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MAJOR ARTICLE

Factors Associated With the Transmission of the Delta Severe Acute Respiratory Syndrome Coronavirus 2 Variant in Households: The Israeli COVID-19 Family Study (ICoFS)

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Understanding how interpersonal interactions and immunological factors shape severe acute respiratory syndrome coronavirus 2 transmission in households is crucial for designing control measures. We developed a Bayesian data augmentation transmission model to evaluate the effects of isolation, parental care, and vaccine-induced immunity on Delta variant transmission from the follow-up of 1093 Israeli households (July–August 2021). Among the 2883 household contacts, 1096 (38%) were infected. Children were 38% (95% Credibleconfidence interval [CrI], 7%–81%) more likely to be infected than adults. Isolation measures reduced transmission by 52% (95% CrI, 46%–57%). Transmission was 39% (95% CrI, 11%–76%) higher between children and female adults than between children and male adults. Vaccine effectiveness was 78% (95% CrI, 54%–90%), 85% (95% CrI, 70%–94%), and 73% (95% CrI, 49%–88%), respectively, for 1, 2, and 3 recent vaccine doses (within ≤90 days) but dropped to 18% (95% 95% CrI, −6% to 36%) for 2 doses administered >90 days earlier. Household member interactions significantly shaped transmission, and isolation measures effectively reduced transmission.

Keywords. SARS-CoV-2; household study; vaccine effectiveness; isolation measures; contact pattern.

The coronavirus disease 2019 (COVID-19) pandemic has affected a considerable number of individuals worldwide, with 774 million cases confirmed to date and >7 million deaths [1]. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission rates are high within households [2], underscoring the role of this environment as a major transmission site. Therefore, understanding the determinants of transmission within households remains important to guide public health interventions.

Household transmission patterns can be influenced by biological and behavioral characteristics. Multiple studies investigated the contribution of biological factors, exploring for example, how vaccination status affects transmission patterns [3, 4]. Recent vaccination can significantly reduce transmission [5, 6], primarily by reducing the risk of infection [5, 7] and lowering infectivity in those who are infected [8]. Estimates of the extent and speed of waning of protection have exhibited important variations as shown by this meta-analysis on the Alpha and Delta variants [9]. Conversely, research on how behavioral factors affect household transmission has been more limited. This includes the dynamics of interpersonal interactions within households [10–12], and changes in behavior when a household member is infected, along with adherence to isolation guidelines [13].

Here, we develop a modeling framework to build an integrated understanding of how behavioral and biological factors shape within-household SARS-CoV-2 transmission. We use this model to analyze a large Israeli household transmission study implemented during the Delta wave in 2021. The large number of households recruited in the study, along with the sophisticated modeling framework, makes it possible

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to obtain a detailed picture of how the household risk of transmission is shaped by heterogeneous immunity profiles derived from past infections and vaccination histories, as well as by complex contact and behavioral patterns within households.

METHODS

Study Design

The Israeli COVID-19 Family Study (ICoFS) was a prospective cohort conducted during the Delta variant wave (July–November 2021). At the time, the Ministry of Health required symptomatic individuals and their contacts (inside or outside the household) to be tested. Eligible households within 40 km of Sheba Medical Center were invited to participate after the detection of 1 SARS-CoV-2–positive case. Adults provided informed consent and underwent polymerase chain reaction (PCR) testing, while those <18 years old were encouraged to be tested at local centers. PCR testing was free and widely available. People were highly motivated to be tested, as recovered individuals received a "green pass" granting exemptions from social distancing (regardless of vaccine status). Testing was encouraged, particularly after day 7 (later stages of follow-up), and uninfected contacts averaged 3 tests during follow-up Supplementary Figure 7. A phone interview 20–60 days after index case identification collected data on age, vaccination, infection history, symptoms, and isolation practices.

Data Collected

SARS-CoV-2 infections were assessed by means of PCR tests conducted by Sheba Medical Center after the detection of an index case (start of follow-up) or local testing centers, with results reported to the national Ministry of Health database. Participants could also self-report independently conducted tests. Index cases were defined as those testing positive on the first day of follow-up. Symptoms were self-reported via a questionnaire, and participants were classified as asymptomatic if no symptoms were reported during follow-up (details in the Supplementary materials).

