

# Risk categorization and outcomes among healthcare workers exposed to COVID-19: A cohort study from a Thai tertiary-care center

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## Abstract

**Background:** A risk categorization tool for healthcare workers (HCWs) exposed to severe acute respiratory syndrome coronavirus-2 is crucial for preventing coronavirus disease 2019 (COVID-19) transmission and requires validation and modification according to local context. We conducted this study to evaluate the performance of the study risk categorization tool and COVID-19-related outcomes among HCWs.

**Methods:** From 1 January to 31 December 2021, a prospective cohort study was conducted among COVID-19 exposing HCWs at a Thai tertiary-care center. The study risk categorization tool was specifically created in this study and modified from the United States Centers for Disease Control and Prevention recommendations, which classified HCWs into low-risk (LR), intermediate-risk (IR), and high-risk (HR) groups based on types of activities, duration of exposure, and protective methods used during exposure. Subsequent measures were determined for the HCWs based on the risk categories. The primary outcome was the difference in rates of COVID-19 in the LR, IR and HR HCWs.

**Results:** There were 1,892 HCWs included; 52%, 25% and 23% were LR, IR, and HR, respectively. The median age was 30 years (IQR, 26-36 years). The majority was female (79%) and nurses (33%). The most common risk activities were being in the same room with closed space without wearing a mask with COVID-19 cases (75%). COVID-19 was diagnosed in 157 HCWs and 27%, 5% and 1% of HR, IR and LR HCWs, respectively (P<0.001). By multivariable analysis, factors associated with COVID-19 included household or community exposure [adjusted odds ratio (aOR), 1588.68; P<0.001], being HR group (aOR, 11.94; P<0.001), working at outpatient departments (aOR, 2.54; P<0.001), and no history of COVID-19 vaccination (aOR, 2.05; P=0.01). The monthly rates of COVID-19 among LR, IR, and HR HCWs significantly decreased after the incremental rate of full vaccination. In-hospital transmission between HCWs occurred in 8% and was mainly due to eating at the same table (58%).

**Conclusions:** The study risk categorization tool can differentiate risks of COVID-19 among the HCWs. Prevention of COVID-19 should be focused on HCWs with the identified risk factors and behaviors associated with COVID-19 development and encouraging receipt of full vaccination.

## Background

- Healthcare workers (HCWs) are front-line workers in the COVID-19 pandemic and are at higher risk of COVID-19 than the general population.
- A risk categorization tool for HCWs exposed to COVID-19 is crucial for preventing COVID-19 transmission and requires validation and modification according to the local context.
- There have no data on the performance of risk categorization tools, factors associated with sCOVID-19 and the rate of in-hospital transmission among HCWs in Thailand.

