Slutrapport til Arbejdsmiljøforskningsfonden:

Forebyggelse af COVID-19 og andre luftvejsinfektioner blandt sygehuspersonale: FOCUS-projektet

Regionshospitalet Gødstrup, Arbejdsmedicin, Dansk Ramazzini Center

Bispebjerg og Frederiksberg Universitetshospital, Arbejds- og miljømedicinsk afdeling

Aarhus Universitet, Institut for Folkesundhed, Dansk Ramazzini Center

Aarhus Universitetshospital, Arbejdsmedicin, Dansk Ramazzini Center, Klinisk Mikrobiologi, Infektionsmedicin, BI-enheden

Forord

Idéen til dette projekt opstod den 28. februar 2020, hvor det første tilfælde af COVID-19 blev registeret i Danmark, i erkendelse af at COVID-19 kunne indebære en betydelig og hidtil uset risiko for vores sundhedspersonale. I løbet af få uger - for lånte midler – opbyggede vi daglig indsamling af oplysninger om symptomer på COVID-19, arbejdsopgaver og værnemidler ved hjælp af spørgeskemaer leveret til sundhedspersonalet i Region Midtjylland og Region Hovedstaden via deres smartphones. Efter at alle godkendelser, juridiske og videnskabsetiske forhold var afklaret, startede dataindsamlingen den 24. april 2020 i Region Midtjylland og den 6. maj 2020 i Region Hovedstaden og varede til 30. juni 2020, hvor antallet af nye tilfælde var faldet betragteligt. Da infektionshyppigheden igen begyndte at stige i løbet at efteråret 2020, blev dataindsamlingen genoptaget den 17. november i Region Midtjylland og 15. december i Region Hovedstaden, og varede indtil henholdsvis 30. april og 28. februar 2021.

Den 30. august 2020 ansøgte vi Arbejdsmiljøforskningsfonden om støtte til projektet, og den 17. december 2020 bevilgede Arbejdsmiljøforskningsfonden det halve af de budgetterede projektomkostninger (projektnummer 20205100734). Vi takker Arbejdsmiljøforskningsfonden for støtten, uden denne havde det ikke været muligt at gennemføre så store dele af projektet, som det er lykkedes os.

Projektpopulationen fik fra starten akronymet COBRA (COVID-19 blandt Regions Ansatte) kohorten. Det aktuelle projekt har anvendt FOCUS akronymet (Forebyggelse af COVID-19 og andre luftvejsinfektioner blandt sygehuspersonale).

Århus 16. oktober 2024

Henrik Kolstad, projektleder, professor i arbejdsmedicin ved Aarhus Universitetshospital

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Resumé

Idéen til dette projekt opstod den 28. februar 2020, den dag det første tilfælde af COVID-19 blev registeret i Danmark. Dette var i erkendelse af at COVID-19, baseret på alarmerende internationale rapporter om at sundhedspersonale var i særligt høj risiko for sygdom og død pga. COVID-19, kunne indebære en betydelig og hidtil uset risiko for sundhedspersonalet i Danmark.

De første deltagere deltog den 24. april 2020, og i alt deltog 22.526 hospitals- og andre ansatte i Region Midtjylland og Region Hovedstaden under første eller anden bølge af pandemien. Deltagelsen lå mellem 24% og 37% af alle inviterede. Deltagerne svarede på daglige spørgeskemaer om symptomer på COVID-19 og andre luftvejsinfektioner, arbejdsopgaver og brug af værnemidler (i alt 933.628 daglige besvarelser). Sundhedsstyrelsen, Statens Serum Institut og Region Midtjylland leverede oplysninger om PCR (polymerase chain reaction) testresultater for SARS-CoV-2 infektion og vaccination for COVID-19. Fra regionernes personaleregistre fik vi oplysninger om fag og afdeling.

Under den første bølge brugte 1,7% af deltagerne FFP2 eller FFP3 åndedrætsværn og 8,2% brugte andre masker ved patientkontakt. Under den anden bølge steg de tilsvarende tal til 17,8 % og 80,7%. Manglende brug af personlige værnemidler ved undersøgelse og behandling af luftveje faldt fra 21,3% under den første bølge til 0,4% under den anden bølge. Fejl og uheld med personlige værnemidler og manglende overholdelse af retningslinjerne for personlige værnemidler faldt fra 0,7% til 0,4% fra den første til anden bølge.

I en subpopulation som plejede patienter med COVID-19 og enten brugte intakte standard åndedrætsværn eller en ny sending åndedrætsværn, som viste sig at indeholde mange defekte eksemplarer, fandt vi at brug af intakt åndedrætsværn nedsatte risikoen for SARS-CoV-2 smitte med 60%.

Vi fandt at sundhedspersonale, som under anden bølge havde tæt kontakt til patienter, kollegaer og personer uden for arbejdet med kendt COVID-19, havde henholdsvis 3,17 (40 tilfælde), 2,54 (10 tilfælde) og 17,79 (35 tilfælde) gange forøget risiko for SARS-CoV-2 infektion i forhold til dem, som ikke var vidende om tæt kontakt med personer med COVID-19.

Sundhedspersonale som rapporterede fejl og uheld ved brug af værnemidler, havde 30% forøget risiko for SARS-CoV-2 infektion, men dette estimat var forbundet med stor usikkerhed pga. få eksponerede cases, og kunne såvel være foreneligt med en 20% beskyttende effekt som en 130% forøget risiko.

Vi fandt, at blandt sundhedspersonale der udførte arbejdsopgaver med risiko for smitte med virus eller bakterier, var fejl og uheld ved brug af åndedrætsværn forbundet med en forøget risiko for øvre luftvejsinfektion (relativ risiko 1,65; 95% konfidensinterval [KI] 0,53-5,14) under første bølge og 1,30; 95% KI 0,56-3,03) under anden bølge. Også manglende overholdelse af retningslinjer for åndedrætsværn var forbundet med forøget risiko for øvre luftvejsinfektion, men også her var estimaterne usikre pga. få cases.

Alt i alt dokumenterer projektet en betydelig stigning i brugen af personlige værnemidler blandt sundhedspersonale fra første til anden bølge af COVID-19 pandemien. På trods af dette havde personale, som under den anden bølge havde tæt kontakt med patienter og kollegaer med COVID-19, forøget risiko for SARS-CoV-2 infektion. Fejl og uheld ved personlige værnemidler samt manglende overholdelse af retningslinjerne for personlige værnemidler kan formodentlig forklare noget af den forøgede risiko for SARS-CoV-2 risiko ligesom en forøget risiko for andre former for øvre luftvejsinfektioner. Disse fund understreger behovet for fortsat fokus på brug af anbefalede personlige værnemidler for at forebygge fremtidige pandemier og almindelige smitsomme luftvejssygdomme, såvel som andre sygdomme forårsaget af biologiske agenser og kemisk eksponering i arbejdsmiljøet, når substitution, tekniske foranstaltninger og organisatoriske foranstaltninger ikke giver tilstrækkelig beskyttelse.

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Abstract

This project started on February 28, 2020, the day the first case of COVID-19 was registered in Denmark. This was in recognition that COVID-19, based on alarming international reports that healthcare workers were at particularly high risk of infection and death due to COVID-19, could pose a significant and unprecedented risk to healthcare workers in Denmark.

The first participants joined on April 24, 2020, and a total of 22,526 hospital and other staff in the Central Denmark Region and the Capital Region of Denmark participated during the first or second wave of the pandemic. Participation ranged between 24% and 37% of all invited. Participants answered daily questionnaires about symptoms of COVID-19 and other respiratory infections, work tasks, and the use of PPE (personal protective equipment) (a total of 933,628 daily responses). The Danish Health Authority, Statens Serum Institut, and the Central Denmark Region provided information about PCR (polymerase chain reaction) test results for SARS-CoV-2 infection and vaccination for COVID-19. From the regions' personnel registers, we obtained information about profession and department.

During the first wave, 1.7% of participants used FFP2 or FFP3 respirators, and 8.2% used other masks during patient contact. In the second wave, these figures rose to 17.8% and 80.7%, respectively. The lack of use of PPE during examination and treatment of the airways decreased from 21.3% in the first wave to 0.4% in the second wave. Failure and accidents with PPE and non-compliance with the guidelines for the use of PPE, decreased from 0.7% to 0.4% from the first to the second wave.

In a subpopulation, that cared for patients with COVID-19 and either used intact standard respirators or respirators from a batch found to contain many defective pieces, we found that using intact respirators reduced the risk of contracting SARS-CoV-2 by 60%.

We found that participants with close contact with patients, colleagues, and persons outside of work with known COVID-19 had 3.17 (40 cases), 2.54 (10 cases), and 17.79 (35 cases) times higher risk of SARS-CoV-2 infection compared to those who were unaware that they had been in contact with people with COVID-19.

Self-reported failure and accidents with the use of PPE was associated with a 30% increased risk of SARS-CoV-2 infection, but this estimate was associated with great uncertainty because of a limited number of exposed cases and could be consistent with either a 20% protective effect or a 130% hazardous effect.

We found that, among healthcare workers performing tasks at risk of viral or bacterial infection, accidents and failure with respirators were associated with an increased risk of upper airways infection during the first wave (relative risk 1.65; 95% confidence interval [CI] 0.53-5.14) and the second wave (relative risk 1.30, 95% CI 0.56-3.03). Also, failure to comply with personal PPE guidelines was associated with an increased risk of upper airways infection, but the estimates were uncertain due to the few cases.

Overall, the project documents a significant increase in the use of PPE among healthcare workers from the first to the second wave of the COVID-19 pandemic. Despite this, healthcare workers, who had close contact with patients and colleagues with COVID-19 during the second wave, were at increased risk of SARS-CoV-2 infection. Failure and accidents with PPE and non-compliance with PPE guidelines may likely explain some of the increased risk of SARS-CoV-2, as well as an increased risk of other types of upper respiratory infections. These findings thus highlight the need for continued focus on the use of recommended PPE to prevent future pandemics and common infectious respiratory diseases as well as other diseases caused by other biological agents and chemical exposures at work when substitution, technical and organizational measures do not provide sufficient protection.

Projektets baggrund og formål august 2020

Covid-19

Corona Virus Disease 2019 (COVID-19) er en infektionssygdom i luftvejene forårsaget af *severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2) (1, 2). Fra december 2019 bredte COVID-19 pandemien sig til alle kontinenter med høj sygelighed og dødelighed. Omfattende international dokumentation viste, at sundhedspersonale var i særlig risiko for COVID-19 (1, 3-13).

Ud af 18.000 medarbejdere i Region Midtjylland som foråret 2020 blev testet, havde 3,4% antistoffer mod SARS-CoV-2 (14). På de akutte modtageafdelinger på sygehusene i Hospitalsenheden Vest var 30% af personalet smittet, og smittehyppigheden var også høj på flere andre afdelinger i Region Midtjylland. Plejepersonale, læger, bioanalytikere og servicepersonale var særligt udsatte faggrupper. Blandt 29.000 sygehusansatte i Region Hovedstaden havde 4,0% af dem, som blev testet foråret 2020, SARS-CoV-2 antistoffer (15). På COVID-19 afsnit og blandt andet frontlinje personale var der højere smittehyppighed.

Vi forventede, baseret på erfaringer fra andre luftvejsinfektioner, at smitterisikoen var knyttet til arbejdsopgaver med tæt kontakt til smittede personer, eller dråbesmitte, som sjældent når udover en afstand på 1 meter (16-18). Der var i foråret 2020 begrundet mistanke om, at SARS-CoV-2 virus også kunne smitte via aerosoler, som kan overføres over længere afstande og dermed involvere brede grupper af arbejdsopgaver og personale (19). Der var begrænset viden om risikoen for SARS-CoV-2 smitte ved forskellige arbejdsopgaver i sundhedsvæsenet (11, 12).

Andre luftvejsinfektioner

Influenza rammer hver vinter 4-6% af befolkningen, og under de tilbagevendende epidemier kan op til 20% smittes (20, 21). Infektion med influenza, forkølelsesvirus og andre luftvejsinfektioner havde indtil COVID-19 pandemien været den dominerende årsag til kort sygefravær i Danmark (22). Under influenza A H1N1 pandemien i 2009 havde sygehuspersonale fordoblet smitterisiko (23). Særlig høj risiko fandt man ved procedurer i luftvejene, autopsier og patienttransport (24). Der var mangelfuld dokumentation for at kirurgiske masker og åndedrætsværn beskytter sundhedspersonale mod influenza virus (25, 26).

Værnemidler

Baseret på erfaringer fra SARS-CoV-1 og MERS epidemierne (SARS-CoV-1 og MERS er ligesom SARS-CoV-2 coronavirus) ville masker, åndedrætsværn, øjenbeskyttelse og fysisk afstand også beskytte mod SARS-CoV-2 smitte (21). Der var dog kun få studier af den beskyttende effekt mod SARS-CoV-2, men resultaterne var i tråd med resultaterne for SARS-CoV-1 og MERS (21-25). Samlet var der således holdepunkter for, at masker og åndedrætsværn nedsætter risikoen med 66% (27). Tilsvarende tal for en afstand på >1 meter til smittede personer var 82%, og for øjenbeskyttelse (visir eller beskyttelsesbrille) 78%.

SARS-CoV-2 studierne var baseret på ad hoc opsporing af kontakter til smittede patienter og karakteriseret ved retrospektiv dataindsamling og begrænset kontrol for konkurrerende faktorer. Der var derfor risiko for informations- og selektionsbias og confounding og dermed over- såvel som undervurdering af de sande beskyttende effekter.

Forskningsbehov

Det var behov for robust viden om årsagerne til den markant forøgede risiko for COVID-19 blandt sygehuspersonale i Danmark. Det krævede forløbsstudier med løbende indsamling af detaljerede oplysninger om risikofaktorer i arbejdsmiljøet, værnemidler og andre virkemidler inden smitte, symptomer og sygdom opstår. Ydermere fordrede det kvantificering af eksponering som grundlag for risikovurdering, samt kontrol for smitte i hjemmet og nærmiljøet og andre potentielle confoundere. Der var også behov for robust viden om hvilke værnemidler, som bedst beskytter mod COVID-19 baseret på studier af SARS-CoV-2 eksponerede populationer i Danmark. Det var endelig behov for at undersøge, om sundhedspersonale har forøget risiko for influenza, andre luftvejsinfektioner og sygefravær, og om den kan nedbringes med de samme infektionshygiejniske tiltag, som aktuelt anvendes mod COVID-19.

Hovedformål og forskningsspørgsmål

Hovedformålet var at forebygge COVID-19 (SARS-Cov-2 smitte og COVID-19 sygdom) og andre luftvejsinfektionssygdomme blandt sygehuspersonale.

Vi ville besvare følgende forskningsspørgsmål:

1. I hvilket omfang kan tæt kontakt med COVID-19 patienter, arbejdsopgaver og arbejdsplads forklare den forøgede risiko for COVID-19 blandt sygehuspersonale?

2. Er tæt kontakt med patienter og kollegaer, arbejdsopgaver og arbejdsplads forbundet med forøget risiko for andre luftvejsinfektioner end COVID-19 og sygefravær blandt sygehuspersonale?

3. Hvilke værnemidler, afstande, retningslinjer og træning giver den bedste beskyttelse mod COVID-19 og andre luftvejsinfektioner?

