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Parental risk perception and influenza vaccination of children in daycare centres

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SUMMARY

Little information is available about perceptions of influenza vaccination of parents with healthy children in daycare. Therefore, we systematically explored the relationship between parental risk perception and influenza vaccination in children attending daycare. We distributed a self-administered paper survey to parents of children aged 6–59 months attending licensed daycare centres in Tarrant County, Texas. We used conditional logistic regression with penalized conditional likelihood to estimate odds ratios (ORs) and 95% profile likelihood confidence limits (PL) for parental risk-perception factors and influenza vaccination. A high level of parental prevention behaviours (OR 9·1, 95% PL 3·2, 31) and physician recommendation (OR 8·2, 95% PL 2·7, 30) had the highest magnitudes of association with influenza vaccination of healthy children in daycare. Our results provide evidence about critical determinants of influenza vaccination of healthy children in daycare, which could help inform public health interventions aimed at increasing influenza vaccination coverage in this population.

Key words: Epidemiology, influenza, paediatrics, public health, vaccination (immunization).

INTRODUCTION

The most effective public health intervention to prevent influenza-associated illness is vaccination. Nevertheless, annual influenza vaccination coverage rates remain suboptimal, particularly in paediatric populations [1, 2]. For example, during the 2009–2010 influenza season, vaccination coverage was 56% and 38% in children aged 6–23 months and 24–59 months, respectively [3]. An important consideration for improving coverage rates is that childhood vaccination is parent-dependent [4, 5]. Consequently, elucidating factors that affect parental decision-making may provide evidence for tailoring approaches to increase vaccination coverage in paediatric populations.

Previous studies suggest that external stimuli which motivate parental action by altering risk perception,

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such as physician recommendation [6–13], are associated with parental decisions to vaccinate their children. Perceptions of susceptibility to influenza [13] and the severity of the disease [13] have also been associated with parental decisions to vaccinate their children against influenza [10, 11]. Nonetheless, such factors have primarily been investigated in school-aged children and clinic-based populations. Limited evidence is available about the relationship between parental risk perception and influenza vaccination coverage for healthy children in daycare. The elucidation of factors that influence parental risk perception and influenza vaccination coverage of children in daycare may provide unique insight for targeting a population in a high-risk environment for influenza transmission [14]. Therefore, we aimed to estimate the proportion of children in licensed daycares who were vaccinated against influenza during the 2010–2011 influenza season, and systematically explore the relationship between parental risk perception and influenza vaccination in this population.

METHODS

Study population

We randomly selected 30 licensed daycare centres in Tarrant County, Texas from all licensed daycare centres listed in the Texas Department of Family and Protective Services (TDFPS) database [15]. Tarrant County is the third most populous county in Texas and incorporates the Fort Worth metropolitan area [16]. The county is home to approximately 1·8 million residents (racial/ethnic distribution: 51·8% White, non-Hispanic; 26·7% Hispanic or Latino origin; 14·9% Black; 4·7% Asian) [17]. A licensed daycare centre in this area is defined as an establishment that provides care for $\geqslant 7$ children aged <14 years for fewer than 24 h per day, and is located outside of a home [18]. These centres are routinely monitored and inspected by the TDFPS to ensure that state-defined minimum operating standards are met. The selected centres were contacted by phone using a pre-determined script to describe the purpose of our study, eligibility criteria, procedures, and the risks and benefits of participation.

Eligible participants were English-speaking parents or primary caregivers, aged $\geqslant 18$ years, of children aged between 6 months and 5 years in the selected daycare centres. Parents with children aged <6 months were ineligible for our study because the influenza vaccine is not indicated or approved for use in this age group [2]. Daycare personnel from participating centres distributed the survey to a parent or primary caregiver who met the eligibility criteria. Families with more than one child in the randomly selected centre who met the age criteria were requested to complete only one survey with responses pertaining to the oldest eligible child in the household. We offered gift cards to daycare centres for the amount of US $25–75 based on their size and survey participation rate. This study was approved by the University of North Texas Health Science Centre Institutional Review Board (Protocol no. 2010-160).

Variables

We used data from a self-administered 39-question paper survey that measured parental perceptions of the influenza vaccine, influenza vaccination of their children, and personal prevention behaviours. This survey (Supplementary Fig. S1) included previously validated questions from the National 2009 H1N1 Flu Survey (NHFS) [19] modified for relevance to our study period, and questions that measured factors of potential interest that were identified from current literature [10, 13]. Our outcome of interest was influenza vaccination in children, defined as having received at least one dose of influenza vaccine during the current influenza season, August 2010 to May 2011. Influenza vaccination status was ascertained from responses to the question, 'Has your child gotten a flu shot this year (August 2010 to April 2011)?' and coded as a dichotomous variable.