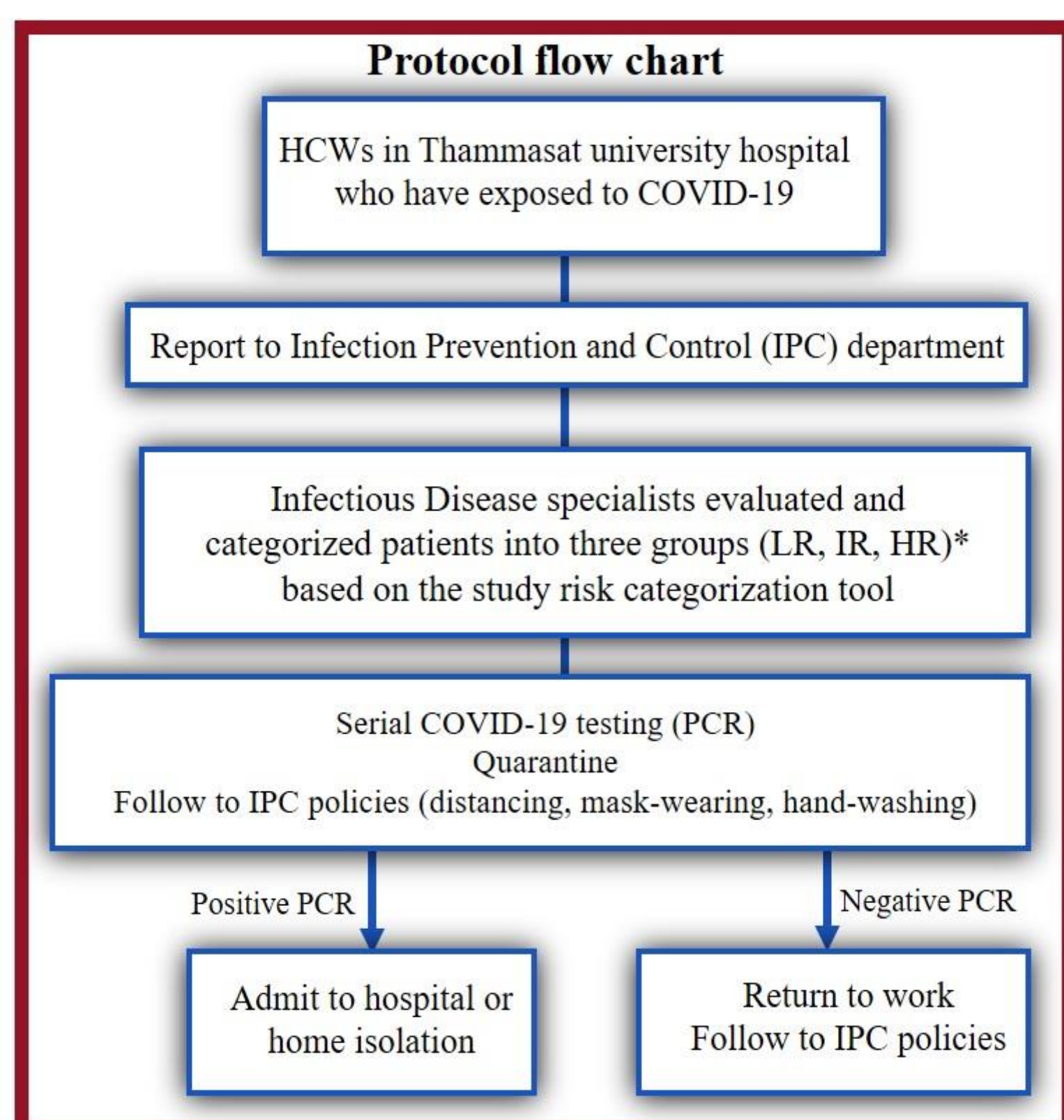
## Methods

**Population:** HCWs who have exposed to COVID-19

**Settings:** Thammasat University Hospital (TUH), a 650-bed tertiary-care hospital in Pathumthani, Thailand

**Design:** A prospective cohort study

**Study period:** 1 January 2021 to 31 December 2021



\* LR, low risk exposure, IR, intermediate risk exposure, HR, high risk exposure

## Methods

TUH risk categorization tool*			
Risk level	Characteristics of exposure		
High	<ul style="list-style-type: none"> <li>Sustained physical contact without wearing appropriate PPE with the person who tested positive and does not wear a mask</li> <li>Duration of contact more than 15 minutes</li> <li>Distance within 2 meters</li> <li>A place with poor ventilation</li> <li>Sharing food or beverage</li> <li>The person who tested positive coughs, sneezes, talks or shouts</li> <li>Examination close to a person's nose and mouth</li> </ul>		
Intermediate	<ul style="list-style-type: none"> <li>Sustained physical contact without wearing appropriate PPE with the person who tested positive but wears a mask</li> <li>Duration of contact 5-15 minutes</li> <li>Wearing appropriate mask but does not wear appropriate eye protection</li> </ul>		
Low	<ul style="list-style-type: none"> <li>Person in close contact and a person who tested positive wear appropriate mask</li> <li>Duration of contact less than 5 minutes</li> <li>Staying more than 2 meters away at all times from a person who tested positive</li> <li>Examination away from a person's nose and mouth</li> <li>A place with good ventilation</li> </ul>		
Action		Low risk	High risk
COVID 19 RT-PCR		No	Day 5
Quarantine		No	Doctor's decision
Duration of symptom observation		14 days	14 days