Tabel 1. Hovedkarakteristika ved de fem del-studier

Studie	Første bølge		Anden bølge		Populationskarakteristika	Eksponering	Udfald
	Deltagere	Person-dage	Antal deltagere	Person-dage			
Studie 1: Brug af værnemidler blandt sundhedsarbejdere under den første og anden bølge af COVID-19 pandemien (28)	21.684	953.122	10.097	933.628	Alle deltagere	Arbejdsopgaver	Forskellige former for personlige værnemidler
Studie 2: SARS-CoV-2 infektionsrater ved brug af intakte sammenlignet med defekte åndedrætsværn når man plejer patienter med COVID-19: En retrospektiv forløbsundersøgelse (29)	-	-	631	5.383	Sundhedsarbejdere, som anvendte defekt eller intakt åndedrætsværn ved pleje af COVID-19 patienter og som ikke tidligere var testet positive for SARS-CoV-2	Defekt åndedrætsværn	SARS-CoV-2 smitte påvist ved PCR test
Studie 3: SARS-CoV-2 infektionsrater blandt sundhedsarbejdere under pandemiens andre bølge: en forløbsundersøgelse (30)	-	-	5.985	514.165	Deltagere fra anden bølge ansat i Region Midtjylland	Tæt kontakt med patienter, kollegaer og personer udenfor arbejdet med COVID-19	SARS-CoV-2 infektion påvist ved PCR test
Studie 4: : Risiko for SARS-CoV-2 infektion blandt sundhedsarbejdere uden tilstrækkelige værnemidler I Danmark (31)	15.127*	780.515*	*	*	Sundhedsarbejdere med patientkontakt	Fejl og manglende overholdelse af retningslinjer for åndedrætsværn	SARS-CoV-2 infektion påvist ved PCR test
Studie 5: Fejl og manglende overholdelse af retningslinjer for åndedrætsværn og risiko for øvre luftvejsinfektioner – en forløbsundersøgelse med gentagne malinger blandt sundhedsarbejder under COVID-19 pandemien (32)	12.564	202.425	5.164	122.267	Sundhedsarbejdere med patientkontakt, som ikke havde aktuel SARS-CoV-2 infektion påvist ved PCR test	Fejl og manglende overholdelse af retningslinjer for åndedrætsværn	Øvre luftvejsinfektion
*Deltagerne blev rekrutteret under første og anden bølge							

Projektets metode og udførelse

Population

Studiepopulationen bestod af sundhedspersonale på hospitaler samt relateret teknisk, administrativt og andet personale i Region Midtjylland og Region Hovedstaden (herefter omtalt som sundhedspersonale), som deltog under den første (forår-tidligt sommer 2020) eller anden (vinter 2020-2021) bølge af COVID-19-pandemien i Danmark.

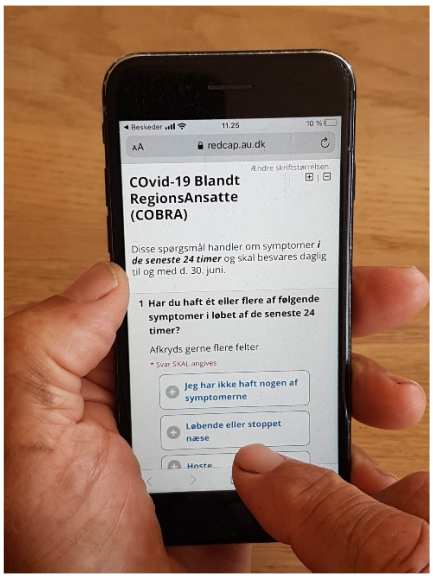
Under den første bølge blev sundhedspersonale i Region Midtjylland (n = 32.413) og Region Hovedstaden (n = 39.520) inviteret via arbejdsmail til at deltage ved at svare på daglige spørgeskemaer. Forud for den anden bølge blev kohorten fra Region Midtjylland opdateret; nyansatte medarbejdere blev inkluderet, og midlertidige medarbejdere blev ekskluderet (n = 26.024). Kohorten fra Region Hovedstaden blev begrænset til medarbejdere, der deltog under den første bølge (n = 9.569). Under den første bølge deltog 12.115 (37% af inviterede) fra Region Midtjylland og 9.569 (24% af inviterede) fra Region Hovedstaden. Under den anden bølge var disse tal henholdsvis 6.687 (26% af inviterede) og 3.410 (36% af inviterede). Baseret på denne population, som i alt bestod af 22.526 deltagere, udførte vi fem undersøgelser, baseret på hele populationen eller delmængder heraf, som det fremgår af tabel 1.

Spørgeskemaer

Ved begge bølger indhentede vi baselineoplysninger om rygning og generel sundhed. Herefter modtog alle deltagere via deres smartphones et dagligt spørgeskema (Figur 1) om COVID-19-relaterede og andre luftvejssymptomer, arbejdsopgaver, kontakt med personer med kendt COVID-19, brug af personlige værnemidler, fejl og uheld ved brug af personlige værnemidler og overholdelse af retningslinjer for værnemidler. I alt blev der indsamlet 933.628 daglige besvarelser (Tabel 1). Oplysninger om defekte åndedrætsværn (FFP2 eller FFP3 åndedrætsværn) indsamlede vi med et særligt spørgeskema, som primært adresserede dette.

Vi informerede løbende deltagerne om fremdriften i dataindsamlingen og forskningsresultaterne via 10 nyhedsbreve. Informationsmateriale, invitationsmails, samtykkeerklæringer, baseline spørgeskema, de daglige spørgeskemaer og nyhedsbrevene findes i bilagene.

Figur 1. Deltagerne besvarede spørgeskemaerne via deres smartphones eller (arbejds-) PC



SARS-CoV-2 tests, vaccination, fag og afdeling

Ved registerkobling med Dansk Mikrobiologi Database (MiBa) identificerede vi alle deltagere, som var testet PCR positive eller negative for SARS-CoV-2. Oplysninger om vaccination hentede vi fra Sundhedsdatastyrelsen og Serum Instituttets register for COVID-19 vaccinationer. Tilsvarende data fik vi også fra Region Midtjylland. Fra regionernes personaleregistre fik vi oplysninger om fag og afdeling.

Eksponering
Vi definerede tæt kontakt til personer med COVID-19 (patienter, kollegaer, personer udenfor arbejdet) baseret på de daglige spørgeskemaer. Fejl og uheld ved brug af personlige værnemidler blev defineret som en kombination af brud på barriererne for personlige værnemidler (f.eks. åndedrætsværn, maske eller visir, der falder af) og skade på værnemiddel (f.eks. punkteret handske) under arbejdsopgaver. Manglende overholdelse af retningslinjerne for brug af personlige værnemidler blev defineret baseret på deltagernes egen oplevelse af dette. Undersøgelse og behandling af luftveje blev bl.a. defineret som CPAP, PEP, intubering og genoplivning.

Udfald
Vi definerede SARS-CoV-2 infektion som første tilfælde af en PCR-positiv test for SARS-CoV-2 (29-31) og øvre luftvejsinfektion som tilstedeværelsen af mindst 2 af følgende symptomer på en given dag: hoste, ondt i halsen, feber og tilstoppet næse (kun i bølge 2) (32). Fejl og uheld med værnemiddel blev også analyseret som udfald og blev defineret som for eksponering (28).

Statistiske analyser
Vi estimerede odds-ratio for fejl og uheld ved brug af personlige værnemidler og manglende overholdelse af retningslinjer for personlige værnemidler for hver type værnemiddel: højisoleringsdragt, FFP2- eller FFP3-åndedrætsværn, ansigtsmaske, visir, handsker, medicinske sikkerhedsbriller og plastforklæde for de to bølger ved hjælp af logistisk regression (28). Standardfejl-baserede 95% konfidensintervaller (95% CI) blev opnået baseret på 50 boot strap prøver blandt de inkluderede deltagere. Vi kontrollerede for køn, alder, fag (sygeplejersker, læger og biomedicinske laboratorieforskere) og afdelinger (akut-, medicinske, kirurgiske og anæstesiologiske afdelinger).

Vi analyserede risiko for SARS-CoV-2 infektion som incidens rate ratioer (IRR) med Poisson eller binomial regression, hvor analyseenheden var person-dage. Vi klassificerede hver person-dag baseret på eksponeringsoplysninger 3-7 dage tidligere af hensyn til inkubationstiden for SARS-CoV-2 virus. Vi kontrollerede for alder, køn, måned, vaccinestatus, andre typer af COVID-19 kontakt (patient, kollega, kontakt udenfor arbejdet), antal tidligere PCR-tests, fag, afdeling, med nogen variation mellem studierne (29-31).

Vi analyserede øvre luftvejsinfektioner med generaliserede lineære modeller for binomialfamilien med en log-link-funktion ved brug af boot strapning med 100 gentagelser for at angive 95% konfidensintervaller på grund af de gentagne målinger af eksponering og øvre luftvejsinfektion.

Studiet blev registreret i Region Midtjyllands (1-16-02-150-20) og Region Hovedstadens (P-2020-455) interne forskningsfortegnelser, og de to datasæt blev samlet på platformen for Sundhedsdata. Begge regionale videnskabsetiske komitéer godkendte, at der ikke var behov for etisk godkendelse (1-10-72-1-20 og H-20027931). Alle deltagere gav informeret samtykke.

Resultater: om projektets formål er opnået

Studie 1: Brug af værnemidler blandt sundhedsarbejdere under den første og anden bølge af COVID-19 pandemien (Personal Protective Equipment Among Healthcare Workers During the First and the Second Wave of the COVID-19 Pandemic)(28)

Under den første bølge brugte 1,7% FFP2- eller FFP3-åndedrætsværn og 8,2% brugte andre masker [væskeresistente (type IIR) masker, masker med visir (typisk type IIR), og andre uspecificerede ansigtsmasker] under fysisk kontakt med patienter. Under den anden bølge steg de tilsvarende tal til 17,8% og 80,7%. Under procedurer på luftvejene steg brugen af FFP2- eller FFP3-åndedrætsværn fra 5,6 til 24,3%, og brugen af andre masker fra 14,7 til 77, %. Manglende brug af personlige værnemidler i forbindelse med procedurer på luftvejene faldt fra 21,3% under den første bølge til 0,4% under den anden bølge. Den totale andel af fejl og uheld med personlige værnemidler faldt fra 0,7 til 0,4% fra første til anden bølge. Andelen af personer, der ikke overholdt retningslinjerne for personlige værnemidler, faldt fra 3,6 til 2,2% under tæt

kontakt med patienter og fra 6,5 til 4,6% under procedurer på luftvejene. Fejl, uheld og manglende overholdelse af retningslinjer for personlige værnemidler varierede med alder, køn og afdelingstype. Hyppige årsager til manglende overholdelse af retningslinjerne var glemsomhed og mangel på tid; og under den første, men ikke den anden bølge, begrænset tilgængelighed af personlige værnemidler.

Tabel 2. Daglige rapporter om brug af personlige værnemidler ved forskellige arbejdsopgaver under første og anden bølge af COVID-19 pandemien

Table 2. Daily reports on use of personal protective equipment (PPE) during different work tasks during the first and the second wave of the COVID-19 pandemic.

	Consultations		Procedures with physical contact		Respiratory procedures		Surgical procedures or births		Transportation of patients		Other tasks <2 m		Cleaning of patient room		Multiple work tasks and multiple PPE[a]	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
First wave																
No PPE	62552	54.1	35900	34.1	1602	21.3	584	8.7	1391	29.4%	23806	46.5	3070	19.9	0	0.0
High isolation suit	13	0.0	79	0.1	21	0.3	18	0.3	0	0.0%	22	0.0	6	0.0	500	0.7
FFP2 or FFP3 respirator	528	0.5	1783	1.7	423	5.6	324	4.8	50	1.1%	508	1.0	159	1.0	10455	14.4
Face mask[b]	2764	2.4	8683	8.2	1106	14.7	3862	57.5	104	2.2%	2422	4.7	528	3.4	43754	60.3
Visor	1889	1.6	5607	5.3	448	5.9	476	7.1	23	0.5%	1960	3.8	278	1.8	16691	23.0
Gloves	49431	42.7	65260	61.9	5512	73.2	5488	81.7	3255	68.8%	25022	48.9	12130	78.6	71150	98.1
Medical safety goggles	411	0.4	2786	2.6	506	6.7	869	12.9	15	0.3%	546	1.1	133	0.9	17283	23.8
Medical gown or plastic apron	1495	1.3	10345	9.8	691	9.2	3188	47.4	69	1.5%	1632	3.2	1979	12.8	54565	75.2
Second wave																
No PPE	685	1.7	168	0.4	6	0.4	8	0.3	28	3.9%	196	1.4	57	1.0	0	0.0
High isolation suit	17	0.0	81	0.2	25	1.5	22	0.7	<5	<5	10	0.1	11	0.2	787	0.8
FFP2 or FFP3 respirator	7332	18.2	7531	17.8	398	24.3	342	10.7	163	22.6%	2865	20.6	1163	19.4	22514	22.0
Face mask[b]	29890	74.4	34085	80.7	1273	77.8	2876	90.0	459	63.7%	9982	71.8	4129	68.9	86190	84.1
Visor	4645	11.6	9026	21.4	362	22.1	434	13.6	122	16.9%	3125	22.5	1567	26.1	32743	31.9
Gloves	5155	12.8	18859	44.7	892	54.5	2787	87.2	254	35.2%	3318	23.9	4249	70.9	97134	94.8
Medical safety goggles	285	0.7	1373	3.3	214	13.1	490	15.3	15	2.1%	229	1.6	110	1.8	12717	12.4
Medical gown or plastic apron	1222	3.0	9698	23.0	478	29.2	2208	69.1	90	12.5%	1563	11.2	2566	42.8	51419	50.2
Plexiglass/plastic screen[c]	1321	3.3	303	0.7	21	1.3	7	0.2	<5	<5	889	6.4	29	0.5	2351	2.3

Presented as percent of total number of times the specific task was conducted.
[a]Responses containing multiple work tasks and multiple PPE on the same day.
[b]Face mask include the following: type IIR mask, mask with visor (typically type IIR) and other unspecified face masks.
[c]Plexiglass/plastic screen was only an available option during the second wave.

Studie 2: SARS-CoV-2 infektionsrater ved brug af intakte sammenlignet med defekte åndedrætsværn når man plejer patienter med COVID-19: En retrospektiv forløbsundersøgelse. (SARS-CoV-2 Infection Rates Following Use of Regular Compared with Defective Respirators When Caring for COVID-19 Patients: A Retrospective Follow-up Study)(29)

Den 24. december, 2020, begyndte man at anvende en ny type FFP3 åndedrætsværn i Region Midtjylland. Den 5. januar, 2021 blev man, når man tog dem af, klar over at mange af dem var gået op i sømmene, og den 8. januar 2021 blev de nye åndedrætsværn trukket tilbage. 463 og 163 sundhedsarbejdere havde brugt henholdsvis den sædvanlige og den nye type defekte åndedrætsværn, når de plejede COVID-19 patienter mellem 24. december, 2020, og 8. januar, 2021. Vi observerede otte og syv nye SARS-CoV-2-smittetilfælde i løbet af 4059 og 1324 person-dage. Dette svarede til daglige infektionsrater på 0,2% og 0,5%, en incidens rate ratio på 0,4 [95% KI 0,1; 1,0], og en incidens rate difference på 0,3% (95% KI −0,1; 0,8) ved sammenligning af brugere som brugte intakte versus defekte åndedrætsværn. Vi kan betragte defekte åndedrætsværn som en placebo intervention, og denne undersøgelse gav yderligere evidens for den beskyttende effekt af åndedrætsværn ved eksponering for SARS-CoV-2 virus.

