Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Infection 83 (2021) e34–e36

Contents lists available at ScienceDirect

Journal of Infection

journal homepage: www.elsevier.com/locate/jinf

Letter to the Editor

Lower household transmission rates of SARS-CoV-2 from children compared to adults

Dear editors,

Lockdown measures such as closure of businesses, public offices, schools, and entertainment areas as well as face masks mandates, and social distancing effectively reduce SARS-CoV-2-transmission in public space. The question remains what happens in private households. We have read with interest the recent letter by Wang et al.[1] showing relevant transmission within households of infected individuals.

We recently conducted a seroprevalence study among households with at least one confirmed case of SARS-CoV-2. The collection of further data on the specific households allowed us to define possible risk factors as well as effective safety measures that could reduce transmission of SARS-CoV-2 among household members. From June 2020 on, SARS-CoV-2-PCR-positive individuals and their household members in Dresden/Germany were invited via the local public health office to participate in the FamilyCoviDD19-study. Households with SARS-CoV-2 seropositive members detected via our seroprevalence studies in schools and preschools (SchoolCoviDD19 and KiTaCoviDD19) were invited to participate as well. Upon informed consent, 5 mL of peripheral venous blood was collected from each individual. Additionally, demographics and information on implemented hygiene and distancing measures within the household were obtained.

The investigation is part of the FamilyCoviDD19-study which was approved by the Ethics Committee of the Technische Universität (TU) Dresden (BO-EK-342072020) and has been assigned clinical trial number DRKS00022564.

SARS-CoV-2 IgG antibodies were detected via Diasorin LIAISON® SARS-CoV-2 S1/S2 IgG Assay and positive or equivocal results were confirmed via Abbott Diagnostics® ARCHITECT SARS-CoV-2 and Euroimmun® Anti-SARS-CoV-2 ELISA. Participants whose positive or equivocal LIAISON® test result could be confirmed by an additional serological test were considered seropositive for SARS-CoV-2. Five individuals (2.3%, all adults) were excluded due to this definition (see supplemental Table 1). 150 households, with a median size of 3 (IQR 2–4) members, were enrolled in this study. Individuals under the age of 18 were living in 66/150 (44%) of the households. Serostatus of 414/470 (88%) of all potential household members was analyzed. In 106 (71%) of households all household members participated (see supplemental Table 2). 139 (92%) households were enrolled based on a PCR-confirmed SARS-CoV-2 positive index-person and 11 households were enrolled via seroprevalence studies in schools and preschools.

In total, 211/414 (51%) study participants were seropositive. 143/211 (68%) seropositive participants reported a previous positive SARS-CoV-2 PCR. 107/137 (78%) of all PCR-confirmed index-cases were seropositive. There was no significant difference in the seropositivity rate of adult index-cases compared to children and adolescents (98/125 (78%) vs. 9/12 (69%); $p = 0{\cdot}725$). The Secondary Attack Rate (SAR) of the 17 index-cases <18 years (41 contacts / 6 seropositive; SAR 0•15) was significantly lower compared to the 126 adult index-cases (207 contacts / 79 seropositive; SAR 0•38; $p = 0{\cdot}0036$). There was no transmission from an index-person < 18 years to a household contact < 18 years (0/7), but 26 transmission from adult index-cases to household contacts < 18 years (26/71, SAR 0•37). In 84/150 (56%) households, no transmission was detected. In 35/150 (23%) households, all members were found to be seropositive. The likelihood of all household members being seropositive decreased with household size. Households with children and adolescents were significantly less likely to be completely seropositive compared to households without children ($p = 0{\cdot}0188$, see Table 2).

123/139 (88•5%) index-persons were symptomatic at the time the PCR was positive. SAR of symptomatic index-persons (0•37) did not differ significantly to the SAR from asymptomatic index-persons (0•27, Table 1). 93/139 (67%) of households with a PCR-confirmed index-case implemented hygiene or distancing measures during their mandated quarantine. Temporal separation in the use of common rooms was implemented most commonly (58/139 (42%)) followed by mask wearing of the index person (19/139 (14%)). Both of these measures reduced transmissions significantly (SAR 0•53 vs. 0•23 and 0•08, respectively; $p = 0{\cdot}0001$ for both) as well as the likelihood of all household members being seropositive (18/46 (39%) vs. 10/58 (17%) and 1/19 (5%), respectively; $p = 0{\cdot}0152$ and $p = 0{\cdot}0065$) (see Table 2). In three households the index-case left the household for the time of the mandated quarantine when tested PCR-positive (spatial separation). In these households there was no transmission to household contacts. Usage of disinfection, increased frequency of hand-washing and/or ventilation did not decrease transmission significantly compared to households without any measures (SAR 0•42 vs. 0•53).