\* Adapted from the US CDC and Ministry of Health of Thailand 2020-2021 Guidelines

## Results

Table 1 Characteristics of HCWs who exposed to COVID-19 stratified by risk category

Characteristics	Total (n = 1891)	Risk categorization <sup>a</sup>			P value <sup>b</sup>
		LR (n = 984)	IR (n = 467)	HR (n = 440)	
Age, years, median (IQR)	30 (26-36)	30 (26-37)	29 (26-34)	29 (26-35)	0.003
Female	1485 (78.5)	762 (77.4)	367 (78.6)	356 (80.9)	0.337
Comorbidities					
- Previously healthy	1455 (76.9)	776 (78.9)	335 (71.7)	344 (78.2)	0.008
- Diabetes Mellitus	78 (4.1)	35 (3.6)	26 (5.6)	17 (3.9)	0.189
- Hypertension	107 (5.7)	41 (4.2)	40 (8.6)	26 (5.9)	0.003
- Dyslipidemia	73 (3.9)	36 (3.7)	23 (4.9)	14 (3.2)	0.353
- Pulmonary disease	29 (1.5)	9 (0.9)	10 (2.1)	10 (2.3)	0.073
- Others <sup>c</sup>	267 (14.1)	142 (14.4)	74 (15.8)	51 (11.6)	0.170
Body Mass Index, kg/m <sup>2</sup> , median (IQR)	22.8 (20.3-25.8)	22.7 (20.4-26.0)	22.4 (20.0-25.4)	23.1 (20.3-25.6)	0.425
Occupation					<0.001
- Physician	347 (18.4)	154 (15.7)	100 (21.4)	93 (21.1)	
- Nurse	625 (33.1)	352 (35.8)	160 (34.3)	113 (25.7)	
- Assistant nurse	438 (23.2)	223 (22.7)	102 (21.8)	113 (25.7)	
- Pharmacist or assistant pharmacist	56 (3)	39 (4)	5 (1.1)	12 (2.7)	
- Laboratory technician	14 (0.7)	1 (0.1)	1 (0.2)	12 (2.7)	
- Medical or nursing student	78 (4.1)	45 (4.6)	21 (4.5)	12 (2.7)	
- Other HCWs with patient contact <sup>d</sup>	126 (6.7)	53 (5.4)	37 (7.9)	36 (8.2)	
- Other HCWs without patient contact <sup>e</sup>	206 (10.9)	117 (11.9)	41 (8.8)	48 (10.9)	
Working place					<0.001
- COVID-19 inpatient department	57 (3)	18 (1.8)	8 (1.7)	31 (7)	
- Non COVID-19 inpatient department	912 (48.2)	416 (42.3)	275 (58.9)	221 (50.2)	
- Outpatient department	210 (11.1)	90 (9.1)	53 (11.3)	67 (15.2)	
- Emergency department	217 (11.5)	180 (18.3)	26 (5.6)	11 (2.5)	
- Laboratory department	14 (0.7)	1 (0.1)	1 (0.2)	12 (2.7)	
- Radiology department	63 (3.3)	28 (2.8)	27 (5.8)	8 (1.8)	
- Operation room	135 (7.1)	74 (7.5)	22 (4.7)	39 (8.9)	
- Others <sup>f</sup>	283 (15)	178 (18)	56 (12)	49 (11.1)	
Source of risk exposure <sup>g</sup>					<0.001
- Patient	697 (36.9)	346 (35.2)	229 (49)	122 (27.7)	
- Healthcare worker	1119 (59.2)	638 (64.8)	232 (49.7)	249 (56.6)	
- Household	35 (1.9)	0 (0)	4 (0.9)	31 (7)	
- Community	40 (2.1)	0 (0)	2 (0.4)	38 (8.6)	
The most common risk exposure activity					0.003
- Being in the same room with closed space without wearing a mask	1326 (75.4)	705 (71.6)	395 (74.6)	326 (74.6)	