The exposures of interest were four factors that have been assessed as determinants of influenza vaccination primarily in young children with chronic diseases but have not been systematically explored in children in a daycare setting, as determined from our review of the literature: (1) parental prevention behaviours [7, 10, 11]; (2) parents' perceived risk of vaccine-related adverse events [8–10, 12, 13]; (3) parents' perceived threat of flu [12, 13]; and (4) physician recommendation [7–10, 12, 20, 21]. Parental prevention behaviours were ascertained through responses to questions on parents' previous year's flu vaccination status, current flu vaccination status, and whether the parent visited a health professional about his/her health within the past year for prevention services (e.g. check-up). Parents' perceived risk of vaccine-related adverse events was assessed by asking parents whether they agreed or disagreed with statements regarding vaccine safety and whether the flu vaccine caused the flu or other

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side-effects and their overall level of concern about the flu shot making their child sick. We ascertained parents' perceived threat of flu by asking parents about their perception of their child's susceptibility to influenza and severity of illness. Only questions conditioned on the child's health status and its relationship to susceptibility and severity of flu considering vaccination status were included in the perceived threat of flu construct [22]. Physician recommendation was ascertained by asking parents whether their 'child's doctor or other health professional recommended that he/she get the flu shot this year'.

Data analysis

For descriptive purposes, we estimated the overall and subgroup-specific proportions of vaccinated children. Additionally, we used conditional logistic regression (to account for potential clustering by daycare centre) with penalized conditional likelihoods for small samples and sparse data [23] to estimate odds ratios (ORs) and 95% profile likelihood confidence limits (PL) for the relationships between parental risk perception constructs (i.e. parental prevention behaviours, parents' perceived risk of vaccine-related adverse events, parents' perceived threat of flu, and physician recommendation) and influenza vaccination in children aged between 6 and 59 months enrolled in licensed daycare centres in Tarrant County, Texas. Furthermore, the estimates were adjusted for a minimal sufficient set of covariates relevant to each exposure-outcome relation to reduce confounding bias, as determined from a directed acyclic graph (DAG) [24]. Briefly, our DAG (Supplementary Fig. S2) encoded dependency assumptions about factors that influence childhood influenza vaccination and parental risk perception based on previous evidence [8, 25, 26]. We applied the back-door criterion to our encoded DAG [27, 28], which identified the following minimal sufficient sets for adjustment in separate models for each exposure-outcome relation: (1) race/ethnicity and socioeconomic status (SES) (i.e. income and education) when estimating the effect of parental prevention behaviours; (2) child's previous influenza vaccination status and child's age when estimating the effect of parents' perceived risk of vaccine-related adverse events; (3) race/ethnicity and physician recommendation when estimating the effect of parents' perceived threat of flu; and (4) child's age, child's medical indications, race/ethnicity, and insurance coverage when estimating the effect of physician recommendation.

The child's age was modelled as a continuous variable (in months) ascertained from adult respondents. The child's race/ethnicity was categorized and reported by the respondent as non-Hispanic White, non-Hispanic Black, Hispanic, or Other. Insurance coverage was modelled as a dichotomous variable indicating whether the child had any kind of healthcare coverage, which included private insurance and government subsidized coverage such as Medicaid. SES was defined as a combination of the respondent's educational status and the total combined family income before taxes for the previous year. The child's previous flu vaccination was measured as a dichotomous variable. Two questions were used to assess medical indications for influenza vaccination (Asthma: 'Has a doctor ever told you that your child has asthma?' and other health conditions considered high risk for influenza-associated complications (e.g. heart problem, cancer, weakened immune system, etc.).

Sensitivity analysis

We explored the sensitivity of our estimate to non-participation for the association between physician recommendation and influenza vaccination using a simple bias analysis [29]. Briefly, we constructed 2×2 contingency tables for the known exposure-outcome distribution in participants and an assumed exposure-outcome distribution in non-participants. We varied the assumptions in non-participants to explore a range of potential scenarios. For example, we varied the prevalence of influenza vaccination from 10% to 65%, with the latter representing the prevalence observed in participants in this study. Furthermore, we assumed null or inverse associations for physician recommendation and influenza vaccination in non-participants. Individual cells in the 2×2 tables for participants and non-participants were subsequently summed as though the non-participants contributed their exposure and outcome information to the current study. Summary crude ORs were estimated for each combined 2×2 table given the varying assumptions.