Tabel 3. Sammenhæng mellem nye tilfælde af SARS-CoV-2 infektion og tidligere brug af intakte sammenlignet med defekte åndedrætsværn i forbindelse med pleje af COVID-19 patienter

Table 2. Association between incident SARS-CoV-2 infection and previous use of a regular compared with a new brand respirator with frequent defects when caring for COVID-19 patients.

Respirator type	Person-days at risk	Positive PCR tests	Daily infection rate (%)	IRR (95% CI)	Incidence rate difference (95% CI)
Regular respirator	4059	8	0.2	0.4 (0.1; 1.0)	0.3 (−0.1; 0.8)
New brand respirator	1324	7	0.5	Reference	Reference

Studie 3: SARS-CoV-2 infektionsrater blandt sundhedsarbejdere under pandemiens andre bølge: en forløbsundesøgelse (Healthcare workers' SARS-CoV-2 infection rates during the second wave of the pandemic: follow-up study)(30)

SARS-CoV2 infektionsraterne efter tæt kontakt 3-7 dage tidligere med patienter, kollegaer og personer uden for arbejdet med kendt COVID-19 var henholdsvis 153,7, 240,8 og 728,1 pr. 100.000 person-dage. Dette svarede til alders-, køns-, måneds-, antal PCR-tests og gensidigt justerede incidens rate ratioer på 3,17 [40 tilfælde, 95% KI 2,15–4,66], 2,54 (10 tilfælde, 95% KI 1,30–4,96) og 17,79 (35 tilfælde, 95% KI 12,05–26,28), hvor sammenligningsgruppen var deltagere, som ikke var vidende om, at de havde været i kontakt med personer med COVID-19. Risikoen for SARS-CoV-2-infektion var således lavere, men det absolutte antal smittede højere efter COVID-19-kontakt på arbejdet sammenlignet med COVID-19-kontakt uden for arbejdet.

Tabel 4. Tæt kontakt med patienter, kollegaer og personer udenfor arbejdet med COVID-19 og incidens rate ratio for SARS-CoV2 infektion

Table 3. Close contact 3–7 days earlier with patients, co-workers and persons outside work with COVID-19 and incidence rate ratios (IRR) of SARS-CoV-2. [CI=confidence interval.]

Contact with persons with COVID-19	Person-days	First positive SARS-CoV-2 PCR tests	Infection rate per 100,000 person-days	Model 1	Model 2 [a]	Model 3 [b]	Model 4 [c]
				IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Patients							
No contact	488 147	119	24.4	Reference	Reference	Reference	Reference
Contact	26 018	40	153.7	6.31 (4.41–9.02)	4.62 (3.21–6.65)	3.72 (2.55–5.44)	3.17 (2.15–4.66)
Co-workers							
No contact	510 012	149	29.2	Reference	Reference	Reference	Reference
Contact	4153	10	240.8	8.24 (4.34–15.63)	5.44 (2.86–10.35)	2.68 (1.37–5.24)	2.54 (1.30–4.96)
Persons outside work							
No contact	509 358	124	24.3	Reference	Reference	Reference	Reference
Contact	4807	35	728.1	29.91 (20.55–43.52)	21.75 (14.75–32.06)	18.87 (12.78–27.88)	17.79 (12.05–26.28)

[a] Model 1 adjusted for age (continuous), sex and month (6 categories, November 2020-April 2021)
[b] As model 2 and additionally adjusted for the other types of COVID-19 contact
[c] As model 3 and additionally adjusted for number of previous PCR tests.

Studie 4: Risiko for SARS-CoV-2 infektion blandt sundhedsarbejdere uden tilstrækkelige værnemilder I Danmark (Risk of SARS-CoV-2 infection in healthcare workers with insufficient use of personal protective equipment in Denmark)(31)

Selvrapporterede fejl, uheld og manglende overholdelse af retningslinjer for personlige værnemidler (utilstrækkelig brug af værnemidler) var let forbundet med SARS-CoV-2 infektion hos sundhedspersonale, men dataene var statistisk konsistente med parameterværdier, der spænder fra en beskyttende effekt til en fordobling af risikoen (IRR 1,3, 95 % KI 0,8; 2,3). Sensitivitetsanalyser, der var begrænset til højrisikoafdelinger og en periode med tilstrækkelig forsyning af værnemidler og fuldt udviklet testningssystem, bekræftede disse resultater.

Tabel 5. *Justerede incidens rate ratioer for COVID-19 for sundhedspersonale, som rapporterer utilstrækkelig brug af værnemidler, for alle (N=15,127) og begrænset til vinter 2020/21 (n=5,903) og høj-risiko afdelinger (n=9,022). (Adjusted incidence rate ratios (IRR) of COVID-19 for HCW reporting insufficient use of PPEcompared to HCW reporting sufficient use of PPE for all (N=15,127) and restricted to winter 2020/21 (n=5,903) or high-risk departments* (n=9,022))*

	Use of PPE	Risk time	Events	Crude rate (per 10,000 days)	IRR	95% CI
Adjusted for vaccination status	Sufficient	712,792	118	1,7	(ref)	
	Insufficient	67,723	15	2,2	1.3	0.8; 2.3
Adjusted for vaccination status, age, and sex	Sufficient	712,792	118	1,7	(ref)	
	Insufficient	67,723	15	2,2	1.3	0.8; 2.2
Restricted to wave 2 and adjusted for vaccination status	Sufficient	300,786	108	3,6	(ref)	
	Insufficient	25,547	12	4,7	1.3	0.7; 2.3
Restricted to wave 2 and adjusted for vaccination status, age, and sex	Sufficient	300,676	108	3,6	(ref)	
	Insufficient	25,547	12	4,7	1.3	0.7; 2.3
Restricted to high-risk departments* and adjusted for vaccination status	Sufficient	461,048	82	1,8	(ref)	
	Insufficient	47,030	10	2,1	1.2	0.6; 2.3
Restricted to high-risk departments* and adjusted for vaccination status, age, and sex	Sufficient	461,048	82	1,8	(ref)	
	Insufficient	47,030	10	2,1	1.2	0.6; 2.3
* Emergency, anesthesiology, surgical, and medical departments						

Studie 5: Fejl og manglende overholdelse af retningslinjer for åndedrætsværn og risiko for øvre luftvejs infektioner – en forløbsundersøgelse med gentagne målinger blandt sundhedspersonale under COVID-19 pandemien (Use, failure, and non-compliance of respiratory personal protective equipment and risk of upper respiratory tract infections - A longitudinal repeated measurement study during the COVID-19 pandemic among healthcare workers in Denmark)(32)

Vi fandt, at blandt sundhedspersonale, der udførte arbejdsopgaver med forøget risiko for overførsel af virus eller bakterier, var fejl og uheld med åndedrætsværn forbundet med forøget risiko for symptomer på øvre luftvejsinfektion forårsaget af andre virus end SARS-CoV-2, RR: 1,65 [95% KI 0,53-5,14] i første bølge og RR: 1,30 [95% KI 0,56-3,03] i anden bølge. Også manglende overholdelse af retningslinjer for åndedrætsværn var forbundet med forøget risiko for symptomer på øvre luftvejsinfektion i første bølge, RR: 1,28 [95% KI 0,87-1,87] og i anden bølge, RR: 1,39 [95% KI 1,01-1,91]. Stratificering på høj- versus lavrisiko arbejdsopgaver viste, at risikoen relateret til fejl og uheld og manglende overholdelse af retningslinjer, primært var forbundet med højrisikoopgaver, selvom det ikke var statistisk signifikant.

Tabel 6 a og b. Sammenhæng mellem brug af åndedrætsværn og symptomer på øvre luftvejsinfektion

Table 4a. Associations among RPE use, non-use, and RPE failure and symptoms of upper respiratory tract infections.

	Wave 1				Wave 2			
	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR -high-risk tasks	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR -high-risk tasks
Use of RPE (reference)	1	1	1	1	1	1	1	1
Non-use of RPE	0.94 (0.75 1.16)	0.94 (0.74 1.20)	1.19 (0.64 2.21)	0.90 (0.73 1.11)	1.35 (0.41 4.51)	1.31 (0.46 3.75)	1.86 (0.60 5.77)	(insufficient data)
Failure of RPE	1.76 (0.59 5.26)	1.65 (0.53 5.14)	(insufficient data)	1.71 (0.53 5.52)	1.61 (0.63 4.11)	1.30 (0.56 3.03)	(Insufficient data)	1.59 (0.71 3.55)

Table 4b. Associations between RPE use, non-use, and non-compliance and symptoms of upper respiratory tract infections.

	Wave 1				Wave 2			
	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR-high-risk tasks	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR-high-risk tasks
Use of RPE (reference)	1	1	1	1	1	1	1	1
Non-use of RPE	0.94 (0.76 1.18)	0.95 (0.78 1.16)	1.10 (0.54 2.25)	0.91 (0.72 1.13)	1.24 (0.35 4.32)	1.25 (0.41 3.83)	1.71 (0.53 5.58)	(Insufficient data)
Non-compliance	1.37 (1.02 1.84)	1.28 (0.87 1.87)	1.85 (0.68 5.07)	1.20 (0.82 1.76)	1.56 (1.12 2.18)	1.39 (1.01 1.91)	0.98 (0.53 1.83)	1.52 (1.03 2.26)

Adjusted: children in the household, gender, age, profession, region and calendar time (and in wave 2 also chronic disease).
Low-risk tasks: consultations with patients or relatives within 2 m distance, transport of patients, cleaning of patients room or other tasks with a distance below 2 m.
High-risk tasks: physical contact with patients (e.g. treatment, examination, personal care, or patient transfer), surgical procedures or birth giving and respiratory procedures.

Erfaringer, konklusioner og perspektiver

Projektet dokumenterer en betydelig stigning i brugen af personlige værnemidler blandt sundhedspersonale fra den første til den anden bølge af COVID-19 pandemien i Danmark. Fejl og uheld med personlige værnemidler var ualmindelige og faldt fra første til anden bølge. Dette er foreneligt med at den omfattende fokus på brugen af personlige værnemidler og andre forebyggende tiltag blandt sundhedspersonale og i almenbefolkningen, øget adgang til værnemidler samt øget træning og erfaring siden første bølge havde båret frugt. Fundene er i tråd med, hvad andre har fundet (33-35). Vi så et mindre fald i antal sundhedspersonale, som ikke overholdt retningslinjerne for brug af personlige værnemidler, og der er behov for et fortsat fokus på dette.

Der var forud for dette projekt begrænset empirisk evidens for, at åndedrætsværn nedsætter risikoen for SARS-CoV-2 infektion (men mange andre stærke argumenter for dette). Vores lille undersøgelse af defekte åndedrætsværn, som tilnærmer sig et naturligt eksperiment, hvor det defekte åndedrætsværn kan opfattes som en placebo intervention, tydede på at åndedrætsværn i praksis virker efter hensigten. Den beskyttende effekt, som vi observerede, svarede til hvad andre har fundet (36-38).

På trods af den omfattende stigning i brug af personlige værnemidler og andre forebyggende tiltag under den anden bølge af pandemien, var sundhedspersonale stadig i forøget risiko for SARS-CoV-2-infektion ved tæt kontakt med patienter, kollegaer eller personer udenfor arbejdet med COVID-19. Vores resultater viste væsentligt lavere risiko for SARSC-CoV-2 risiko end hvad Nguyen et al havde vist for frontlinje sundhedspersonale under den første bølge, men var sammenlignelige med hvad Mo og kollegaer havde vist for sundhedspersonale med opgaver, som mindede om deltagernes opgaver i vores studie (39, 40). Risikoen for SARS-CoV-2 smitte ved kontakt med COVID-19 patienter udenfor arbejdet var i vores studie det halve af, hvad Madewel og kollegaer havde vist ved COVID-19 kontakt i hjemmet (41).

Fejl, uheld ved personlige værnemidler og manglende overholdelse af retningslinjerne for personlige værnemidler kan formodentlig forklare noget af den forøgede risiko for SARS-CoV-2 infektion vi observerede ved kontakt med patienter og kollegaer med COVID-19. Et stort studie fra USA har i tråd med vores fund vist forøget risiko for SARS-CoV-2 infektion blandt sundhedspersonale med utilstrækkelig adgang til værnemidler (39).

Infektion med influenza og forkølelsesvirus var forud for COVID-19 pandemien den hyppigste årsag til øvre luftvejsinfektioner. Vi fandt holdepunkter for, at fejl og uheld med åndedrætsværn og manglende overholdelse af retningslinjer for brug af åndedrætsværn var forbundet med forøget risikoen for øvre

luftvejsinfektion forårsaget af andre virusarter end SARS-CoV-2. Tran og kollegaer viste i en *network meta-analyse,* at masker og N95 åndedrætsværn giver god beskyttelse mod luftvejsinfektioner, specielt hvis de er fit-testet, og understøtter til dels vores fund, men gør også opmærksom på en mulig svaghed ved dansk praksis på dette område: manglende brug af fit-test (42).

En mulig medvirkende årsag til den forøgede risiko for SARS-CoV-2 og andre luftvejsinfektioner, som vi observerede på trods af brug af værnemidler, kan således være at åndedrætsværnet ikke har været tilstrækkeligt tilpasset brugerne. Åndedrætsværn virker kun, hvis det slutter tæt til ansigtet. Desværre er det ofte ikke tilfældet, fordi selvkontrol af tilpasningen er vanskelig. Fit-test træner brugere af åndedrætsværn i korrekt påføring og tilpasning ved hjælp af måling og visualisering af hvor tæt åndedrætsværnet slutter til ansigtet (https://www.hse.gov.uk/pubns/indg479.htm) (Figur 2). Fit-test er lovpligtigt i UK, USA, Australien, Italien og fra 2025 også i Sverige. I Danmark defineres krav til åndedrætsværn og dets brug af en At-vejledning, som ikke stiller specifikke krav til fit-test (https://at.dk/regler/at-vejledninger/aandedraetsvaern-d-5-4/), og os bekendt er brug af fit-test ikke almindeligt i Danmark.

Pga. relativt få deltagere med SARS-CoV-2 infektion og luftvejsinfektion forårsaget af andre vira end SARS-COV-2, og det faktum at en arbejdsdag (analyseenheden i projektet) ofte indeholdt en række forskellige arbejdsopgaver og brug af en række forskellige værnemidler, var vi ikke i stand til at besvare hvilke værnemidler, afstande, retningslinjer og træning der giver den bedste beskyttelse mod COVID-19 og andre luftvejsinfektioner (forskningsspørgsmål 3).