<sup>a</sup> Based on Thammasat University Hospital Infection Prevention and Control protocol for risk assessment and measures for HCWs with risk exposure to SARS-CoV-2  
<sup>b</sup> Comparison between HCWs who had low, intermediate, and high-risk exposure to persons with confirmed COVID-19  
<sup>c</sup> Included thyroid diseases, allergic rhinitis, chronic hepatitis B, gastroesophageal reflux disease, benign prostatic hyperplasia, obstructive sleep apnea, and systemic lupus erythematosus  
<sup>d</sup> Included physical therapists, radiologic technicians, maids, and patient transporters  
<sup>e</sup> Included clerks, security guards, and gardeners  
<sup>f</sup> Included nursing department, physical therapy department, planning and finance department, medical supplies department  
<sup>g</sup> Household acquired COVID-19 is defined as symptoms onset or positive SARS-CoV-2 RT-PCR within 14 days after last contact with persons in the same household with COVID-19. Community acquired COVID-19 is defined as symptoms onset or positive SARS-CoV-2 RT-PCR within 2 days after admission (or within 7 days with a strong suspicion of community transmission).

IQR = interquartile range; RT-PCR = real-time polymerase chain reaction; SARS-CoV-2 = severe acute respiratory syndrome coronavirus-2.

## Results

Table 2 SAR-CoV-2 positivity rate of HCWs who exposed to COVID-19 stratified by risk category

Outcome	Total (n = 1892)	Risk categorization			P value
		LR (n = 984)	IR (n = 467)	HR (n = 440)	
PCR for SARS-CoV-2 positivity	157 (8.3)	13 (1.3)	24 (5.1)	120 (27.3)	<0.001

Table 3 Comparison of characteristics between the HCWs with and without subsequent COVID-19 development

Characteristics	COVID-19 (n = 157)	No COVID-19 (n = 1734)	P value
Age, years, median (IQR)	31 (26-40)	29 (26-36)	0.133
Female	135 (86)	1350 (90.9)	0.017
Occupation			<0.001
- Physician	16 (10.2)	331 (19.1)	
- Nurse	34 (21.7)	592 (34.1)	
- Assistant nurse	47 (29.9)	391 (22.5)	
- Pharmacist or assistant pharmacist	3 (1.9)	53 (3.1)	
- Laboratory technician	4 (2.5)	10 (0.6)	
- Medical or nursing practitioner	0 (0)	78 (4.5)	
- Other HCWs with patient contact <sup>d</sup>	25 (15.9)	101 (5.8)	
- Other HCWs without patient contact <sup>e</sup>	28 (17.8)	178 (10.3)	
Working place			<0.001
- COVID-19 inpatient department	14 (8.9)	43 (2.5)	
- Non COVID-19 inpatient department	51 (32.5)	861 (49.7)	
- Outpatient department	37 (23.6)	173 (10)	
- Emergency department	10 (6.4)	207 (11.9)	
- Laboratory department	4 (2.5)	10 (0.6)	
- Radiology department	4 (2.5)	59 (3.4)	
- Operation room	12 (7.6)	123 (7.1)	
- Others <sup>f</sup>	25 (15.9)	258 (14.9)	
Source of risk exposure <sup>g</sup>			<0.001
- Patient	70 (44.6)	627 (36.2)	
- Healthcare worker	12 (7.6)	1107 (63.8)	
- Household	35 (22.3)	0 (0)	
- Community	40 (25.5)	0 (0)	
History of COVID-19 vaccination			<0.001
- None	23 (14.6)	70 (4)	
- At least one dose	15 (9.6)	82 (4.7)	
- Two doses	101 (64.3)	1184 (68.3)	
- Three doses	18 (11.5)	398 (23)	
Duration from the last dose of COVID vaccine and the time of risk exposure, days, median (IQR)	63 (35-90)	63 (26-36)	0.363
Duration of risk exposure activities, minutes, median (IQR)	15 (10-20)	5 (5-10)	<0.001