Existing studies on household-transmission of SARS-CoV-2 analyze PCR-confirmed SARS-CoV-2 infections among household contacts[1,2], leading to a possible underestimation of the SAR. By conducting a seroprevalence study, we can assess the SAR more accurately, minimizing the likelihood of undetected SARS-CoV-2 infections in the household and thereby explain the higher SAR in our study compared to previous studies (e.g. 0•166 in a review by Madewell et al.[2] vs. 0•35 in our study). However, the low rate of underage index-cases and their lower SAR compared to adult index-cases is consistent with previous studies[3–5]. This supports existing evidence that children are not only less likely to develop severe disease courses but also are less susceptible[6,7] and less likely to transmit SARS-CoV-2[8,9]. One possible explanation for our

https://doi.org/10.1016/j.jinf.2021.04.022

Table 1
Transmissions within households in specific subpopulations; n: Number of households; SAR: secondary attack rate; NS: not significant; * vs. symptomatic index-cases, ** vs. index-case < 18 years, *** vs. no PCR-confirmed index-case; CI: 95% confidence interval.

	n	Contacts	Transmissions	SAR (CI)	*p*
Symptomatic index-case	123	216	79	0•37 (0•31–0•43)	
Asymptomatic index-case	16	22	6	0•27 (0•09–0•46)	NS*
Index-case < 18 years	17	41	6	0•15 (0•05–0•27)	
Index-case ≥ 18 years	126	207	79	0•38 (0•32- 0•45)	0•0036**
No PCR-confirmed index-case	11	28	8	0•29 (0•11–0•46)	
PCR-confirmed index-case	139	238	85	0•35 (0•29–0•43)	NS***

Table 2
Transmissions within households with or without hygiene/distancing measures and with or without persons < 18 y.; NS: not significant; * vs. no measures; ** statistical analysis not performed because $n = 3$;*** vs. households with persons < 18 y.; SAR: secondary attack rate; CI: 95% confidence interval.

	All seropositive (%)	p*	No Transmissions (%)	p*	SAR (CI)	p*
No measures	39		39		0.53 (0•43–0•63)	
Any measure	16	0•005	67	0•003	0.26 (0•19–0•32)	0•0001
Temporal separation	17	0•0152	72	0.0008	0.23 (0•15–0•31)	0•0001
Spatial separation	0	**	100	**	0	**
Face mask	5	0•0065	79	0•006	0.08 (0•0–0•19)	0•0001
Increased hand hygiene, frequent ventilation	27	NS	53	NS	0.42 (0•23- 0•61)	NS
Households with persons < 18 y.	14		50		0•36 (0•30–0•43)	
Households without persons < 18 y.	31	0•0188***	61	NS***	0•31 (0•22–0•35)	NS***

observation might be the age-dependent SARS-CoV-2 viral loads[14]. Although transmission risk scales positively with the duration of exposure and closeness of social interaction[10], 56% of participating households showed no transmission at all, suggesting that hygiene and distancing measures are effective even within confined spaces. Importantly though, temporal separation of common rooms and mask wearing are clearly more effective than increased hand hygiene or ventilation alone. These findings are important when counseling affected families.

Contributors

J.A, L.G., R.B. and A.D designed the study and wrote the protocol. J.A., L.G., J.B., E.K and L.H. collected samples. A.D. and C.L. performed serological testing. J.A., L.G. and R.B. analyzed and verified the data. L.G., J.A., L.H., J.B. and E.K. wrote the manuscript. A.D., C.L. and R.B. reviewed the manuscript.

Declaration of Competing Interest

A.D., R.B. and J.A. report grants from Federal State of Saxony during the conduct of the study.

Role of the Funding Source

This study was supported by a grant by the Federal State of Saxony.

Data sharing

We share data if reasonable requests are received. Requests should be directed to the corresponding author at lukas.galow@ukdd.de

Acknowledegement

We gratefully acknowledge the support of Dr. F. Trautmann (public health office Dresden) in recruting participants for this study.

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