Sammenfattende, dokumenterer projektet en betydelig stigning i brugen af personlige værnemidler blandt sundhedspersonale fra første til anden bølge af COVID-19 pandemien. På trods af dette havde personale, som under den anden bølge havde tæt kontakt med patienter og kollegaer med COVID-19, forøget risiko for SARS-CoV-2 infektion. Fejl og uheld med personlige værnemidler og manglende overholdelse af retningslinjerne for personlige værnemidler kan formodentlig forklare noget af den forøgede risiko for SARS-CoV-2 infektion og andre former for øvre luftvejsinfektioner. Disse fund understreger behovet for fortsat fokus på brug af anbefalede personlige værnemidler for at forebygge fremtidige pandemier og almindelige smitsomme luftvejssygdomme, såvel som andre sygdomme forårsaget af biologiske agenser og kemisk eksponering i arbejdsmiljøet, når substitution, tekniske foranstaltninger og organisatoriske foranstaltninger ikke giver tilstrækkelig beskyttelse.

Økonomisk støtte
Projektet er støttet af Arbejdsmiljøforskningsfonden (projektnummer 20205100734).

Figur 2. Fit test af FP2 åndedrætsværn

Fortegnelse over publikationer og produkter fra projektet

Videnskabelige publikationer med peer review

1. Cramer C, Hansen KK, Kinnerup MB, Flachs EM, Vestergaard JM, Biering K, et al. Use of Personal Protective Equipment Among Healthcare Workers During the First and the Second Wave of the COVID-19 Pandemic. Ann Work Expo Health. 2023;67(1):59-75.

2. Kolstad HA, Frydenberg M, Nielsen KJ, Schlünssen V, Biering K, Kjærsgaard M, et al. SARS-CoV-2 Infection Rates Following Use of Regular Compared With Defective Respirators When Caring for COVID-19 Patients: A Retrospective Follow-up Study. Ann Work Expo Health. 2023;67(1):141-6.

3. Würtz AM, Kinnerup MB, Pugdahl K, Schlünssen V, Vestergaard JM, Nielsen K, et al. Healthcare workers' SARS-CoV-2 infection rates during the second wave of the pandemic: follow-up study. Scand J Work Environ Health. 2022;48(7):530-9.

4. Bungum AB, Tøttenborg SS, Begtrup LM, Petersen KU, Worm MS. Bonde JP, et al Risk of SARS-CoV-2 infection in healthcare workers with insufficient use of personal protective equipment in Denmark. Ann Work Expo Health. 2024; In press.

5. Biering K, Kinnerup M, Cramer C, Dalboge A, Toft Wurtz E, Lund Wurtz AM, et al. Use, failure, and non-compliance of respiratory personal protective equipment and risk of upper respiratory tract infections-A longitudinal repeated measurement study during the COVID-19 pandemic among healthcare workers in Denmark. Ann Work Expo Health. 2024;68(4):376-86.

Mundtlige præsentationer, faglige

Arbejdsmiljøforskningsfondens årskonference, København, januar 2021: FOCUS projektet: Forebyggelse af COVID-19 og andre luftevejsinfektioner blandt sygehusansatte.

DASAM årsmøde 16.-17. september 2021: Healthcare workers' risk of SARS-CoV-2 infection following contact with patients, colleagues and persons outside work diagnosed with COVID-19 during the second wave of the pandemic: prospective follow-up study

EPICOH konference i Canada (online) 25.-29. oktober 2021: Are healthcare workers using personal protective equipment during the COVID-19 pandemic?

Ramazzini Forum, 10. september 2021: COVID-19 Blandt Regions Ansatte: COBRA-projektet

Infektionsmedicin, Aarhus Universitets Hospital, 8. oktober 2021: COVID-19 Blandt RegionsAnsatte: COBRA-projektet

DASAM årsmøde 29.-30. marts 2023: Use of Personal Protective Equipment Among Healthcare Workers During the First and the Second Wave of the COVID-19 Pandemic

Mundtlige præsentationer, populære

Kvalitetsforum, Aarhus Universitetshospital, 10. oktober 2022: COVID-19 Blandt Regions Ansatte: COBRA-projektet

Skriftlige præsentationer, populærvidenskabelige

Århus Stiftstidende, april 2020: Forskere undersøger om patientkontakt giver øget risiko for coronasmitte

Jyllands-Posten, 25. juli 2020: Hospitalsansatte har glemt eller undladt corona værnemidler

Midtnyt, 3. december 2020: 5500 medarbejdere hjælper os med at ruste os mod covid-19

Midtnyt, 22. september 2022: Risiko for COVID-19 smitte blandt hospitalsansatte kortlagt

Region Midtjyllands hjemmeside: 4. november 2022: Risiko for COVID-19-smitte blandt hospitalsansatte kortlagt

Bilag

1 Fem artikler, som angivet i fortegnelsen over videnskabelige publikationer med peer review

2 Invitationsmail, samtykke erklæring, baseline spørgeskema og dagligt spørgeskema, 1. bølge.

3 Baseline spørgeskema, dagligt spørgeskema og symptom spørgeskema, 2. bølge.

4 Løbende nyhedsbreve (10 stk.) til deltagerne om projektets forløb og resultater

5 Populærvidenskabelig artikel: COVID-19 blandt sundhedspersonale i Danmark 2020-2021: risiko, symptomer og personlige værnemidler

6 Afslutningsskema til Arbejdsmiljøforskningsfonden

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Bilag 1: Publikationer med peer review

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Original Article

Original Article

Use of Personal Protective Equipment Among Healthcare Workers During the First and the Second Wave of the COVID-19 Pandemic

Christine Cramer[1,2,*,†], Karoline Kærgaard Hansen[2,†], Martin Byskov Kinnerup[2,3], Esben Meulengracht Flachs[4], Jesper Medom Vestergaard[2,3], Karin Biering[3], Kent Nielsen[3], Anne Mette Würtz[1], Annett Dalbøge[2], Else Toft Würtz[2], Mona Kjærsgaard[5], Henrik Albert Kolstad[2] and Vivi Schlünssen[1,6]

[1]Department of Public Health, Work, Environment and Health, Danish Ramazzini Centre, Aarhus University, DK-8000 Aarhus C, Denmark; [2]Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, DK-8200 Aarhus N, Denmark; [3]Department of Occupational Medicine, Danish Ramazzini Centre, Goedstrup Hospital, DK-7400 Herning, Denmark; [4]Department of Occupational and Environmental Medicine, Bispebjerg and Frederiksberg Hospital, University of Copenhagen, DK-2400 Copenhagen, Denmark; [5]Department of Clinical Microbiology, Aarhus University Hospital, DK-8200 Aarhus N, Denmark; [6]National Research Center for the Working Environment, DK-2100 Copenhagen, Denmark

[†]Shared first-authorship.
*Author to whom correspondence should be addressed. Tel.: +4578450900; e-mail: chcrch@rm.dk

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Abstract

Introduction: To treat and properly care for COVID-19 patients it is vital to have healthy healthcare workers to ensure the continued function of the healthcare system and to prevent transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) to patients, co-workers, and the community. Personal protective equipment (PPE) can prevent healthcare workers from being infected with and transmitting SARS-CoV-2. Experience and training are pivotal to ensure optimal protection. This study aims to examine the use and failure of PPE and compliance with PPE guidelines during the first and the second wave of the COVID-19 pandemic among Danish healthcare workers.
Methods: Healthcare workers from the Central Denmark Region and the Capital Region of Denmark were invited to participate April–June 2020 during the first wave and November 2020–April 2021 during the second wave. Day-by-day, participants reported work procedures, use and failure of PPE, and compliance with PPE guidelines. Register-based information on sex, age, department, and profession was available for all participants.

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Results: In total, 21 684 and 10 097 healthcare workers participated during the first and the second wave, respectively. During the first wave, 1.7% used filtering face piece-2 or -3 (FFP2 or FFP3) respirators and 8.2% used face masks [fluid resistant (type IIR) masks, masks with visor (typically type IIR), and other unspecified face masks] during physical contact with patients. During the second wave, the corresponding figures increased to 17.8% and 80.7%. During respiratory procedures, the use of FFP2 or FFP3 respirators increased from 5.6 to 24.3%, and the use of face masks from 14.7 to 77.8%. The no PPE use decreased from 21.3% during the first wave to 0.4% in the second wave, during respiratory procedures. Total PPE failures decreased from 0.7 to 0.4% from the first to second wave. The proportion not complying with PPE guidelines declined from 3.6 to 2.2% during physical contact with patients and from 6.5 to 4.6% during respiratory procedures. PPE failure and non-compliance varied by age, sex and type of department. Frequent reasons for non-compliance were *forgetfulness* and *lack of time*, and during the first but not during the second wave, *limited availability of PPE*.
Conclusion: We found a substantial increase in the use of PPE and a substantial decrease in PPE failures from the first to the second wave of COVID-19 in Denmark. However, there is still a need for continuous focus on compliance in use of PPE among healthcare workers.

Keywords: compliance; COVID-19; face masks; healthcare workers; personal protective equipment

What's Important About This Paper?

Personal protective equipment (PPE) is a primary strategy for preventing COVID-19 among healthcare workers. This study surveyed Danish healthcare workers during two waves of the COVID-19 pandemic, and found changes in PPE use and compliance with PPE guidelines. This study demonstrates that healthcare workers' use of PPE and PPE failures can be modified.

Introduction

The number of people infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has increased dramatically worldwide since it was first identified and described in China on the 31st of December 2019 (World Health Organization, 2020a). The World Health Organization announced on the 11th of March 2020 that coronavirus disease (COVID-19) had reached the scope of a pandemic (World Health Organization, 2020b). The Danish Government concurrently introduced measures to reduce social contact and increase social distancing as part of the efforts to limit the spread of the COVID-19 (The Danish Government, 2020). Since then, guidelines for hospital hygiene and infection control during the COVID-19 pandemic have been updated several times. Indications for use of respirators as part of COVID-19 supplementary precautions were by large unchanged during the first and the second wave. During the second wave, healthcare workers (HCW) were demanded by the Danish Health Board to use a type II face mask during all patient contact as part of general precautions, to prevent droplet transmission. Current guidelines for the Central Denmark Region (valid since the 26th of November 2020, and concurrently updated to follow national guidelines) can be found in the supplementary material (see Supplementary Document 1 in online edition).

To properly care for and treat patients with COVID-19, healthy HCW are crucial. However, HCW are at greater risk of being infected with SARS-CoV-2 than the general population (Shaman *et al.*, 2020; Jespersen *et al.*, 2021; Verbeeck *et al.*, 2021; Würtz *et al.*, 2021). Four percent of HCW in the Capital Region of Denmark (April 2020) and 3.4% in the Central Denmark Region (May through June 2020) had antibodies against SARS-CoV-2 (Iversen *et al.*, 2020; Jespersen *et al.*, 2021). This was significantly higher than among Danish blood donors, where only 1% had antibodies against SARS-CoV-2 when screened in April 2020 (Erikstrup *et al.*, 2021). As expected, nursing staff, medical doctors, and biomedical laboratory scientists were particularly at risk (Jespersen *et al.*, 2021).

Compliance with personal protective equipment (PPE) donning and doffing guidelines has been shown to reduce and prevent transmission of infections including SARS-CoV-2 (Chu *et al.*, 2020; Liu *et al.*, 2020; Verbeek *et al.*, 2020), but it requires experience

and training to use PPE properly (Verbeek *et al.*, 2020; Piche-Renaud *et al.*, 2021). Furthermore, reduced availability of PPE, widespread in the first wave of the pandemic, may also have been an issue for HCW (Kim *et al.*, 2021; Mantelakis *et al.*, 2021; Rebmann *et al.*, 2021). Breach in the barrier of PPE (e.g. medical gown pulled back from glove exposing skin or HCW sweating and then wiping their face) and damage to PPE (e.g. tear in medical gown) have previously been of concern (Begley *et al.*, 2020; Verbeek *et al.*, 2020), but the combination of breach and damage (failure) of PPE among HCW during the COVID-19 pandemic has to our knowledge not been studied.

Information on mitigating factors for SARS-CoV-2 transmission among HCW such as the (proper) use of PPE and access to appropriate PPE and sufficient training is needed to prevent COVID-19 among HCW (Jespersen *et al.*, 2021). Therefore, this study aims to examine the use and failure of PPE, and compliance with PPE guidelines during the first and the second wave of the COVID-19 pandemic.

Methods

Study population

The COBRA (COVID-19 among Danish healthcare workers) study consists of two waves of daily questionnaires covering the first (spring-early summer 2020) and second (winter 2020–2021) waves of the COVID-19 pandemic in Denmark.

During the first wave, healthcare workers, technical, administrative, and other staff (hereafter, called HCW) of the Central Denmark Region (n = 32 413) and the Capital Region of Denmark (n = 39 520) were invited via work email to participate. Invitations were sent on the 24th of April 2020 in the Central Denmark Region and on the 6th of May 2020 in the Capital Region of Denmark. The first wave of questionnaires ended on the 30th of June 2020.

Prior to the second wave of the questionnaire, the Central Denmark Region cohort was updated; newly hired employees were included and temporary workers were excluded (n = 26 024). The Capital Region of Denmark cohort was restricted to workers participating during the first wave (n = 9569). The first questionnaire in the second wave was sent out on the 17th of November 2020 and 15th of December 2020, for the two Regions, respectively. The questions on work tasks and PPE use concluded on the 30th of April 2021 and the 28th of February 2021.

The first wave of the COVID-19 pandemic in Denmark had a peak in SARS-CoV-2 infection rates on the 4th of April, 2020, with 417 polymerase chain reaction (PCR) verified cases, and a peak in COVID-19 related deaths on the 5th of April 2020, with 22 deaths in a population of 5 771 877 citizens (World Health Organization, 2021). The second wave in Denmark was characterized by a peak in SARS-CoV-2 infection rates on the 17th of December 2020, with 4329 PCR verified cases, and a peak in COVID-19 related deaths on the 15th of January 2020, with 43 deaths (World Health Organization, 2021).

The study was registered at the repository of the Central Denmark Region (1-16-02-150-20) and the Capital Region of Denmark (P-2020-455), and the two dataset were merged at the Danish Health Data Authority platform. Both Regional Scientific Ethical Committees approved that ethical approval was not required (1-10-72-1-20 and H-20027931). All participants gave informed consent and could withdraw from the study at any time point.

Questionnaire

Daily questionnaires were sent to participants' smartphones at approximately 3:30 pm. Both waves addressed baseline information such as smoking habits and general health, and furthermore, daily COVID-19 related symptoms, work tasks, contact with SARS-CoV-2 positive individuals, use of PPE, and failure of PPE during work tasks. The questionnaire also addressed whether participants were compliant with PPE guidelines during work tasks.

In the second wave, the questionnaire was expanded to better address why PPE guidelines were not complied with (see Supplementary Document in online edition).

The daily questionnaire typically took between 15 s and 2 min to complete, dependent on whether the participant had been at work with tasks related to patients on that particular day. Most questions allowed multiple answers to accommodate participants with multiple daily tasks and the use of multiple types of PPE. Questions that included a *none* or *no* option had an included mutually exclusive function added to eliminate conflicting answers (e.g. answering that *no PPE* and gloves were used on the same day).

Work tasks were divided into nine categories: (i) consultations with patients or relatives within two meters distance, (ii) physical contact with patients (e.g. treatment, examination, personal care, or patient transfer), (iii) surgical procedures or birth giving, (iv) respiratory procedures (e.g. continuous positive airway pressure (CPAP), positive expiratory pressure (PEP), intubation or resuscitation), (v) transport of patients, (vi) other tasks with a distance less than 2 m, (vii) cleaning of

patient room, (viii) at work but doing none of the mentioned tasks, or (ix) not at work (sick leave, day off, or working from home).