Table 4 Multivariable logistic regression analysis for factors associated with COVID-19 development in HCWs

Factors	Adjusted OR (95% CI)	P value
Household or community exposure	1588.68 (218.24-11564.84)	<0.001
High risk exposure	11.94 (7.69-18.53)	<0.001
Working at outpatient departments	2.54 (1.61-4.00)	<0.001
No history of COVID-19 vaccination	2.05 (1.17-3.61)	0.012
Assistant nurse	1.23 (0.82-1.85)	0.325
Duration of exposure	1.00 (0.99-1.03)	0.394
Male sex	0.60 (0.36-1.00)	0.053

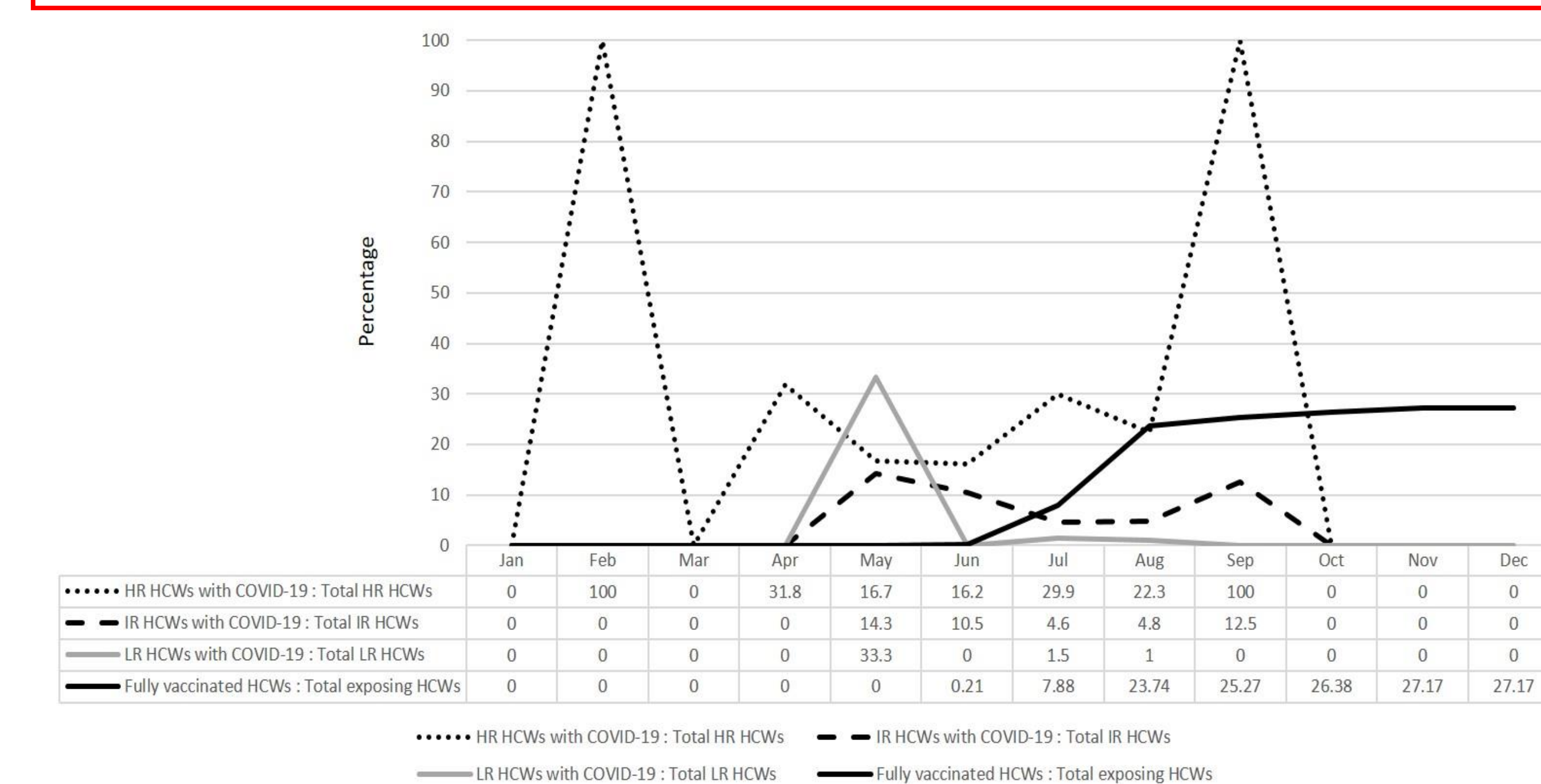
## Rate of in-hospital transmission

Patient-to-HCW transmission	44.6% (70/157)
HCW-to-HCW transmission	7.6% (12/157)

Table 5 Summary of the 12 HCWs who developed COVID-19 due to in-hospital HCW-to-HCW transmission

No.	Age	Sex	Occupation	Characteristics of risk exposure with another HCW with COVID-19	Duration of exposure (minute)	Location of exposure	PPE wearing	Risk level	Vaccination history	Severity of disease
1	37	Male	Physician	Eating at the same non-partitioned table	30	Common room	None	HR	CoronaVac, CoronaVac	Mild
2	37	Female	Assistant Nurse	Eating at the same non-partitioned table	30	Dining room	None	HR	CoronaVac, CoronaVac	Mild
3	42	Female	Assistant Nurse	Eating at the same non-partitioned table	30	Dining room	None	HR	CoronaVac, CoronaVac	Mild
4	24	Female	Assistant Nurse	Face-to-face contact within distance of < 2 meter	15	Ward	Surgical mask	IR	CoronaVac, CoronaVac	Mild
5	29	Female	Assistant Nurse	Being in the same room Closed space ≤15 m <sup>2</sup>	30	Ward	Surgical mask	HR	CoronaVac, CoronaVac	Mild