An individual was considered vaccinated with n doses if the n^{th} dose was received >7 days before the household's first positive test result. We also explored vaccine effectiveness using a 15-day activation period. Further details on vaccine rollout are provided in the Supplementary materials. Those testing positive were encouraged to isolate by staying in a separate room, using separate dining and bathrooms and wearing masks. Households were considered to follow isolation measures if infected members consistently wore masks and ate separately.

Statistical Analysis

We conducted 2 types of analyses to assess transmission factors, both requiring complete data on age, vaccination, past infection, isolation, and symptom severity. Households with 2–7 members were included, and those with incomplete information were excluded.

First, we computed the secondary attack rate (SAR), defined as the proportion of cases among household contacts, and examined its variation by age, vaccination, past infection of the index case and the contact individual, and isolation measures. Individuals were considered adolescents/adults if they were >12 years old and children otherwise. Children were split between immunized (vaccinated or previously infected) and unimmunized (not vaccinated and not previously infected). We considered 7 immune statuses among adolescents/adults: unimmunized, unvaccinated reporting past infections, vaccinated with 1 dose reporting past infection, vaccinated with 1 dose not reporting past infection, vaccinated with 2 doses within 90 days before first household infection, vaccinated with 2 doses >90 days earlier, and vaccinated with 3 doses.

The SAR was computed in households where 1 of the index cases was unimmunized or where they were all immunized, where 1 of the index cases was symptomatic or they were all asymptomatic, and where 1 of the index cases was a child or they were all adolescents/adults. The SAR is reported with its 95% confidence interval (CI), computed as the binomial confidence interval of the proportion.

Second, we used a mathematical model [14] to assess the person-to-person transmission probability between household members based on their age, immune status, household size, pairwise relationship, and symptom severity (see the Supplementary materials). The model estimated the risk of transmission between household members including the risk of transmission from secondary cases. We also estimated the community risk of infection. The risk of transmission depended on household size and was modulated by the infector's age, immunity status, and severity as well as the age and immune status of the contact. We also examined the effect of isolation measures implementation and the nature of the interaction between 2 household members. We defined contact rates between female adults and children and between male adults and children, with other contact rates assumed to be similar and used as a reference.

The model estimated parameters based on the sequence of positive test dates within households, using Bayesian Markov chain Monte Carlo sampling with data augmentation [14, 15]. Symptom onset times were augmented from test dates, assuming that symptomatic cases were tested within 1 day after symptom onset, given the high testing rates in Israel with PCR tests being free and widely available. For asymptomatic cases, a wider window (from 2 days before to 1 day after the test) was used to augment a theoretical symptom onset time (ie, the point in the infection course when symptomatic cases would experience symptoms). In sensitivity analysis, we tested broader testing windows (details in the Supplementary materials). Infection times were augmented using the Delta variant's incubation period

[16], allowing the model to explore possible infection sequences. The force of infection was a function of time since infection and the incubation period [17]. We reported the median and 95% credible interval (CrI) for estimated parameters. Vaccine effectiveness was calculated as the reduction in susceptibility compared with unvaccinated individuals.

In our baseline analysis, the prior distribution for the relative susceptibility of age-immunity, isolation, infectivity, and contact rate factors was a log-normal with a log mean of 0 and a log SD of 1. In a sensitivity analysis, we explored log SDs of 2 and 0.7. We ran a simulation study simulating 2000 datasets with parameters drawn from the posterior distribution and extracted the SAR per household size to compare it with the observed one. To assess the identifiability of model parameters, we calibrated our model to the simulated data set and examined the bias and the proportion of 95% CrI covering the simulation value. (The code is available at https://gitlab.pasteur.fr/mmmi-pasteur/hh_israel_sarscov2_delta2).

RESULTS

Study Population

Households were recruited between 25 July and 31 August 2021, during the S-CoV-2 Delta wave. A total of 1454 households with ≥1 SARS-CoV-2–positive index cases were approached. We selected households ranging in size from 2 to 7 members (Supplementary Figure 1), excluding 35 households. We excluded 303 households in which ≥1 individual had missing age, isolation status, or information on symptom severity. Finally, 1116 households, comprising 4256 individuals, were included in the analysis (Figure 1).