RESULTS

Of the 30 randomly selected licensed daycare centres in our sample, 14 (46%) centres agreed to participate. Our eligible population comprised 466 parents, of

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whom 124 responded to the survey (27% participation rate). Complete-subject data (i.e. no missing values for relevant covariates) were available for 119–122 participants depending on the exposure of interest. Table 1 provides detailed characteristics of sample parents/guardians and their children. Briefly, our study population comprised parents of children with a median age of 41 months [interquartile range (IQR) 25–53]. Slightly more than half of the children in the sample were male. Children of racial/ethnic minorities comprised 32% of our study population. Adult respondents were primarily the child's mother. The median age of adult respondents was 36 years (IQR 32–39 years) with ages ranging from 21 years to 65 years. More than 75% of the adult respondents had at least some college education or a college degree. A large proportion of adult respondents reported family total combined incomes over US$50 000, with 45% of families reporting combined incomes of more than US$100 000. Nearly all children were covered by some type of insurance (including government subsidized programmes).

Table 2 summarizes the overall and subgroup-specific proportions of vaccinated children. The overall proportion of influenza vaccination was 65% in our study population with vaccination coverage of 82% and 60% in children aged 6–23 months and 24–59 months, respectively. A higher proportion of female children were vaccinated than male children (female 67%, male 62%). The proportion vaccinated was highest for non-Hispanic White children (non-Hispanic White 73%, Black 44%, Hispanic 47%, Other 50%). A large proportion (83%) of families with household incomes >US$100 000 reported having their children vaccinated against influenza, whereas only one third of children from families with reported incomes between US$50 000 and US$74 999 received the influenza vaccine. Children whose parent or guardian had a college degree or higher represented the highest vaccinated proportion (college graduate or higher 74%). Of children with asthma, 58% received the influenza vaccine, whereas the proportion vaccinated for children without asthma was 65%.

Table 3 summarizes the ORs for the associations between factors that influence parental risk perception and influenza vaccination. Specifically, the odds of vaccinating a child were considerably higher for parents who reported a physician's recommendation compared to parents who did not report that a physician had recommended influenza vaccination for their children (OR 8·2, 95% PL 2·7, 30). Parents with high levels of reported prevention behaviours had higher odds of having their children vaccinated against influenza than parents with moderate or low levels of prevention behaviours (high: OR 9·1, 95% PL 3·2, 31; moderate: OR 1·3, 95% PL 0·29, 6·2). Parents describing beliefs consistent with a high or moderate perceived risk of vaccine-related adverse events had lower odds of having their children vaccinated compared to parents with a low perceived threat of vaccine-related adverse events (high: OR 0·17, 95% PL 0·03, 0·71; moderate: OR 0·37, 95% PL 0·10, 1·3).

Table 1. *Characteristics of parents/guardians and their children aged 6–59 months attending daycare centres in Tarrant County, Texas for the 2010–2011 influenza season*

Characteristic	($n = 124$)
Age, median (IQR)	
Child, months	41 (25–53)
Adult respondent, years	36 (32–39)
Sex, male, *n* (%)	69 (56)
Race/ethnicity, *n* (%)	
Non-Hispanic White	84 (68)
Black	9 (7)
Hispanic	15 (12)
Other	16 (13)
Uninsured child*, *n* (%)	2 (1·6)
Respondent's relationship to child	
Mother	109 (88)
Father	11 (9)
Other	4 (3)
Family income (US$), *n* (%)	
$0–$34 999	21 (18)
$35 000–$49 999	5 (4)
$50 000–$74 999	23 (19)
$75 000–$99 999	17 (14)
>$100 000	53 (45)
Education level of parent or guardian, *n* (%)	
Did not graduate high school	1 (1)
High school graduate	17 (14)
Vocational or trade school	5 (4)
Some college	28 (23)
College graduate or higher	73 (59)
More than one child in daycare	38 (31)
Vaccination coverage	
Current year	80 (65)
Previous year	86 (71)

IQR, Interquartile range.
* Uninsured child is a child that was reported by the parent/caregiver to not have healthcare insurance of any type including private health insurance, prepaid plans such as health maintenance organizations, or government plans such as Medicaid.

