some caregivers might have had intendedly reported that they were unaware of the necessity of vaccination or that they were not properly advised by their health-care provider. Finally, data collected were based solely on parental reports which cannot rule out recall bias.

Conclusions

In conclusion, we found suboptimal influenza vaccination rates among caregivers and household contacts of children with CHD. On the contrary, vaccination coverage of children themselves was much higher. To improve vaccination coverage among caregivers' appropriate interventions should be planned. The role of

primary care providers is of paramount importance in the field. Ideally, influenza vaccination campaigns should take into consideration the specific characteristics of parental groups and target intervention strategies according to their risk status and indirectly protect children with CHD.

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Data Availability Statement

Data are available upon request.

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