There were a total of 1286 index cases (positive on the first day of follow-up) in 1096 households; that is, 151 households had multiple index cases (Supplementary Table 2). Table 1 displays the demographic and clinical characteristics of household index cases and contacts.

Children represented 33% of index cases (429 of 1286) and 24% of contact (703 of 2882). Nearly all children (99% of index cases and contacts) were unvaccinated. Among adolescents/adults, 16% of index cases and 9% of contacts were unvaccinated. Among adolescent/adult contacts, 89 (4%), 90 (4%), 1754 (80%), and 60 (3%) were vaccinated with 1 dose, with 2 doses within 90 days, with 2 doses >90 days earlier, and with 3 doses, respectively. The median ages of individuals in these 4 dose groups were 24, 15, 42, and 66 years, respectively (Supplementary Figure 2).

Adolescents/adults reported a higher proportion of prior infections (6%–9%) than children (2%–2%) among index cases and contacts. The proportion of asymptomatic cases was higher among children (28%–32%) than among adolescents/adults (9%–13%), in both index cases and contacts cases. About 50% of children and 65% of adolescents/adults were in households with isolation measures.

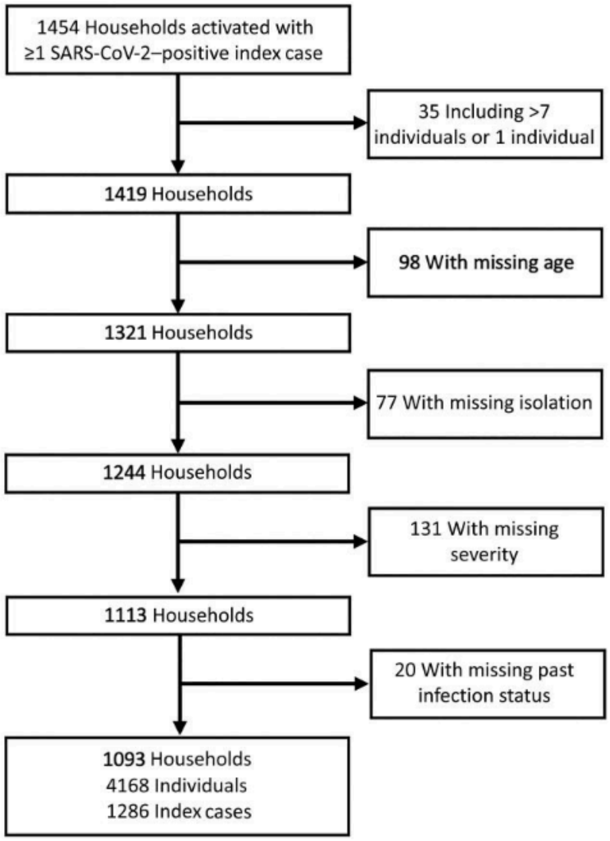

Figure 1. Flow chart of the households included in our analysis with the filtering criteria based on missing information. Abbreviation: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

SAR Analysis

The overall SAR was 38% (95% CI, 36%–40%) after filtering for missing information. We calculated the SAR based on contact characteristics (Table 2). The SAR was 51% (95% CI, 48%–55%) among children compared with 34% (32%–36%) among all adolescents/adults and 44% (36%–53%) among unimmunized adolescents/adults. Among adolescent/adult contacts, the SARs were 44% (95% CI, 36%–53%), 14% (5%–28%), 13% (5%–26%), and 7% (2%–14%) among individuals who were unimmunized, unvaccinated individuals who reported a previous infection, individuals vaccinated with 1 dose who did not report a previous infection, and those vaccinated with 1 dose who did report a previous infection, respectively. The SARs were 7% (95% CI, 2%–14%), 37% (34%–39%), and 11% (5%–22%) among those vaccinated with 2 doses ≤90 days earlier, with 2 doses >90 days earlier, or with 3 doses, respectively. The SAR was 26% (95% CI, 24%–28%) in households that observed isolation measures compared with 57% (54%–60%) in households that did not.