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Table 2. *Overall and subgroup-specific proportions of vaccinated children aged 6–59 months attending daycare centres in Tarrant County, Texas for the 2010–2011 influenza season*

Characteristic	Proportion vaccinated* (%)
Overall	80/124 (65)
Subgroup-specific	
Age	
6–23 months	22/27 (82)
24–59 months	58/97 (60)
Sex	
Male	43/69 (62)
Female	37/55 (67)
Race/ethnicity	
Non-Hispanic White	61/84 (73)
Black	4/9 (44)
Hispanic	7/15 (47)
Other	8/16 (50)
Health insurance for child†	
Insured	79/122 (65)
Uninsured	1/2 (50)
Family income (US$)	
$0–$34 999	12/21 (57)
$35 000–$49 999	4/5 (80)
$50 000–$74 999	8/23 (35)
$75 000–$99 999	11/17 (65)
>$100 000	44/53 (83)
Education level of parent or guardian	
Did not graduate high school	1/1 (100)
High school graduate	8/17 (47)
Vocational or trade school	3/5 (60)
Some college	14/28 (50)
College graduate or higher	54/73 (74)
Number of children in daycare	
More than one	25/38 (66)
One	54/85 (64)
Asthma	
Asthmatic	11/19 (58)
Not asthmatic	68/104 (65)

* Proportion vaccinated for previous vaccination refers to the proportion of children who had received a previous influenza vaccination and were vaccinated for the current year.

† Health insurance for child means healthcare insurance of any type including private health insurance, prepaid plans such as health maintenance organizations, or government plans such as Medicaid reported by parent.

Furthermore, parents with high or moderate perceived threat of influenza illness had higher odds of having their children vaccinated than parents with low perceived threat of influenza illness (high: OR 3·7, 95% PL 0·94, 15; moderate: OR 1·7, 95% PL 0·41, 7·2).

Table 4 summarizes the results of the sensitivity analysis to assess the influence of non-participation on estimates of the association between physician recommendation and influenza vaccination for children in daycare centres. Assuming a null association between physician recommendation in non-participants and varying the vaccination coverage proportion from 65% (similar to the vaccination coverage observed in participants) to 10% in non-participants resulted in summary OR estimates between 1·6 and 3·8, respectively. Assuming an inverse association for non-participants (i.e. non-participant parents who received a physician recommendation had twofold lower odds of having their children vaccinated) and varying the vaccination coverage proportion from 65% to 10% in non-participants resulted in summary OR estimates between 2·1 and 0·93, respectively.

DISCUSSION

Our results from the 2010–2011 influenza season suggest that a majority of children aged 6–59 months in licensed daycare centres are vaccinated against influenza. Notably, physician recommendation and high parental prevention behaviours are strongly associated with influenza vaccination for children attending daycare centres. Furthermore, high perceived threat of influenza illness in parents is modestly associated with influenza vaccination for their children attending daycare centres, whereas high or moderate perceived risk of vaccine-related adverse events was inversely associated with vaccination.

Although the low participation rate in our study is consistent with participation rates in contemporary epidemiological studies [30, 31], consideration of potential bias from non-participation (e.g. if non-participants comprised parents or guardians with lower educational attainment than participants) is warranted. We quantitatively explored the sensitivity of our estimate to non-participation for the association between physician recommendation and influenza vaccination. We intentionally assumed extreme conditions for the association between physician recommendation and vaccination in non-participants, and varied assumptions about vaccination coverage in non-participants to explore the durability of the observed positive association. Our sensitivity analysis suggests that a positive association between physician recommendation and vaccination would persist even if a null association between physician recommendation and vaccination exists in non-participants.

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Table 3. *Prevalence odds ratios for the association between parental risk-perception factors and influenza vaccination* of children aged 6–59 months attending licensed daycare centres in Tarrant County, Texas for the 2010–2011 influenza season*

	Vaccinated, *N* (%)	Unvaccinated, *N* (%)	OR	95% PL
Physician recommendation†				
Recommended	72 (92)	21 (48)	8·2	2·7, 30
Not recommended	6 (7·7)	21 (48)	1·0	Reference
Parental prevention behaviours‡				
High	56 (70)	10 (24)	9·1	3·2, 31
Moderate	6 (7·5)	9 (21)	1·3	0·29, 6·2
Low	18 (23)	23 (55)	1·0	Reference
Perceived threat of influenza illness§				
High	48 (62)	19 (46)	3·7	0·94, 15
Moderate	22 (28)	15 (37)	1·7	0·41, 7·2
Low	8 (10)	7 (17)	1·0	Reference
Perceived risk of vaccine-related adverse events¶				
High	2 (2·5)	13 (33)	0·17	0·03, 0·71
Moderate	8 (10)	8 (20)	0·37	0·10, 1·3
Low	69 (87)	19 (48)	1·0	Reference

OR, Odds ratio; PL, profile likelihood confidence limits.
* Vaccination: refers to children who received at least one dose of the influenza vaccine.
† Adjusted for child's age, child's medical indications, race/ethnicity, and insurance coverage.
‡ Adjusted for race/ethnicity and socioeconomic status (defined using income and education).
§ Adjusted for physician recommendation and race/ethnicity.
¶ Adjusted for child's previous influenza vaccination status and child's age.