The PPE addressed in the questionnaire were divided into the following eight categories: (i) high isolation suit, (ii) filtering face piece (FFP2 and FFP3) respirator, (iii) face mask (fluid resistant (type IIR) mask, mask with visor (typically type IIR), and other unspecified face masks), (iv) visor, (v) gloves, (vi) medical safety goggles, (vii) medical gown or plastic apron, and (viii) plexiglass/plastic screens (only the second wave).

Failure of PPE was defined as a combination of breach in the barrier of PPE (e.g. mask or visor falling off) and damage to PPE (e.g. punctured glove) during work tasks.

Non-compliance with PPE guidelines was defined as non-use of what participants perceived as the recommended PPE during work tasks.

Registers

Information on sex, age, department, and profession was provided by the two Regions, via the Danish Civil Registration System (Schmidt *et al.*, 2014).

Register information was linked to the study population by use of the unique 10-digit personal identification number given to all individuals in Denmark.

Data management and statistical analysis

All questionnaire data was collected using REDCap (Research Electronic Data Capture) tools (Harris et al., 2009). All subsequent data management and handling were performed in Stata (version 17.0; StataCorp, College Station, TX, USA) and SAS studio (3.8, version 9.04, SAS Institute Inc., Cary, NC, USA.).

When evaluating PPE use, PPE failure, and compliance with PPE guidelines, only a subgroup of the COBRA population was used, namely participants with patient-related work tasks on the given day. When evaluating the reasoning for non-compliance with PPE guidelines, only participants who reported not having complied with PPE guidelines were assessed. Thus, the populations in tables and figures vary accordingly.

Questionnaire responses indicating the use of multiple PPE and only one work task had all the PPE types assigned to that work task and vice versa. To avoid misclassification of PPE use and work tasks, responses with multiple PPE and multiple work tasks were categorized as "multiple work tasks and multiple PPE".

A comparison of the use and failure of PPE and the non-compliance with PPE guidelines was performed by calculating proportions.

Data are presented as *N* (%) unless stated otherwise. Numbers less than 5 are reported as <5 in concordance with the data protection policy.

Odds ratios (OR) for failures of PPE and non-compliance with PPE were estimated by each type of PPE (high isolation suit, FFP2, or FFP3 respirator, face mask, visor, gloves, medical safety goggles, and medical gown or plastic apron) for the two waves by logistic regression. Standard error-based 95% confidence intervals (95% CI) were obtained based on 50 bootstrap samples among the included participants. The logistic regression models were adjusted for sex (female and male), age (<30, 30–39, 40–49, 50–59, and ≥60 years), profession (nursing staff, medical doctors, and biomedical laboratory scientists) and departments (emergency, medical, surgical, and anesthesiology departments), and reported as adjusted odds ratios (AOR).

Results

Participation

During the first wave, 12 115 (37% of invited) participated from the Central Denmark Region and 9569 (24% of invited) from the Capital Region of Denmark. During the second wave, these numbers were 6687 (26% of invited) and 3410 (36% of invited), respectively (Table 1). This corresponded in total to 948 978 responses on daily questionnaires during the first and 928 880 during the second wave. During the first wave, the mean number of days a participant participated was 44 (IQR 35;59), and the mean percentage of possible answered questions 85 (IQR 80;97). The corresponding numbers during the second wave were 93 (IQR 36;156) and 82 (IQR 74;96), respectively. Also, the mean proportion of all participants reporting being in close contact with a COVID-19 patient during the first wave was 0.8%. The corresponding number during the second wave was 2.2%. In both waves, participants were predominantly female and aged 30–59 years. Nurse was the most frequent profession and medical departments supplied the largest percentage of participants.

Comparing the participants with the invited non-participants, participants were generally older and more frequently female. Nursing as profession and employment at a medical department dominated in both populations. A table with the characteristics of participants and non-participants is available as supplementary material (see Supplementary Table 1a in online edition).

Use of personal protective equipment

Only participants who performed patient-related work tasks had their PPE use evaluated (Table 2).

Table 1. Characteristics of participants in the COBRA study.

	First wave						Second wave					
	Central Denmark Region			Capital Region of Denmark			Central Denmark Region			Capital Region of Denmark		
	N	%	% of invited	*N*	%	% of invited	*N*	%	% of invited [a]	*N*	%	% of invited
Participants	12 115	100.0%	37.4%	9569	100.0%	24.4%	6687	100.0%	25.7%	3410	100.0%	35.6%
Sex												
Female	10 232	84.5%	40.1%	8087	84.5%	26.2%	5899	88.2%	27.4%	2943	86.3%	36.4%
Male	1883	15.5%	27.3%	1482	15.5%	17.1%	788	11.8%	17.4%	467	13.7%	31.5%
Age												
<30	1221	10.1%	20.9%	872	9.1%	12.8%	627	9.4%	15.7%	169	5.0%	18.7%
30–39	2551	21.1%	35.0%	1927	20.1%	19.7%	1356	20.3%	20.5%	480	14.1%	24.7%
40–49	3445	28.4%	44.0%	2594	27.1%	28.0%	1875	28.0%	29.7%	970	28.4%	37.5%
50–59	3355	27.7%	45.3%	2771	29.0%	31.8%	1984	29.7%	33.2%	1205	35.3%	43.3%
≥60	1543	12.7%	37.9%	1405	14.7%	28.2%	845	12.6%	26.9%	586	17.2%	43.2%
Profession												
Nursing staff[b]	4735	39.1%	41.0%	4586	47.9%	25.7%	2564	38.3%	23.8%	1527	44.8%	33.3%
Medical doctors	1328	11.0%	28.8%	1264	13.2%	19.6%	640	9.6%	15.8%	396	11.6%	31.6%
Biomedical Laboratory Scientists	661	5.5%	57.3%	509	5.3%	23.7%	413	6.2%	34.3%	234	6.9%	45.8%
Medical secretaries	1015	8.4%	53.3%	745	7.8%	35.6%	616	9.2%	31.4%	341	10.0%	45.8%
Other[c]	4376	36.1%	33.2%	2465	25.8%	22.4%	1813	27.1%	22.5%	912	26.7%	36.8%
Department												
Emergency	443	3.7%	35.6%	287	3.0%	24.7%	229	3.4%	17.6%	99	2.9%	34.1%
Medical[d]	2676	22.1%	41.3%	2301	24.0%	26.0%	1542	23.1%	23.5%	812	23.8%	35.9%
Surgical[e]	1729	14.3%	39.0%	1664	17.4%	25.1%	945	14.1%	19.6%	614	18.0%	37.1%
Biochemistry	725	6.0%	52.6%	531	5.5%	22.7%	448	6.7%	32.3%	229	6.7%	44.0%
Service section[f]	280	2.3%	18.6%	284	3.0%	11.4%	150	2.2%	17.4%	91	2.7%	33.3%
Anesthesiology	1140	9.4%	48.2%	789	8.2%	25.6%	593	8.9%	45.3%	264	7.7%	32.4%
Radiology and nuclear medicine	457	3.8%	44.4%	446	4.7%	27.0%	268	4.0%	26.3%	154	4.5%	34.5%
Psychiatry	1806	14.9%	29.0%	1697	17.7%	24.6%	690	10.3%	22.6%	515	15.1%	30.4%
Departments with limited patient contact[g]	2396	19.8%	44.7%	1330	13.9%	27.7%	954	14.3%	28.8%	548	16.1%	40.2%
Other[h]	463	3.8%	19.3%	240	2.5%	14.8%	227	3.4%	9.4%	84	2.5%	33.5%

[a]For all estimates except *Total (% of invited)* 65 individuals have been removed since no data on sex, age, profession or department was available.
[b]Nurses, social- and healthcare assistants, and radiographers.
[c]Primarily administrative, technical and educational staff.
[d]Internal medicine, paediatrics, oncology, and neurology.
[e]All surgical departments, including: obstetrics and gynaecology; otorhinolaryngology and head and neck surgery; and ophthalmology.
[f]Cleaning services; hospital porters; clothing and waste management; depot and archive; telephone switchboard; and guidance for patients, relatives, and staff.
[g]Occupational and social medicine; physio- and occupational therapy; administration; department of technical services; and kitchen.
[h]Participants without affiliation, e.g. students and participants on call, wage subsidy, and hourly waged.

Table 2. Daily reports on use of personal protective equipment (PPE) during different work tasks during the first and the second wave of the COVID-19 pandemic.

	Consultations		Procedures with physical contact		Respiratory procedures		Surgical procedures or births		Transportation of patients		Other tasks <2 m		Cleaning of patient room		Multiple work tasks and multiple PPE[a]	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
First wave																
No PPE	62552	54.1	35900	34.1	1602	21.3	584	8.7	1391	29.4%	23806	46.5	3070	19.9	0	0.0
High isolation suit	13	0.0	79	0.1	21	0.3	18	0.3	0	0.0%	22	0.0	6	0.0	500	0.7
FFP2 or FFP3 respirator	528	0.5	1783	1.7	423	5.6	324	4.8	50	1.1%	508	1.0	159	1.0	10455	14.4
Face mask[b]	2764	2.4	8683	8.2	1106	14.7	3862	57.5	104	2.2%	2422	4.7	528	3.4	43754	60.3
Visor	1889	1.6	5607	5.3	448	5.9	476	7.1	23	0.5%	1960	3.8	278	1.8	16691	23.0
Gloves	49431	42.7	65260	61.9	5512	73.2	5488	81.7	3255	68.8%	25022	48.9	12130	78.6	71150	98.1
Medical safety goggles	411	0.4	2786	2.6	506	6.7	869	12.9	15	0.3%	546	1.1	133	0.9	17283	23.8
Medical gown or plastic apron	1495	1.3	10345	9.8	691	9.2	3188	47.4	69	1.5%	1632	3.2	1979	12.8	54565	75.2
Second wave																
No PPE	685	1.7	168	0.4	6	0.4	8	0.3	28	3.9%	196	1.4	57	1.0	0	0.0
High isolation suit	17	0.0	81	0.2	25	1.5	22	0.7	<5	<5	10	0.1	11	0.2	787	0.8
FFP2 or FFP3 respirator	7332	18.2	7531	17.8	398	24.3	342	10.7	163	22.6%	2865	20.6	1163	19.4	22514	22.0
Face mask[b]	29890	74.4	34085	80.7	1273	77.8	2876	90.0	459	63.7%	9982	71.8	4129	68.9	86190	84.1
Visor	4645	11.6	9026	21.4	362	22.1	434	13.6	122	16.9%	3125	22.5	1567	26.1	32743	31.9
Gloves	5155	12.8	18859	44.7	892	54.5	2787	87.2	254	35.2%	3318	23.9	4249	70.9	97134	94.8
Medical safety goggles	285	0.7	1373	3.3	214	13.1	490	15.3	15	2.1%	229	1.6	110	1.8	12717	12.4
Medical gown or plastic apron	1222	3.0	9698	23.0	478	29.2	2208	69.1	90	12.5%	1563	11.2	2566	42.8	51419	50.2
Plexiglass/plastic screen[c]	1321	3.3	303	0.7	21	1.3	7	0.2	<5	<5	889	6.4	29	0.5	2351	2.3

Presented as percent of total number of times the specific task was conducted.

[a]Responses containing multiple work tasks and multiple PPE on the same day.

[b]Face mask include the following: type IIR mask, mask with visor (typically type IIR) and other unspecified face masks.

[c]Plexiglass/plastic screen was only an available option during the second wave.

Characteristics of this population are available as supplementary material (see Supplementary Table 1b in online edition).

Apart from gloves (see below), the use of PPE increased markedly from the first to the second wave (Table 2). During consultations, 54.1% reported not using any PPE in the first wave. This number decreased to 1.7% in the second wave. The decrease in no PPE use was seen for all tasks: procedures with physical contact (34.1–0.4%), respiratory procedures (21.3–0.4%), surgical procedures or births (8.7–0.3%), transportation of patients (29.4–3.9%), other tasks performed less than 2 m from the patient (46.5–1.4%), and cleaning of patient room (19.9–1.0%).

The use of both FFP2/FFP3 respirators and face masks increased markedly for all tasks from the first to the second wave. The increase in use of FFP2/FFP3 respirators for the different tasks was substantial: consultations (0.5–18.2%), procedures with physical contact (1.7–17.8%), respiratory procedures (5.6–24.3%), surgical procedures, or births (4.8–10.7%), transportation of patients (1.1–22.6%), other tasks with a distance less than 2 m (1.0–20.6%), and cleaning of patient room (1.0–19.4%). The corresponding numbers for face masks were: consultations (2.4–74.4%), procedures with physical contact (8.2–80.7%), respiratory procedures (14.7–77.8%), surgical procedures or births (57.5–90.0%), transportation of patients (2.2–63.7%), other tasks with a distance less than 2 m (4.7–71.8%), and cleaning of patient room (3.4–68.9%).

The use of gloves decreased between the first and the second wave. The decrease was most prominent for consultations (42.7–12.8%) and transportation of patients (68.8–35.2%). However, a decrease was seen in almost all tasks: procedures with physical contact (61.9–44.7%), respiratory procedures (73.2–54.5%), other tasks with a distance less than two meters (48.9–23.9%), and cleaning of patient room (78.6–70.9%). The only task for which the use of gloves increased was surgical procedures or births (81.7–87.2%).

Two most frequent combinations of work tasks in the "multiple work tasks and multiple PPE" category were *consultations and procedures with physical contact* and *consultations, procedures with physical contact, and other tasks <2 m* in both the first and second wave. The two most frequent combinations of PPE were *gloves and medical gown or plastic apron* and *gloves, face mask, and medical gown or* plastic apron in the first wave, and *gloves and* face mask and *gloves, face mask, and medical gown or* plastic apron in the second wave. The 10 most frequent combinations are available as supplementary material (see Supplementary Table 2a in online edition).

Failure of personal protective equipment

During the first wave, 1344 participants reported failures of PPE, and of these only 0.4% reported repetitive failures of PPE (10 or more times), mean 1.16 times, inter quartile range (IQR) 1;1. The same pattern was seen during the second wave, where 877 participants reported failures, and of these 1.3% reported failures of PPE 10 or more times (mean 1.22 times, IQR 1;1).

During the second wave, fewer failures were experienced by the participants for all types of PPE compared to the first wave (4.1‰ and 6.8‰ of PPE used, respectively) as shown in Fig. 1. Face masks had the greatest reduction in failures (from 4.8‰ during the first wave to 1.8‰ during the second wave). Gloves were the PPE with which most participants reported failures (9.9‰ during the first wave and 8.2‰ during the second wave). During both waves, procedures with physical contact were the task in which most participants reported failure of PPE (7.1‰ during the first wave and 6.6‰ during the second wave) as seen in Fig. 2.

Compliance with personal protective equipment guidelines

During the first wave, 4158 participants reported not having complied with PPE guidelines, and of these 4.9% reported not having complied with PPE guidelines 10 or more times (mean 1.38 time, IQR 1;2). The same pattern was seen during the second wave, where 1878 participants reported not having complied with PPE guidelines, and of these 8.0% reported not having complied with PPE guidelines 10 or more times (mean 1.46 times, IQR 1;2).