Table 1. Characteristics of Index cases and Contacts by Age Group

	Index Cases, No. (%)[a]		Contacts, No. (%)[a]	
Characteristic	Children (n = 429)	Adolescents/Adults (n = 857)	Children (n = 703)	Adolescents/Adults (n = 2179)
Age, mean, y	7.7	41	6.8	39.3
Sex				
Female	223 (52)	295 (34)	362 (51)	1148 (53)
Male	206 (48)	562 (66)	341 (49)	1031 (47)
First SARS-CoV-2 infection?				
Yes	420 (98)	778 (91)	686 (98)	2048 (94)
No	9 (2)	79 (9)	17 (2)	131 (6)
Vaccination status				
Unvaccinated	426 (99)	137 (16)	693 (99)	186 (9)
1 dose	2 (1)	12 (1)	1 (0)	89 (4)
2 doses (within ≤90 d)	0 (0)	4 (1)	9 (1)	90 (4)
2 doses (within >90 d)	1 (0)	680 (79)	0 (0)	1754 (80)
3 doses	0 (0)	24 (3)	0 (0)	60 (3)
In a household with isolation measures				
No	223 (52)	295 (34)	356 (51)	764 (35)
Yes	206 (48)	575 (66)	347 (49)	1415 (65)
Severity among infected[b]				
Asymptomatic	121 (28)	76 (9)	117 (32)	96 (13)
Symptomatic	308 (72)	781 (91)	245 (67)	638 (87)

Abbreviation: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a]Data represent no. (%) of cases or contacts, unless otherwise specified.

[b]Percentages in this category represent the proportion of cases.

Table 2. Secondary Attack Rates by Characteristics in Contacts and Index Cases

Case Group	Characteristic	No. of Contacts	No. of Infected Contacts	SAR (95% CI)
Contacts	In a household with isolation measures?			
	No	1120	643	0.57 (.54–.60)
	Yes	1762	453	0.26 (.24–.28)
	Age class			
	Child	703	362	0.51 (.48–.55)
	Adolescent/adult	2179	734	0.34 (.32–.36)
	Adolescent/adult immune status			
	Unvaccinated, not reporting past infection	143	63	0.44 (.36–.53)
	Unvaccinated, reporting past infection	43	6	0.14 (.05–.28)
	1 dose, reporting past infection	43	3	0.07 (.01–.19)
	1 dose	46	6	0.13 (.05–.26)
	2 doses (within ≤90 d)	90	6	0.07 (.02–.14)
	2 doses (within >90 d)	1754	643	0.37 (.34–.39)
	3 doses	60	7	0.12 (.05–.23)
	Child immune status			
	Unvaccinated, not reporting past infection	676	354	0.52 (.49–.56)
	Vaccinated or reporting past infection	27	8	0.30 (.14–.50)
Index case	Unimmunized adolescent/adult			
	Yes	334	143	0.43 (.37–.49)
	No	2548	953	0.37 (.36–.39)
	Symptomatic			
	No	404	110	0.27 (.23–.32)
	Yes	2478	986	0.40 (.38–.42)
	Child			
	No	1705	641	0.38 (.35–.40)
	Yes	1177	455	0.39 (.36–.42)

Abbreviations: CI, confidence interval; SAR, secondary attack rate.

We also calculated the SAR based on index case characteristics. The SARs were 43% (95% CI, 37%–49%) and 37% (CI: 36–39) in the contacts of unimmunized and immunized index cases. They were 27% (23%–32%) and 40% (38%–42%) in the contacts of asymptomatic and symptomatic index cases, respectively, and 38% (35%–40%) and 39% (36%–42%) in households with children or adolescent/adult index cases, respectively.

We computed the SARs excluding households with multiple index cases, which did not change much the values reported above or the rankings within each factor (Supplementary Table 3). SARs were primarily reported for descriptive purposes, as no multivariate analysis or adjustments for confounding factors were performed.

Modeling Transmission Factors

Using our mathematical model, we estimated that the person-to-person transmission probability between 2 unvaccinated adolescents/adults was 47% (95% CrI, 37%–56%) in a household of 5 individuals in the absence of isolation measures and with a symptomatic infector. We studied how the risk of transmission varied with a combination of factors associated with the susceptibility and infectivity of individuals, as well as contact patterns and behaviors.