Table 4. *Sensitivity of the estimate to potential non-participation for the association between physician recommendation and influenza vaccination for children aged 6–59 months in daycare centres*

Vaccination coverage in non-participants	Odds ratio in non-participants	Summary odds ratio*
65%	1·0	1·6
50%	1·0	1·7
30%	1·0	2·2
10%	1·0	3·8
65%	0·50	0·93
50%	0·50	1·0
30%	0·50	1·2
10%	0·50	2·1

* If exposure-outcome distribution of non-participants was combined with exposure-outcome distribution of participants.

A positive association between physician recommendation and vaccination would also persist even in the improbable scenario that non-participant parents had twofold lower odds of having their children vaccinated despite a physician recommendation (i.e. an inverse association in non-participants) unless influenza vaccination coverage exceeded 50% in non-participants. The durability of our estimate may not be surprising given the observed magnitude of association and given that studies with participation rates as low as 30% can incur little bias from non-participation [32, 33]. Nonetheless, our sensitivity analysis is limited to estimates for an unadjusted association of only one of our exposures of interest. Different parameters may apply to other exposures, but these parameters, similar to the parameters for the presented sensitivity analysis, are speculative because of lack of exposure-outcome data for non-participants.

Given the parent-reported nature of our data, potential misclassification of the child's influenza vaccination status might appear to be a limitation of our study. Nevertheless, a previous study suggests that parent-reported influenza vaccination status of children aged 6–59 months has high accuracy (sensitivity 88%, specificity 90%) when compared to medical records [34]. Therefore, bias from misclassification of the child's influenza vaccination status may not be a serious concern.

Despite certain limitations, our findings extend the current evidence on parental risk perception and preventive behaviours for children by elucidating

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determinants of vaccination in parents with healthy children attending daycare centres. We observed strong associations for both physician recommendation and parental prevention behaviours with vaccination, and an inverse association between parental concerns regarding vaccine safety and vaccination of healthy children attending daycare centres. These findings are directionally consistent with other studies of young children despite the majority of previous studies being focused on clinic-based paediatric populations [6–12, 21, 35]. Previous studies reported inverse or null associations between perceived threat of influenza (i.e. susceptibility or severity) and vaccination [10], but we observed a strong association between parents with high perceived threat of influenza illness and influenza vaccination for their children in daycare. This inconsistency may be partially attributable to a spurious effect that occurs in cross-sectional studies that does not account for vaccination status at the time of survey when measuring parental perception of susceptibility or severity of flu. We conditioned our risk perception measures to reduce this spurious effect, whereas previous studies [10, 11, 13, 22] did not account for the child's vaccination status at the time of survey. Otherwise, few studies have explored parental prevention behaviours and their effect on influenza vaccination of healthy young children. Therefore, our study addresses an important gap in the literature.

In summary, although a majority of children aged 6–59 months in licensed daycare centres are vaccinated against influenza, considerable improvement of vaccination coverage is still warranted because of the high risk of infectious disease transmission in this setting [14, 36]. We observed that high levels of parental prevention behaviours, physician recommendation, and perceived threat of influenza illness have positive associations, whereas parental concerns about vaccine-related adverse effects has an inverse association with influenza vaccination for children in daycare centres. Of the determinants we explored, physician recommendation is arguably the simplest target for improving vaccination coverage, and this association appears to persist despite extreme assumptions about the effects of non-participation in our study. Notably, vaccination coverage of children was 77% for parents who reported that a physician recommended influenza vaccination, which is consistent with the proportion of parents who express considerable trust in their child's paediatrician for information about vaccines [37] and emphasizes the importance of physician–parent interaction for improving influenza vaccination coverage in children attending daycare centres. Our study is one of the few to extend research on influenza vaccination into healthy paediatric populations, and provides evidence about critical determinants of influenza vaccination. Our findings may be enhanced by evidence from longitudinal studies in other geographical regions with larger sample sizes that allow not only confirmation but also further exploration of potential seasonal and subgroup-specific effects. A synthesis of the collective evidence on critical determinants could then help inform comprehensive public health interventions that aim to increase influenza vaccination coverage in healthy children attending daycare.

SUPPLEMENTARY MATERIAL

For supplementary material accompanying this paper visit http://dx.doi.org/10.1017/S0950268813000782.

DECLARATION OF INTEREST

None.

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