Fewer tasks were performed without complying with PPE guidelines during the second wave, compared to the first wave, as seen in Fig. 3. Respiratory procedures were the most frequent task where participants reported not having complied with PPE guidelines (6.5 % during the first wave and 4.6 % during the second wave). The corresponding numbers for the other work tasks were: consultations (2.5–1.7%), procedures with physical contact (3.6–2.2%), surgical procedures or births (3.2–1.9%), transportation of patients (2.7–0.8%), other tasks with a distance less than 2 m (2.8–1.7%), and cleaning of patient room (1.9–0.6%).

During the first wave, face masks, and gloves were the PPE with which most participants reported non-compliance with PPE guidelines, 7.1% and 2.8% respectively, Fig. 4. During the second wave, apart from face masks (1.4%) most participants reported non-compliance with PPE guidelines for visors (4.2%).

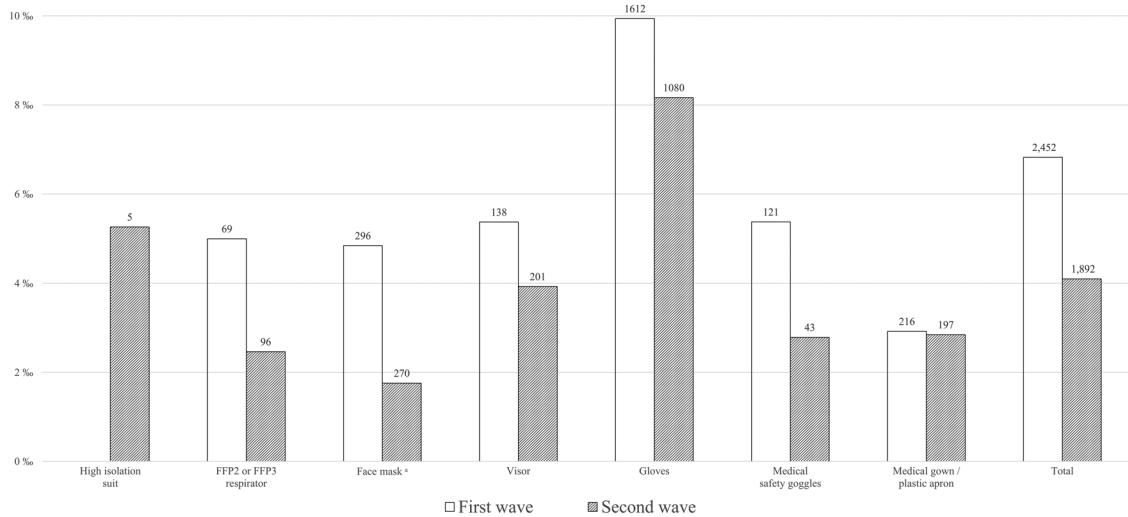

Figure 1. Failure of personal protective equipment (PPE) by type of PPE during the first and the second wave of the COVID-19 pandemic. Presented as per mille of personal protective equipment used (y-axis) as well as total number of events (top of columns). [a]Face mask include the following: type IIR mask, mask with visor (typically type IIR) and other unspecified face masks.

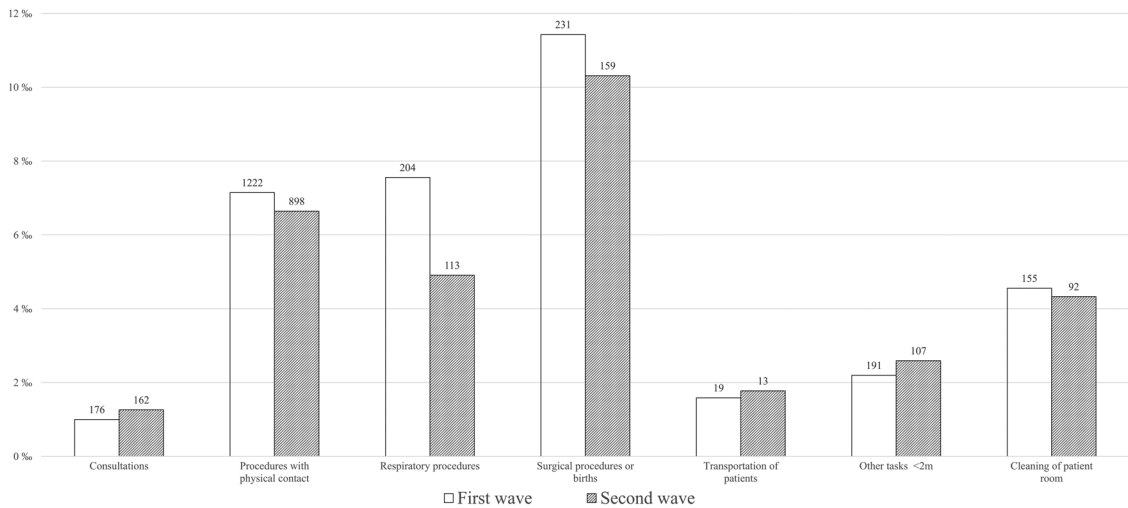

Figure 2. Failure of personal protective equipment (PPE) by task during the first and the second wave of the COVID-19 pandemic. Presented as per mille of personal protective equipment used (y-axis) as well as total number of events (top of columns).

Reasons for non-compliance with personal protective equipment guidelines

The reasons most frequently reported by the participants for non-compliance were *forgetfulness* (25.9% during the first wave and 27.2% during the second wave), *lack of time* (21.6% during the first wave and 13.3% during the second wave), *maintaining good patient contact* (7.1% during the second wave) and *considered it to be unnecessary* (17.7% during the second wave) as seen in Fig. 5. During the first wave, participants also reported *limited availability of PPE* as an issue (10.0% during the first wave and 3.0% during the second wave).

Healthcare workers' characteristics associated with failures of personal protective equipment and non-compliance with personal protective equipment guidelines

During both waves and across all PPE, older HCW tended to less often experience failure compared to

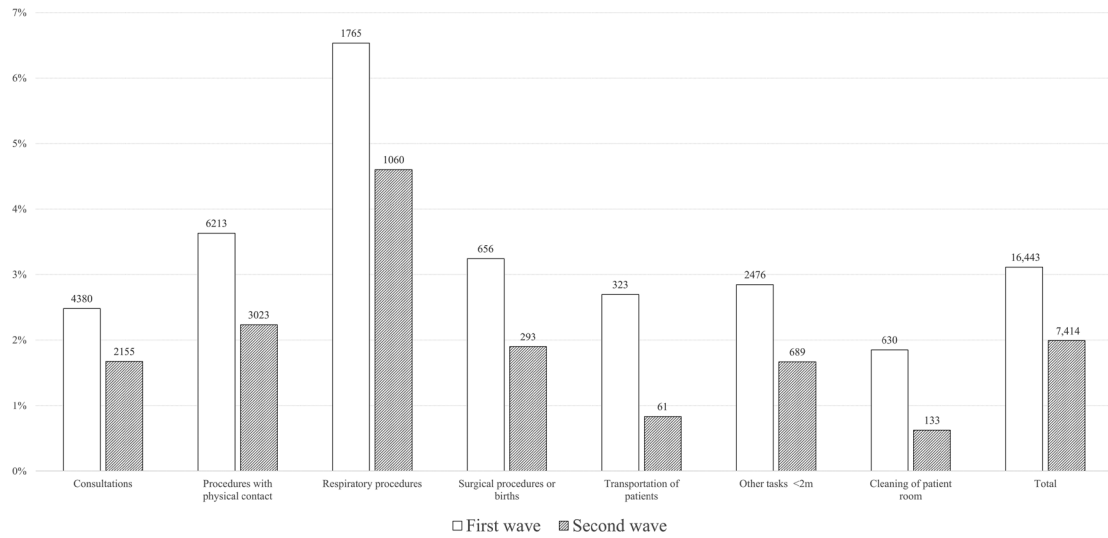

Figure 3. Non-compliance with personal protective equipment (PPE) guidelines by task during the first and the second wave of the COVID-19 pandemic. Presented as percent of total number of times the specific task was conducted (y-axis) as well as the total number of events (top of columns).

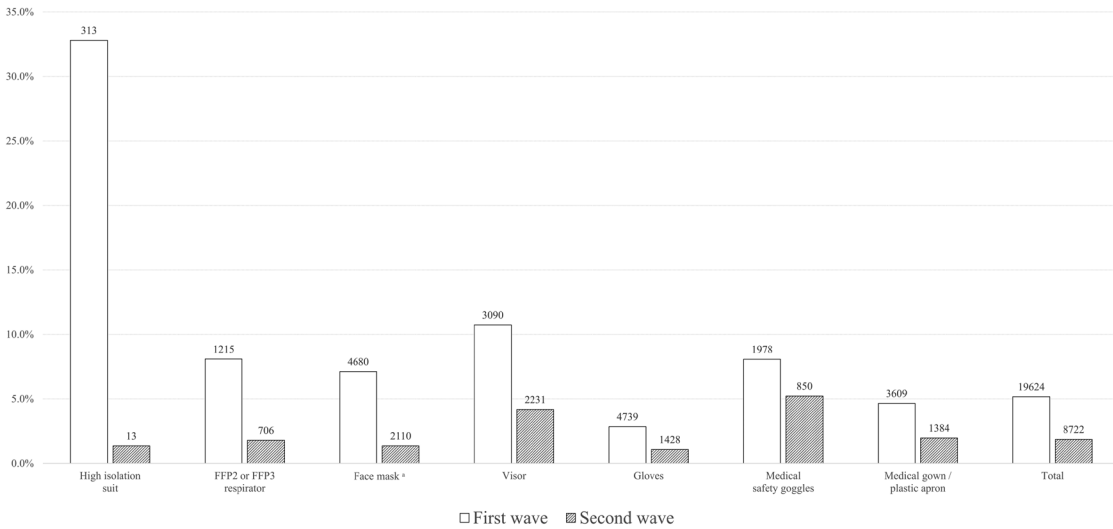

Figure 4. Non-compliance with personal protective equipment (PPE) guidelines by PPE during the first and the second wave of the COVID-19. Presented as percent of total number of times the specific PPE was used (y-axis) as well as the total number of events (top of columns). [a]Face mask include the following: type IIR mask, mask with visor (typically type IIR) and other unspecified face masks.

younger HCW. The greatest difference was seen for FFP2 and FFP3 respirators, where the adjusted odds ratio (AOR) for reporting a failure was 0.2 (0.0;0.8) for participants aged 60< compared to participants aged <30 during the first wave, and the corresponding number for the second wave was 0.1 (0.0;0.4), as seen in Table 3. During both waves and across all PPE, there was a tendency towards the surgical departments less often experiencing failure of PPE compared to the emergency departments. The greatest difference was seen for FFP2 or FFP3 respirators, where the AOR for reporting a failure was 0.1 (0.0;0.5) for surgical departments compared to emergency departments during the first wave, and the corresponding number for the second wave was

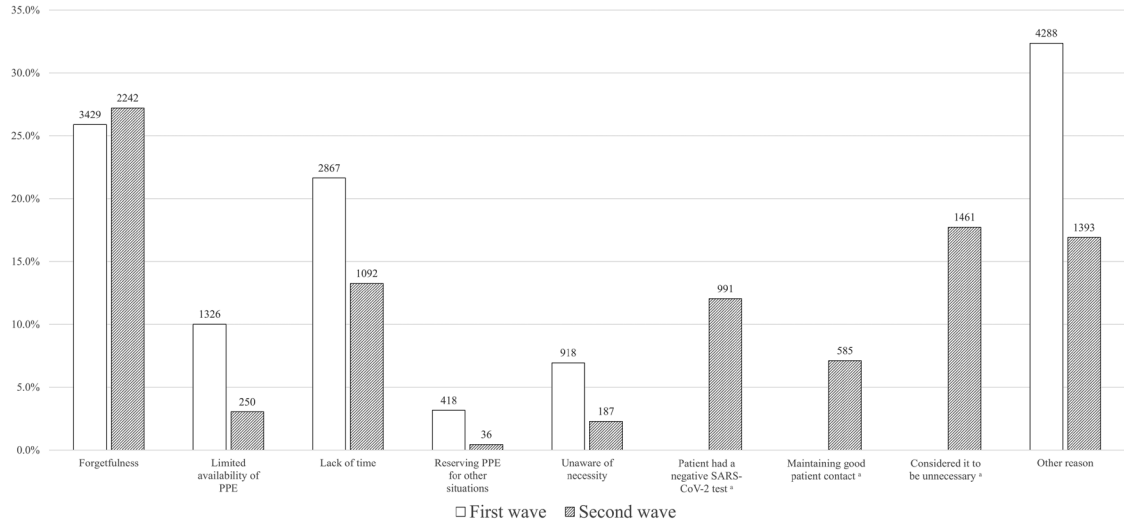

Figure 5. Reasons for non-compliance with personal protective equipment (PPE) guidelines during the first and the second wave of the COVID-19 pandemic. Presented as percent of registered number of times where PPE guidelines were not complied with (y-axis) as well as the total number of events (top of columns). [a]This response was only an available option during the second wave.

0.6 (0.1;2.3). Across all PPE the difference between the two types of departments decreases from the first to the second wave.

During both waves and across all PPE, female HCW tended to report non-compliance with PPE guidelines less often compared to male HCW. The greatest difference was seen for FFP2 or FFP3 respirators, where the AOR for reporting non-compliance with PPE guidelines was 0.6 (0.4;0.8) for females compared to males during the first wave. The corresponding number for the second wave was 0.4 (0.3;0.6), as seen in Table 4. During both waves and across all PPE, there was a tendency that the surgical and medical departments less often reported non-compliance with PPE guidelines compared to emergency departments. The greatest difference was seen for medical safety goggles, where the AOR for reporting non-compliance with PPE guidelines was 0.3 (0.2;0.3) for medical departments compared to emergency departments during the first wave, and the corresponding number for the second wave was 0.9 (0.3;2.2). Across all PPE the difference between the departments decreased from the first to the second wave.

Discussion

Main results

Overall, the proportion of PPE use increased and the proportion of PPE failures decreased from the first wave to the second wave. PPE failure and non-compliance varied by age, sex, and type of department. Reasons for non-compliance with PPE guidelines were predominately *forgetfulness*, *lack of time,* and *maintaining good patient contact*. During the first wave, participants also reported *limited availability of PPE* as an issue.

Interpretations

There were substantial differences in the use of PPE from the first to the second wave. This may be explained by factors such as changes in guidelines over time, more stable PPE deliveries, and awareness of and training in proper use of PPE, both at hospital and at community level. HCW were required to use a type II face mask during all patient contact during the second wave, as part of general precautions. This was not the case during the first wave. During the course of the first wave, infection control units experienced increasing awareness of the use of PPE as part of general precautions (e.g. mask and eye protection when at risk of splashes or sprays) among HCW.

During the second wave, we found a decrease in the use of gloves in almost all tasks compared to the first wave. A reason for this could be that participants were more efficiently trained in good hand hygiene and thus did not consider it necessary to wear gloves. Also, the guidelines for procedures for e.g. transportation of patients changed during the COVID-19 pandemic, where HCW were urged not to be in direct contact with patients or their belongings. Therefore, a HCW could

Table 3 Healthcare workers' characteristics associated with failures of personal protective equipment (PPE) expressed as odds ratios (OR) and adjusted odds ratios (AOR) (95% confidence intervals) for each type of PPE.