Protection Due to Vaccination and Past Infections

Among adolescents/adults, we estimated vaccine effectiveness as the reduction of susceptibility compared with unimmunized adolescents/adults. Vaccine effectiveness was estimated at 78% (95% CrI, 54%–90%) after 1 dose and 85% (95% CrI, 70%–94%) in individuals who received 2 doses ≤90 days earlier (Figure 2*A*). It dropped to 18% (95% CrI, −6% to 36%) in individuals who had received their second dose >90 days earlier. A third vaccine dose increased vaccine effectiveness to 73% (95% CrI, 49%–88%).

Compared with unimmunized adolescents/adults, the reduction of susceptibility was 72% (95% CrI, 46%–88%) in unvaccinated adolescents/adults who reported a previous infection and 80% (95% CrI, 58%–93%) in adolescents/adults who reported a previous infection and had received 1 vaccine dose (Figure 2*B*). Children who were immunized were 51% (95% CrI, 16%–75%) less susceptible than those who were not.

Impact of Demographics, Contact Patterns, and Behaviors

The person-to-person transmission risk decreased with the size of the household. It was 2.07 (95% CrI, 1.72–2.50) times higher in households with 2 members than in those with 5 (Figure 3*A*). Isolation behavior within the household reduced the transmission risk by 52% (95% CrI, 46%–57%) (Figure 3*B*). The transmission risk was 39% (95% CrI, 11%–76%) higher between a child

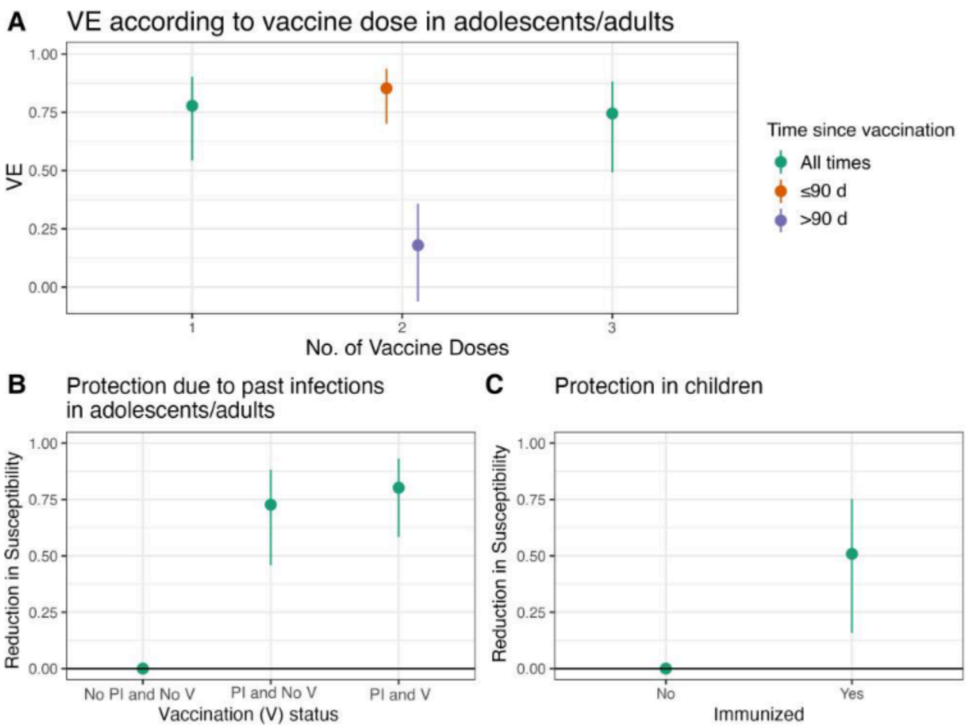

Figure 2. Protection due to vaccination and past infections. *A*, Vaccine effectiveness (VE) among adolescents/adults, according to the number of vaccine doses and the time since vaccination. The reference group is adolescents/adults who were unimmunized (unvaccinated and not previously infected). *B*, Reduction in susceptibility of adolescents/adults reporting previous infection (PI) and no vaccination (V) or previous infection and vaccination relative to adolescents/adults who were unimmunized. *C*, Reduction in susceptibility of immunized (previously infected or vaccinated) children relative to those who were unimmunized.

