CORRESPONDENCE

Effect of Vaccination on Transmission of SARS-CoV-2

TO THE EDITOR: Whether vaccination of individual persons for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) protects members of their households is unclear. We investigated the effect of vaccination of health care workers in Scotland (who were among the earliest groups to be vaccinated worldwide) on the risk of coronavirus disease 2019 (Covid-19) among members of their households.

We evaluated data from 194,362 household members (which represented 92,470 households of 2 to 14 persons per household) of 144,525 health care workers who had been employed during the period from March 2020 through November 2020. The mean ages of the household members and the health care workers were 31 and 44 years, respectively; a majority (>96%) were White. A total of 113,253 health care workers (78.4%) had received at least one dose of either the BNT162b2 (Pfizer–BioNTech) mRNA vaccine or the ChAdOx1 nCoV-19 (Oxford–AstraZeneca) vaccine, and 36,227 (25.1%) had received a second dose.

The primary outcome was any confirmed case of Covid-19 that occurred between December 8, 2020, and March 3, 2021. We also report results for Covid-19–associated hospitalization. The primary time periods we compared were the unvaccinated period before the first dose and the period beginning 14 days after the health care worker received the first dose. No adjustment was made for multiplicity. Events that occurred after any household member was vaccinated were censored. Detailed methods and results, strengths and limitations, and the protocol are provided in the Supplementary Appendix, which is available with the full text of this letter at NEJM.org. This study was approved by the Public Benefit and Privacy Panel (2021-0013), and the scientific officer of the West of Scotland Research Ethics Committee provided written confirmation that formal ethics review was not required.

Cases of Covid-19 were less common among household members of vaccinated health care workers during the period beginning 14 days after the first dose than during the unvaccinated period before the first dose (event rate per 100 person-years, 9.40 before the first dose and 5.93 beginning 14 days after the first dose). After the health care worker's second dose, the rate in household members was lower still (2.98 cases per 100 person-years). These differences persisted after fitting extended Cox models that were adjusted for calendar time, geographic region, age, sex, occupational and socioeconomic factors, and underlying conditions. Relative to the period before each health care worker was vaccinated, the hazard ratio for a household member to become infected was 0.70 (95% confidence interval [CI], 0.63 to 0.78) for the period beginning 14 days after the first dose and 0.46 (95% CI, 0.30 to 0.70) for the period beginning 14 days after the second dose (Table 1 and the Supplementary Appendix). Not all the cases of Covid-19 in the household members were transmitted from the health care worker; therefore, the effect of vaccination may be larger.[1] For example, if half the cases in the household members were transmitted from the health care worker, a 60% decrease in cases transmitted from health care workers would need to occur to elicit the association we observed (see the Supplementary Appendix). Vaccination was associated with a reduction in both the number of cases and the number of Covid-19–related hospitalizations in health care workers between the unvaccinated period and the period beginning 14 days after the first dose.

Given that vaccination reduces asymptomatic infection with SARS-CoV-2,[2,3] it is plausible that vaccination reduces transmission; however, data from clinical trials and observational studies are lacking.[4,5] We provide empirical evidence suggesting that vaccination may reduce transmission by showing that vaccination of health care workers is associated with a decrease in documented cases

Table 1. Effect of Vaccination of Health Care Workers on Documented Covid-19 Cases and Hospitalizations in Health Care Workers and Their Households.*

Variable	Health Care Workers			Household Members		
	Unvaccinated Period	Period Beginning 14 Days after First Dose	Hazard Ratio (95% CI)	Unvaccinated Period	Period Beginning 14 Days after First Dose	Hazard Ratio (95% CI)
Cases†						
No. of patients	144,525	109,074		194,362	148,366	
No. of events	3191	1152		2037	1086	
Mean person-time — days	40	45		41	45	
Rate per 100 person-yr	20.13	8.51		9.40	5.93	
Comparison of rates per 100 person-yr						
Unadjusted model			0.51 (0.48–0.55)			0.74 (0.67–0.82)
Model 1			0.52 (0.49–0.56)			0.73 (0.66–0.81)
Model 2			0.55 (0.51–0.59)			0.75 (0.68–0.83)
Model 3			0.45 (0.42–0.49)			0.71 (0.63–0.78)
Model 4‡			0.45 (0.42–0.49)			0.70 (0.63–0.78)
Hospitalizations						
No. of patients	144,525	111,081		194,362	149,689	
No. of events	158	19		111	64	
Mean person-time — days	41	45		41	45	
Rate per 100 person-yr	0.97	0.14		0.51	0.35	
Comparison of rates per 100 person-yr						
Unadjusted model			0.16 (0.10–0.27)			0.83 (0.58–1.17)
Model 1			0.16 (0.10–0.27)			0.81 (0.57–1.15)
Model 2			0.17 (0.10–0.29)			0.86 (0.61–1.23)
Model 3			0.15 (0.09–0.26)			0.77 (0.53–1.10)
Model 4‡			0.16 (0.09–0.27)			0.77 (0.53–1.10)

* Results are shown for Cox regression models stratified according to health board geographic region, with calendar time as the timescale and the vaccination status as a time-varying covariate. The models were adjusted sequentially for age (with the use of a penalized spline to allow for nonlinearity) and sex (model 1); for category on the Scottish Index of Multiple Deprivation (a measure of socioeconomic deprivation based on geographic region) and ethnic group (model 2); for health care worker role (patient-facing, non–patient-facing, or undetermined), occupation, and part-time status (model 3); and for coexisting conditions (as both a count of coexisting conditions and the presence or absence of type 2 diabetes) (model 4). Covid-19 denotes coronavirus disease 2019.

† Cases were defined on the basis of results of a polymerase-chain-reaction test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA (estimated at 90% sensitivity and 99% specificity in Scotland-Wellcome Open Res 2020;5:254. DOI:10.12688/wellcomeopenres.16342.1).

‡ In sensitivity analyses that tested the robustness of the findings of the primary analysis to the proportional-hazards assumption, all the covariates were instead included as stratifying variables in the extended Cox models. Age was categorized in 10-year bands (e.g., 20 to 29 years of age), with the remaining covariates treated as unordered categorical variables. In these models, the hazard ratio for a health care worker to become infected was 0.44 (95% CI, 0.40 to 0.47), and the hazard ratio for a household member to become infected was 0.68 (95% CI, 0.62 to 0.75).

of Covid-19 among members of their households. This finding is reassuring for health care workers and their families.

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