	FFP2 or FFP3 respirator		Face mask[a]		Visor		Gloves		Medical safety goggles		Medical gown or plastic apron	
	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]
First wave												
Sex												
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Female	1.4	0.9 (0.2;4.0)	0.7	0.6 (0.3;1.2)	1.6	2.0 (0.7;5.5)	1.0	0.7 (0.5;1.0)	1.1	1.5 (0.7;3.4)	0.8	0.7 (0.3;1.3)
Age												
<30	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30–39	0.5	0.6 (0.2;1.8)	1.2	1.2 (0.6;2.5)	1.0	1.2 (0.5;3.2)	0.9	1.0 (0.7;1.2)	1.3	1.5 (0.7;3.2)	0.7	0.8 (0.5;1.4)
40–49	0.4	0.4 (0.1;1.2)	1.1	1.1 (0.6;2.0)	0.6	0.7 (0.3;1.7)	0.5	0.6 (0.4;0.7)	0.5	0.5 (0.2;1.4)	0.4	0.5 (0.3;0.8)
50–59	0.6	0.5 (0.1;1.9)	0.9	0.8 (0.4;1.6)	0.3	0.4 (0.1;1.1)	0.5	0.5 (0.4;0.7)	0.5	0.5 (0.2;1.2)	0.2	0.3 (0.1;0.5)
≥60	0.2	0.2 (0.0;0.8)	0.6	0.6 (0.2;1.4)	0.4	0.5 (0.1;1.9)	0.3	0.3 (0.2;0.5)	0.1	0.1 (0.0;0.4)	0.2	0.3 (0.1;0.9)
Profession												
Biomedical Lab Scientists	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Medical doctors	0.3	0.4 (0.1;1.2)	0.9	0.8 (0.4;1.4)	1.1	1.4 (0.7;2.9)	1.7	1.7 (0.7;4.2)	1.4	1.8 (0.9;3.5)	0.9	0.7 (0.4;1.2)
Nursing staff	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	2.7	3.1 (1.2;8.2)	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Department												
Emergency	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Anesthesiology	0.8	0.9 (0.3;2.6)	0.9	1.0 (0.5;2.0)	0.2	0.2 (0.1;0.5)	0.8	0.9 (0.7;1.3)	0.2	0.3 (0.1;0.7)	0.3	0.3 (0.2;0.7)
Surgical[c]	0.1	0.1 (0.0;0.5)	0.4	0.4 (0.2;0.9)	0.3	0.3 (0.1;0.6)	0.8	1.0 (0.7;1.3)	0.2	0.2 (0.1;0.4)	0.3	0.3 (0.1;0.7)
Medical[d]	0.2	0.3 (0.1;0.8)	0.3	0.4 (0.2;0.7)	0.4	0.4 (0.2;0.9)	0.8	0.9 (0.6;1.2)	0.3	0.3 (0.1;0.6)	0.4	0.4 (0.2;0.8)
Second wave												
Sex												
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Female	0.5	0.5 (0.2;1.1)	1.7	1.7 (0.3;9.8)	1.6	1.0 (0.4;2.6)	1.2	0.7 (0.4;1.2)	0.6	0.4 (0.1;1.3)	1.3	1.2 (0.4;3.4)
Age												
<30	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30–39	0.4	0.4 (0.1;1.6)	1.0	1.1 (0.3;4.2)	0.6	0.7 (0.3;1.5)	0.4	0.4 (0.3;0.7)	1.5	2.0 (0.5;8.7)	2.1	2.4 (0.6;8.8)
40–49	0.3	0.3 (0.1;1.3)	1.4	1.5 (0.5;4.4)	0.5	0.5 (0.2;1.0)	0.5	0.6 (0.4;0.9)	1.8	2.3 (0.6;9.4)	2.7	2.8 (0.8;10.5)
50–59	0.3	0.3 (0.1;1.1)	1.1	1.1 (0.3;3.8)	0.4	0.4 (0.2;0.8)	0.3	0.3 (0.2;0.5)	0.7	0.8 (0.2;3.7)	1.0	1.0 (0.3;3.2)

Table 3 Continued

	FFP2 or FFP3 respirator		Face mask[a]		Visor		Gloves		Medical safety goggles		Medical gown or plastic apron	
	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]
60≤	0.1	0.1 (0.0;0.4)	0.7	0.8 (0.2;3.3)	0.3	0.3 (0.1;1.2)	0.2	0.2 (0.1;0.5)	Insufficient data	Insufficient data	0.9	0.9 (0.1;5.5)
Profession												
Biomedical Lab Scientists	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Medical doctors	1.0	0.8 (0.3;1.8)	0.8	1.0 (0.3;3.4)	0.4	0.4 (0.2;1.0)	0.4	0.3 (0.2;0.6)	0.6	0.4 (0.1;1.8)	0.6	0.7 (0.3;1.5)
Nursing staff	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Department												
Emergency	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Anesthesiology	1.2	1.7 (0.5;5.5)	0.4	0.4 (0.2;0.9)	0.6	0.6 (0.2;1.6)	0.7	0.8 (0.4;1.5)	5.1	5.4 (1.7;17.5)	0.6	0.7 (0.3;1.7)
Surgical[c]	0.4	0.6 (0.1;2.3)	0.3	0.3 (0.1;0.9)	0.3	0.3 (0.1;0.9)	0.7	0.8 (0.4;1.7)	0.6	0.6 (0.1;3.0)	0.3	0.3 (0.1;0.7)
Medical[d]	0.7	1.0 (0.3;3.4)	0.4	0.4 (0.2;0.8)	0.5	0.6 (0.3;1.2)	0.4	0.5 (0.3;1.0)	0.7	0.7 (0.2;3.0)	0.4	0.4 (0.2;0.9)

[a]Face mask include the following: type IIR mask, mask with visor (typically type IIR) and other unspecified face masks.
[b]Adjusted for sex, age, profession, and department.
[c]All surgical departments, including: obstetrics and gynecology; otorhinolaryngology and head and neck surgery; and ophthalmology.
[d]Internal medicine, pediatrics, oncology, and neurology.

Table 4 Healthcare workers' characteristics associated with non-compliance with personal protective equipment (PPE) guidelines expressed as odds ratios (OR) and adjusted odds ratios (AOR) (95% confidence intervals) for each type of PPE.

	FFP2 or FFP3 respirator		Face mask[a]		Visor		Gloves		Medical safety goggles		Medical gown or plastic apron	
	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]
First wave												
Sex												
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Female	0.5	0.6 (0.4;0.8)	0.8	0.9 (0.7;1.2)	0.9)	1.0 (0.7;1.5)	0.7	0.7 (0.5;1.0)	0.8	0.9 (0.6;1.3)	0.9	0.9 (0.6;1.1)
Age												
<30	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30–39	0.8	0.8 (0.5;1.2)	0.8	0.8 (0.6;1.0)	0.8	0.8 (0.6;1.2)	0.8	0.8 (0.5;1.1)	0.7	0.8 (0.6;1.0)	0.7	0.8 (0.6;1.0)
40–49	0.7	0.7 (0.4;1.1)	0.8	0.7 (0.6;0.9)	0.5	0.5 (0.4;0.8)	0.5	0.5 (0.4;0.7)	0.6	0.5 (0.4;0.7)	0.5	0.5 (0.4;0.6)
50–59	0.7	0.6 (0.4;1.1)	0.7	0.6 (0.5;0.8)	0.5	0.5 (0.4;0.7)	0.4	0.5 (0.3;0.6)	0.4	0.3 (0.2;0.4)	0.4	0.4 (0.3;0.6)
≥60	0.4	0.4 (0.2;0.6)	0.6	0.5 (0.3;0.7)	0.3	0.4 (0.2;0.6)	0.5	0.5 (0.3;0.7)	0.1	0.1 (0.1;0.2)	0.3	0.3 (0.2;0.5)
Profession												
Biomedical Lab Scientists	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Medical doctors	2.8	1.7 (0.7;4.5)	6.0	4.3 (1.3;14.3)	8.1	7.9 (2.7;22.8)	2.7	2.2 (0.7;7.2)	1.1	1.3 (1.0;1.6)	1.5	1.4 (0.2;8.7)
Nursing staff	2.4	1.6 (0.7;3.7)	5.3	3.5 (1.1;11.2)	7.3	7.1 (2.5;20.4)	2.1	2.0 (0.6;6.4)	Insufficient data	Insufficient data	1.7	1.6 (0.2:10.3)
Department												
Emergency	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Anesthesiology	0.8	0.9 (0.6;1.3)	1.1	1.2 (1.0;1.4)	0.4	0.5 (0.3;0.8)	0.6	0.6 (0.5;0.9)	0.8	1.0 (0.7;1.4)	0.3	0.4 (0.3;0.5)
Surgical[c]	0.3	0.3 (0.2;0.5)	0.7	0.7 (0.6;0.9)	0.4	0.4 (0.3;0.7)	0.6	0.6 (0.4;0.8)	0.3	0.3 (0.2;0.5)	0.3	0.3 (0.2;0.4)
Medical[d]	0.3	0.3 (0.2;0.5)	0.4	0.4 (0.3;0.5)	0.5	0.5 (0.3;0.8)	0.6	0.6 (0.4;0.8)	0.2	0.3 (0.2;0.3)	0.4	0.4 (0.3;0.5)
Second wave												
Sex												
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Female	0.3	0.4 (0.3;0.6)	0.7	0.8 (0.4;1.5)	0.7	0.8 (0.4;1.5)	0.4	0.4 (0.2;0.9)	0.6	0.9 (0.3;2.3)	0.6	0.5 (0.3;1.2)
Age												
<30	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
30–39	0.4	0.5 (0.2;1.3)	1.1	1.2 (0.5;2.8)	0.9	1.0 (0.5;2.1)	0.9	1.0 (0.5;1.9)	1.0	0.9 (0.3;3.1)	0.6	0.7 (0.3;1.6)

Table 4 Continued

	FFP2 or FFP3 respirator		Face mask[a]		Visor		Gloves		Medical safety goggles		Medical gown or plastic apron	
	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]	OR	AOR[b]
40–49	0.5	0.6 (0.2;1.6)	1.2	1.2 (0.6;2.4)	0.6	0.6 (0.3;1.3)	0.7	0.8 (0.4;1.7)	1.2	1.0 (0.3;3.3)	0.4	0.5 (0.2;0.9)
50–59	0.3	0.4 (0.2;1.0)	1.1	1.2 (0.6;2.3)	0.4	0.4 (0.2;0.9)	0.8	0.9 (0.4;1.9)	1.0	0.8 (0.2;3.0)	0.4	0.4 (0.2;0.8)
≥60	0.4	0.5 (0.2;1.5)	1.9	2.1 (0.8;5.5)	0.4	0.4 (0.2;1.2)	1.6	1.7 (0.6;4.5)	0.6	0.4 (0.1;2.1)	0.3	0.3 (0.2;0.8)
Profession												
Biomedical Lab Scientists	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Medical doctors	2.2	1.4 (1.0;2.1)	7.5	5.9 (1.5;23.5)	3.3	2.5 (0.4;14.3)	14.7	8.5 (3.0;24.0)	1.1	0.5 (0.1;3.6)	0.6	0.4 (0.1;1.3)
Nursing staff	Insufficient data	Insufficient data	6.9	6.3 (1.8;21.5)	3.2	2.8 (0.5;16.9)	9.0	7.9 (2.6;24.2)	0.7	0.3 (0.1;2.0)	0.7	0.6 (0.2;1.6)
Department												
Emergency	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Anesthesiology	0.4	0.5 (0.2;1.1)	0.5	0.4 (0.2;1.1)	0.6	0.7 (0.4;1.2)	0.5	0.5 (0.2;1.2)	4.7	5.4 (1.915.0)	0.5	0.5 (0.3;1.1)
Surgical[c]	0.2	0.3 (0.1;0.7)	0.8	0.8 (0.3;2.4)	0.4	0.4 (0.3;0.8)	0.6	0.6 (0.2;1.5)	2.8	2.8 (1.1;7.5)	0.4	0.4 (0.2;0.7)
Medical[d]	0.3	0.4 (0.2;0.9)	0.4	0.5 (0.2;1.1)	0.4	0.4 (0.3;0.7)	0.4	0.4 (0.2;0.7)	0.9	0.9 (0.3;2.2)	0.3	0.3 (0.2;0.6)

[a]Face mask include the following: type IIR mask, mask with visor (typically type IIR) and other unspecified face masks.
[b]Adjusted for sex, age, profession, and department.
[c]All surgical departments, including: obstetrics and gynecology; otorhinolaryngology and head and neck surgery; and ophthalmology.
[d]Internal medicine, pediatrics, oncology, and neurology.

perform the same work task, e.g. transportation of patients, during the two waves, but the change in guidelines could reduce the need for wearing gloves. We speculate that gloves might have been used more uncritically during the first wave, including in situations where there was no indication for using gloves, in order to be on the safe side. Also, gloves were the PPE where most participants reported failures. In a review Mischke and colleges found 18.5 gloves perforations per 100 person-operations, but they only investigated perforations and not failures (Mischke *et al.*, 2014). Also, almost 70% of glove perforations are not identified by practitioners (Jahangiri *et al.*, 2022), and therefore, our findings of glove failures may be underestimated.

The decrease in PPE failure could be explained partly by the above-mentioned increase in training in PPE use, but also by the PPE being of varying quality (e.g. some batches of PPE had a falsified certificate) throughout the two waves (Proffitt, 2020; World Health Organization, 2020c).

During the first wave, 18.1% of the participants reported not using PPE during respiratory procedures but only 6.6% performing this task reported not complying with PPE guidelines. At first glance, this seems contradictory and could question the validity of participants' own assessment of compliance with guidelines. However, compliance with PPE guidelines presupposes that HCW know what proper use is and are trained to comply with PPE donning and doffing guidelines. Moreover, our findings are based on self-reported compliance, which is not necessarily the same as actual compliance with guidelines. In addition, the definition of respiratory procedures was partly left to the participant besides the mentioned examples (CPAP, PEP, intubation, or resuscitation), for which e.g. FFP2/FFP3 respirators or face masks were required when caring for patients with suspected or confirmed COVID-19. Importantly, FFP2/FFP3 respirators were only recommended when caring for patients with suspected or confirmed COVID-19. Therefore, we do not know if participants performed (other) respiratory procedures that did not require PPE according to the guidelines.

In this study showed availability of PPE was reported as an issue during the first wave, which is in accordance with the literature from other countries (Kim *et al.*, 2021; Mantelakis *et al.*, 2021; Rebmann *et al.*, 2021). This might only have been the case at the beginning of the first wave, but due to the resolution in the analysis, we cannot elaborate on this. More participants from the first wave reported that they were unaware of the necessity of PPE compared to the second wave. At the beginning of the first wave of the COVID-19 pandemic in Denmark, some hospitals experienced a rapid increase of COVID-19 patients causing lack of time to sufficiently train HCW in PPE guidelines. During the second wave, the training of HCW in PPE guidelines was more sufficient and systematic. Our results could be explained by participants being more experienced and trained in PPE use during the second wave, compared to the first. This is in accordance with the literature (Verbeek *et al.*, 2020; Piche-Renaud *et al.*, 2021).