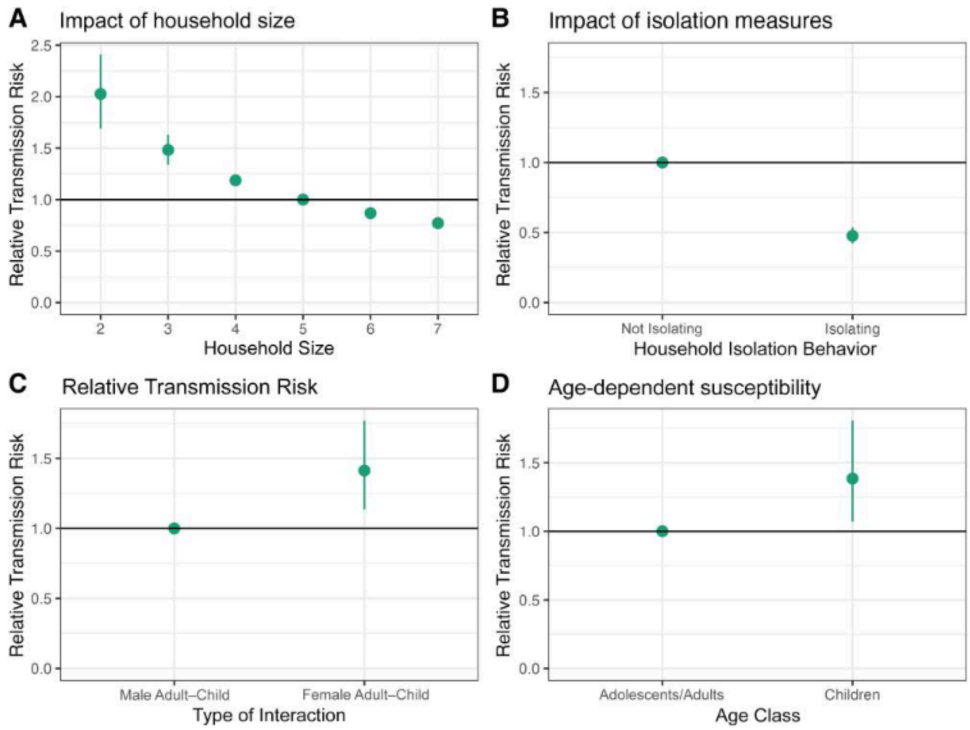

Figure 3. Impact of demographics, contact patterns, and behavior parameters. *A*, Transmission risk according to household size (reference: households with size members). *B*, Transmission risk among households with isolation measures relative to that in households without isolation measures. *C*, Transmission risk between female adults and children relative to that between male adults and children. *D*, Relative transmission risk among children relative to adolescents/adults.

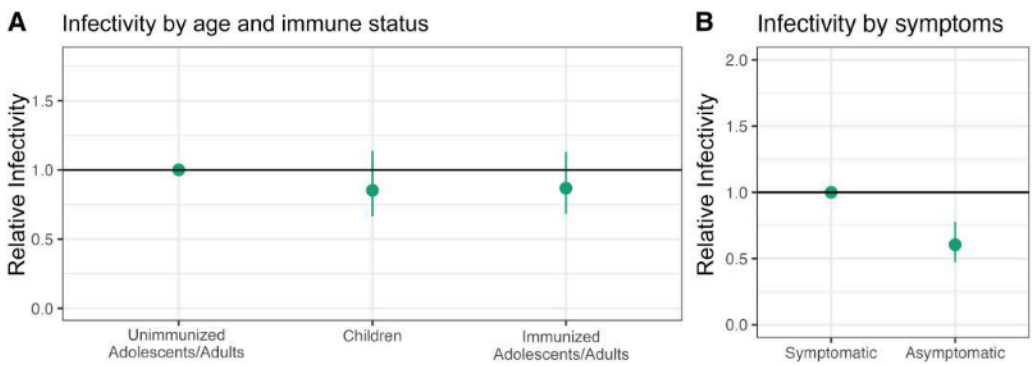

Figure 4. Drivers of infectivity. *A*, Relative infectivity by age and immune status; the reference is adolescents/adults who were unvaccinated and not previously infected (unimmunized). *B*, Relative infectivity according to symptoms; the reference is asymptomatic cases.

and an female adult than between a child and an male adult (both from adults to children and from children to adults) (Figure 3*C*). Among unvaccinated individuals, the susceptibility increased by 38% (95% CrI, 7%–81%) in children compared with adolescents/adults (Figure 3*D*).