6	42	Female	Assistant Pharmacist	Eating at the same non-partitioned table	30	Dining room	None	HR	CoronaVac, CoronaVac	Mild
7	28	Female	Assistant Nurse	Face-to-face contact within distance of < 2 meter	60	Ward	Double mask	IR	None	Mild
8	27	Female	Nurse	Eating at the same non-partitioned table	30	Dining room	None	HR	CoronaVac, CoronaVac	Mild
9	43	Female	Laboratory technician	Being in the same room Closed space ≤15 m <sup>2</sup>	60	Laboratory	Surgical mask	HR	None	Mild
10	34	Female	Assistant Nurse	Eating at the same non-partitioned table	30	Dining room	None	HR	CoronaVac, CoronaVac	Mild
11	22	Female	Nurse	Eating at the same non-partitioned table	30	Dining room	None	HR	ChAdOx1	Asymptomatic
12	32	Female	Assistant Nurse	Being in the same room Closed space ≤15 m <sup>2</sup>	30	Ward	Surgical mask	IR	CoronaVac, CoronaVac	Asymptomatic

## Rates of COVID-19 among HR, IR, and LR HCWs and full vaccination



## Conclusion

- The study risk categorization tool can differentiate risks of COVID-19 among the HCWs.
- The factors associated with COVID-19 development included household or community exposure, being HR, working at outpatient department, and no history of COVID-19 vaccination.
- COVID-19 control measures should focus on reducing at-risk behaviors especially in outpatient departments and community setting and emphasize on up-to-date COVID-19 vaccination.
- In-hospital transmission between HCWs occurred in 8% and was mainly due to eating at the same table and prolonged period of exposure.
- Preventing in hospital HCW-to-HCW transmission should focus on at-risk behaviors especially during eating.

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