Drivers of Infectivity

We studied how the transmission risk varied with the characteristics of the infector. Asymptomatic cases were estimated to be 40% (95% CrI, 26%–53%) less infectious than those with any symptoms. In terms of infectivity, there was no significant difference between unimmunized adolescents/adults and adolescents/adults who were vaccinated or reported past SARS-CoV-2 infections or between unimmunized adolescents/adults and children (Figure 4).

Important Drivers of Person-to-Person Probability of Transmission

We report how these different factors affect the person-to-person transmission probability. In a household with 5 members, the probability of transmission between 2 unvaccinated and nonisolated adolescents/adults was 48% (95% CrI, 38%–57%). It increased to 60% (95% CrI, 49%–70%) between unvaccinated female adults and children, and stagnated at 48% (38%–58%) between unvaccinated male adults and children. These probabilities dropped to 31% (95% CrI, 27%–37%) and 24% (19%–28%), respectively, if adults were vaccinated and observed isolation measures.

Between 2 adolescents/adults recently vaccinated with 2 doses, the probability decreased to 8% (95% CrI, 3%–15%). If they had been vaccinated for >3 months, the transmission probability was 36% (95% CrI, 33%–41%), decreasing to 13% (7%–23%) if they had received a booster dose. The probability of being infected from the community during the 21 days of follow-up was estimated to 1.1% (95% CrI, .4%–2.1%).

Sensitivity Analysis

Filtering for missing data did not significantly change the estimate of the global SAR: 35% (95% CI, 33%–37%) versus 38% (95% CI, 36%–40%). We assessed the robustness of our estimates to modeling assumptions. Most results were robust to change (see Supplementary materials). Under the assumption that the vaccine is effective 15 days after injection (compared with 7 days in our baseline analysis), we observed a slight increase in vaccine effectiveness, more pronounced for the 3-dose group (85% 95% CrI, 57%–96%) versus 74% (95% CrI, 50%–87%); Supplementary Figure 3). When considering a broader period during which cases can test positive, we observed changes only in the relative infectivity of asymptomatic versus symptomatic cases, increased from 0.59 (95% CrI, 0.46–0.74) to 0.83 (95% CrI, 0.67–1.02) (Supplementary Figure 3).

Simulation Study

The observed SAR was contained in the 95% prediction range, obtained when simulating datasets (Supplementary Figure 4). We also verified model parameters identifiability in a simulation study (Supplementary Table 1). The CrIs contained the simulation value with a probability of 88%–96%, showing that all parameters could be well estimated.

DISCUSSION

This study investigated factors affecting SARS-CoV-2 transmission in households. Using a mathematical model analyzing transmission data collected in a large number of households, we gained insight into how age, immunity profiles, contact patterns, and behaviors influence transmission and we deciphered their impact on individual susceptibility and infectivity.

In line with past studies [13, 14], we estimated that the isolation of COVID-19 cases in their households could halve the risk of transmission to other household members. This highlights the benefits of promoting case isolation within households to protect family members during epidemics, in a context where household transmission rates are high for SARS-CoV-2 but also for other respiratory diseases, such as influenza [18]. Households were considered to be following isolation measures if at least the index cases wore masks and ate separately. The level of adherence to isolation was lower for households with children, reflecting the difficulty of implementing these measures with children.

Recent vaccination provided strong protection against infection, after 1 (78% [95% CrI, 54%–90%]), 2 (85% [70%–94%]), or 3 (73% [49%–88%]) doses. Our estimates for full vaccination (2 or 3 doses) align with reported vaccine effectiveness against Delta variant infection [5, 19, 20]. While effectiveness after 1 dose is rarely reported, estimates include 51% in older Israeli adults at days 13–24 [21], 75% at days 15–28 [22], and >80% beyond 24 days [23]. The relatively high effectiveness we observed may be partly due to the younger age of first-dose recipients in our study (Supplementary Figure 2). Reduced protection in children compared with adults should be interpreted cautiously, given the group's limited size. Overall, vaccine protection was evident, as unvaccinated individuals accounted for a higher proportion of index cases (16%) compared with contacts (9%), suggesting that they were more likely to introduce the virus into households.

Six months after vaccination, BNT162b2 effectiveness against the Delta variant ranged from 17% in Qatar [24] to 82% in Canada [25], based on matched test-negative case-control studies. Our estimates align with the lower end, showing limited impact after 6 months. Household studies, like ours, may better detect asymptomatic infections, lowering effectiveness estimates. Another Israeli study reported significant waning after 3 months, with effectiveness dropping to 40% [5]. Variations in participant age and vaccination timing may explain differences across studies.

Household transmission studies are also used to characterize differences between individuals—for example, the relative susceptibility/infectivity of children relative to adults. However, these estimates reflect a combination of biological factors, behaviors, and contact patterns. Our study highlights the role of the latter: children's transmission rates were about 39% higher toward female than toward male adults. A similar difference in child-to-adult transmission rates was observed in French households for SARS-CoV-2 [26], likely due to female adults having substantially more contact with children (eg, 15% more in a Peruvian household study [11]). Other contact types, such as between spouses [27, 28], may also increase transmission risk, though our database did not allow identification of these specific contacts.

We estimated that unimmunized children were 38% more susceptible to Delta variant infection than unimmunized adolescents/adults. Young age was found to be a protective factor for the historical lineage, Alpha and Beta variants [14, 29], which is in line with the lower number of previous infections reported among children. However, the Delta variant exhibited a high prevalence among children in the general population [30, 31], and similar susceptibility of children relative to adults has been reported for the Delta and Omicron variants [32]. As indicated above, estimates of the relative susceptibility of children might be partly explained by other factors, for example, large number of contacts with family members or difficulty in adapting protective behaviors with a sick child. Indeed, through an alternative model where the contact rate between children varied compared with that between adults (Supplementary Figure 5), we showed that a higher contact rate among children could also explain the heterogeneous transmission risk between age classes. To better disentangle the impact of biological factors versus contact/behavior, we suggest monitoring contact patterns and behaviors in future household studies.

We did not observe a significant reduction in infectivity due to vaccination. While vaccine effectiveness against transmission through reduced infectivity was high during the Alpha period [3, 14], it was more moderate for Delta, with some studies showing low to no significant effect [3, 5]. These varying estimates may be due to behavioral changes in vaccinated individuals, depending on their perceived risk.

This study has several limitations. First, age was strongly correlated with vaccine status, making it challenging to estimate the individual effects of age and vaccine protection. The protection provided within each vaccine age group is a composite of both age and vaccine effectiveness. Therefore, the low protection in those vaccinated >90 days earlier (older adults) may partly reflect age-related susceptibility. We could not assess the effect on individuals who were vaccinated with 2 doses >90 days earlier and had a prior infection, as there were only 26 such cases. Since they represent a small fraction of the group, we believe this would introduce only a minor bias toward higher vaccine effectiveness, which was already quite low. Second, if vaccinated individuals reduced other protective behaviors because they felt protected by the vaccine, this could bias estimates of vaccine effectiveness downward. Our study used test dates instead of symptom onset dates to assess the timing of infections.

While test dates are less informative about disease dynamics, participants were encouraged to be tested at the onset of any suspicious symptoms. We expect test dates to be close to symptom onset for symptomatic cases. Increasing uncertainty in symptom onset time in sensitivity analysis did not significantly change transmission estimates, except among asymptomatic cases, whose infectivity slightly increased with longer infection to test delays. Testing procedures differed slightly between juveniles and adults, with adults tested at home and juveniles at local centers. Given the strong encouragement to test and the fact that only 9% of cases were detected by Sheba Medical Center, this likely had minimal impact. Any bias would lean toward underdiagnosis in children, in whom prevalence was already high.

Using mathematical models, we analyzed a large household dataset to understand how age, heterogeneous immunity profiles, complex contact patterns, and behaviors influenced transmission and deciphered their impact on individual susceptibility and infectivity. Such assessment is essential to ascertain the drivers of SARS-CoV-2 transmission.

Supplementary Data

Supplementary materials are available at *The Journal of Infectious Diseases* online (http://jid.oxfordjournals.org/). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyedited. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

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Potential conflicts of interest. All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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