PPE failure and non-compliance varied by age and sex and type of department, but with a decrease in the difference between the first and the second wave. Being a female and of older age decreased the risk for both failure and non-compliance, and we speculate whether this can be explained by sex based difference in behavior. The difference between emergency departments and the other departments in both failures of PPE and non-compliance with PPE guidelines across all types of PPE also decreased from the first wave to the second wave. Jespersen and colleagues (Jespersen *et al.*, 2021) found that the emergency departments in Denmark during the first wave of COVID-19 had the highest seroprevalence (29.7%) of SARS-CoV-2. Also, many of the Danish emergency departments acted as a gateway for COVID-19 patients into the rest of the hospital. We, therefore, speculate that emergency departments have experienced more awareness of and training in proper use of PPE from the first to the second wave.

Strengths and limitations

Major strengths of this study are the large study population, the prospective study design with day-by-day information, which minimizes the risk of recall issues, and the register-based information on sex, age, department, and profession.

Questionnaire data from the Central Denmark Region and the Capital Region of Denmark were combined even though data were not collected during the exact same periods. However, the periods overlap substantially and cover both the first and the second wave of the COVID-19 pandemic in Denmark. Furthermore, the source population and the study population from the two Regions were similar but not identical. Despite the differences, the answer patterns in the two Regions were almost identical.

It is possible that HCW less likely to use PPE would not participate in the study, but this would be expected to be the case for both waves of questionnaires, and thus, would not explain the differences in PPE usage found between the first and the second wave.

The complexity of the questionnaire was high. Participants were able to give multiple answers to work tasks and PPE use. If a participant had two or more tasks and used two or more PPE it was not possible to differentiate between specific PPE used for a specific work task, but if we should have accommodated this in more detail, the questionnaire would have increased significantly in length, possibly leading to less participation.

Generalisability

Due to differences in age and sex distribution among participants and non-participants, our study population is not entirely representative of the source population (HCW at hospitals in Denmark), but still, we anticipate the external validity to be reasonably good.

This study indicates that the focus on prevention of SARS-CoV-2 transmission should be on PPE guideline compliance, but that good quality of PPE to avoid PPE failure is also of importance.

Conclusion

In this study, we observed a substantial increase in use of PPE and a substantial decrease in PPE failure among healthcare workers from the first to the second wave of the COVID-19 pandemic in Denmark. PPE failure and non-compliance varied by age, sex, and type of department. There is still a need for continued focus on compliance with PPE guidelines.

SUPPLEMENTARY DATA

Supplementary data are available at *Annals of Work Exposures and Health* online.

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Conflict of interest

All authors declare no conflicts of interest.

Data availability

The data underlying this paper cannot be shared publicly due to the privacy of the individuals who participated in the study, but data can be shared in an anonymized form on reasonable request to the corresponding author.

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Short Communication

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Short Communication

SARS-CoV-2 Infection Rates Following Use of Regular Compared With Defective Respirators When Caring for COVID-19 Patients: A Retrospective Follow-up Study

Henrik A. Kolstad[1,2,*], Morten Frydenberg[1], Kent Jacob Nielsen[3], Vivi Schlünssen[4], Karin Biering[3], Mona Kjærsgaard[5], Jesper Medom Vestergaard[1], Else Toft Würtz[1], Kirsten Pugdahl[1], Anne Mette Lund Würtz[4], Karoline Kærgaard Hansen[1], Sanne Jespersen[6], Marianne Kragh Thomsen[5], Mette Marie Sørensen[6], Svend Ellermann-Eriksen[5], Jacob Dvinge Redder[7] and Merete Storgaard[6]

[1]Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, DK-8200 Aarhus N, Denmark; [2]Institute of Clinical Medicine, Aarhus University, DK-8200 Aarhus N, Denmark; [3]Department of Occupational Medicine, Danish Ramazzini Centre, Goedstrup Hospital, DK-7400 Herning, Denmark; [4]Department of Public Health, Work, Environment and Health, Danish Ramazzini Centre, Aarhus University, DK-8000 Aarhus C, Denmark; [5]Department of Clinical Microbiology, Aarhus University Hospital, DK-8200 Aarhus N, Denmark; [6]Department of Infectious Diseases, Aarhus University Hospital, DK-8200 Aarhus N, Denmark; [7]Business Intelligence, Central Denmark Region, DK-8200 Aarhus N, Denmark

*Author to whom correspondence should be addressed. Tel: +45 29610359; e-mail: kolstad@clin.au.dk

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Abstract

Background: There is strong observational evidence that respirators are highly effective in protecting the users from being infected with Middle East respiratory syndrome and severe acute respiratory syndrome coronavirus (SARS-CoV), but the evidence for SARS-CoV-2 during daily work is limited. This study utilized a subset of healthcare workers' temporary use of a new brand respirator with frequent defects when caring for coronavirus disease 2019 (COVID-19) patients to assess the protective effect of regular respirators against SARS-CoV-2 infection.

Methods: We retrospectively followed 463 participants wearing a regular respirator and 168 wearing the new brand respirator day-by-day when caring for COVID-19 patients until testing polymerase chain reaction positive for SARS-CoV-2 between 27th December 2020 and 14th January 2021.

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What's important about this paper?

The empirical evidence for a protective effect of respirators against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection during daily work is limited. In this study, a subset of healthcare workers caring for coronavirus disease 2019 (COVID-19) patients temporary used a new brand respirator with frequent defects until the problem was detected. Regarding this failure as a sham intervention, this study retrospectively assessed the protective effect of regular respirators. A 60% reduced risk of SARS-CoV-2 infection was observed among the users of the regular respirators when compared to those who used the new brand.

Results: We observed seven and eight incident SARS-CoV-2-infected cases. This corresponded with daily infection rates of 0.2 and 0.5%, an incidence rate ratio of 0.4 [95% confidence interval (CI) 0.1; 1.0], and an incidence rate difference of 0.3% (95% CI −0.1; 0.8) when comparing a regular with the new brand respirator.

Discussion: We regard the new brand respirator a sham intervention, and this study thus provides further evidence for the protective effect of respirators when exposed to SARS-CoV-2 virus.

Keywords: follow-up study; healthcare worker; incidence rate ratio; respirator; SARS-CoV-2; sham

Introduction

There is strong observational evidence that respirators are highly effective in protecting the users from being infected with Middle East respiratory syndrome and severe acute respiratory syndrome coronavirus (SARS-CoV) (Chu *et al.*, 2020). Similar effects are suggested for SARS-CoV-2 during daily work (Khalil *et al.*, 2020; Wang *et al.*, 2020; Ingram *et al.*, 2021; Lentz *et al.*, 2021). However, the available studies are limited by cross-sectional designs, self-reported coronavirus disease 2019 (COVID-19) outcome information, self-selection into study participation, or lack of ability to separate the effect of respirators from other preventive measures.

We utilized the temporary use of a new brand filtering face piece-3 (FFP3) respirator with frequent defects in the form of seam breaks among a subset of healthcare workers to assess the protective effect of regular respirators. We regarded the new brand respirator a sham intervention and compared the SARS-CoV-2 infection rates following use of the two types of respirators when caring for COVID-19 patients.

Methods

This study was conducted among healthcare workers of the Central Denmark Region in Denmark during the second wave of the pandemic that peaked 16th December 2020. They had since the emergence of the pandemic been instructed to wear a FFP2 or FFP3 respirator during aerosol-generating or other high-risk procedures on patients with confirmed or suspected COVID-19. In case of confirmed COVID-19, FFP2 or FFP3 respirators with exhalation valves were allowed. Also use of a fluid-repellent disposable gown with long sleeves, disposable medical gloves, and protective glasses or visor was required. The healthcare workers were instructed how to do a positive pressure seal check of the respirators, but no formal fit test was done for neither the regular nor the new brand respirators. Donning and removal of personal protective equipment were trained. Detailed infection control instruction for COVID-19 for employees of the Central Denmark Region during the COVID-19 pandemic can be found in the Supplementary Material (available at *Annals of Occupational Hygiene* online). During the week starting 28th December 2020, the SARS-CoV-2 1-week infection rate for all hospital employees in Denmark was 500.0 per 100 000 (Statens Serum Institut, 2021).

A new brand FFP3 respirator with an exhalation valve (Meixin MX50-14V) that was tested for filtration and approved for and only used during care for COVID-19 patients was introduced on 24th December 2020. On 5th January 2021, it became apparent that users had frequently observed seam breaks upon removal of the respirators, and on 8th January 2021, the new brand respirators were withdrawn.

We identified healthcare workers of the Central Denmark Region participating in an ongoing study of risk factors for SARS-CoV-2 infection (Nielsen *et al.*, 2021; Würtz *et al.*, 2021) or caring for COVID-19 patients between 24th December 2020 and 7th January 2021 according to the clinical logistic systems of the study hospitals. They were e-mailed a questionnaire between 26th and 27th January 2021, in which they were asked for each day between 24th December 2020 and

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7th January 2021 whether they had cared for COVID-19 patients. If this was the case, they were asked if they had used the new brand FFP3 respirator or a regular FFP2 or FFP3 respirator during this contact. The new brand respirator was easily differentiated from regular respirators and a picture was included in the questionnaire. They were also asked if they had observed seam breaks for both types of respirators.

All polymerase chain reaction (PCR) test results for SARS-CoV-2 conducted in the Central Denmark Region since 11th March 2020 were obtained by linkage with a regional register with complete test coverage, and incident SARS-CoV-2 infection was defined by the first positive test. Participants were informed about the test result on average 24–36 h after being tested. Vaccination against COVID-19 started on 27th December 2020 and no participants were fully vaccinated during follow-up.

All participants gave written informed consent. The study was registered at the repository of the Central Denmark Region (1-16-02-150-20) and approved by the Danish Patient Safety Authority (Jnr 1-45-70-25-20). The Central Denmark Regional Scientific Ethical Committee approved that ethical approval was not required (Jnr 1-10-72-1-20).

Statistical analyses

We analysed the association between incident SARS-CoV-2 infection and previous use of a regular versus the new brand respirator when caring for COVID-19 patients. Person-day at risk was the unit of analysis and data were analysed by binomial regression yielding incidence rate ratios (IRRs) and incidence rate differences with 95% confidence intervals (CIs). We matched on date when estimating IRR to adjust for calendar time effects.

Each participant was followed day-by-day from 27th December 2020 (3 days after the new brand respirator was introduced) until and including the day of the first positive PCR test or 14th January 2021 (7 days after the new brand respirator was withdrawn). Participants with a positive PCR test before 27th December 2020 were excluded. Participants who had used a regular respirator within the previous 3–7 days when caring for COVID-19 patients were classified as regular respirator user. New brand respirator users were classified similarly. If both respirators had been used, the new respirator overruled a regular respirator. Day-by-day, participants may have used alternate respirators when caring for COVID-19 patients. This was accounted for because person-day at risk was the unit of analysis. Focus on a 5-day exposure window 3–7 days earlier was decided to account for the incubation period (Lauer *et al.*, 2020). Supplementary Figure S1 (available at *Annals of Occupational Hygiene* online) depicts how time at risk during the course of the study varied according to number of days (1–5) with exposure information within the 5-day exposure window. All analyses were conducted with Stata, version 17.

Results

A total of 7601 healthcare workers not tested positive for SARS-CoV-2 before 27th December 2020 were invited and 4442 (58%) responded and filled in the questionnaire. A total of 463 participants had used a regular respirator (4059 person-days at risk) during the previous 3–7 days between 24th December 2020 and 7th January 2021 and 168 the new brand respirator (1324 person-days at risk) when caring for COVID-19 patients (Supplementary Table S1, available at *Annals of Occupational Hygiene* online). They were on average followed-up for 10 days.

Altogether, 68 positive and 4871 negative PCR tests were conducted in the invited population between 27th December 2020 and 14th January 2021. Among participants using the new brand or a regular respirator during contact with COVID-19 patients, there were 7 positive and 133 negative, and 8 positive and 199 negative PCR tests, respectively. Daily testing rates were 3.4% for the invited population, 5.1% following use of a regular respirator, and 10.6% following use of the new brand respirator.

Participant characteristics (person-days at risk) according to use of a regular and the new brand respirator when caring for COVID-19 patients are presented in Table 1. Biomedical laboratory scientists, participants working at medical and surgical departments and at departments of biochemistry, and women used the new brand respirator more often than a regular respirator, while the opposite was seen for medical doctors, emergency department employees, and men. Participants reported seam breaks for 0.4% of a regular respirators and 8.3% of the new brand respirator.

Table 2 shows daily SARS-CoV-2 infection rates of 0.2 and 0.5% following use of a regular and the new brand respirator, respectively, when caring for COVID-19 patients. This corresponded with an IRR of 0.4 (95% CI 0.1; 1.0) and an incidence rate difference of 0.3% (95% CI 0.1; 0.8) when comparing a regular with the new respirator.

Discussion

This study shows an 0.2% daily infection rate, an 0.3% reduced incidence rate difference, and a 60% reduced

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Table 1. Participant characteristics (person-days at risk) according to use of regular respirators and a new brand respirator with frequent defects when caring for COVID-19 patients.[a]

Characteristics	Regular respirator (4059 person-days at risk)[b]		New brand respirator (1324 person-days at risk)[c]	
Department				
Emergency	868	21.4%	67	5.1%
Medicine	1300	32.0%	605	45.7%
Surgery	281	6.9%	176	13.3%
Biochemistry	135	3.3%	75	5.7%
Service	12	0.3%	5	0.4%
Anaesthesiology	807	19.9%	198	15.0%
Radiology and Nuclear Medicine	132	3.3%	6	0.5%
Psychiatry	43	1.1%	0	0.0%
Departments with less frequent patient contact	173	4.3%	71	5.4%
Other	209	5.1%	81	6.1%
Occupation				
Nursing staff	2591	63.8%	901	68.1%
Medical doctors	942	23.2%	193	14.6%
Biomedical laboratory scientists	121	3.0%	85	6.4%
Medical secretaries	0	0.0%	0	0.0%
Other	306	7.5%	105	7.9%
Sex				
Woman	3168	78.0%	1195	90.3%
Man	792	19.5%	89	6.7%
Age, mean years, SD	40.9	11.8	44.6	11.2

[a]Numbers and percentages unless otherwise stated.
[b]Information on characteristics was missing for 99 person-days at risk (2.4%).
[c]Information on characteristics was missing for 40 person-days at risk (3.0%)

Table 2. Association between incident SARS-CoV-2 infection and previous use of a regular compared with a new brand respirator with frequent defects when caring for COVID-19 patients.

Respirator type	Person-days at risk	Positive PCR tests	Daily infection rate (%)	IRR (95% CI)	Incidence rate difference (95% CI)
Regular respirator	4059	8	0.2	0.4 (0.1; 1.0)	0.3 (–0.1; 0.8)
New brand respirator	1324	7	0.5	Reference	Reference

IRR for SARS-CoV-2 infection when using a regular FFP2 or FFP3 respirator compared with the new brand respirator when caring for COVID-19 patients 3–7 days earlier.

The protective effect of a regular FFP2 or FFP3 respirator of this study is lower than that reported for N95 respirators during the early stages of the pandemic (Wang *et al.*, 2020). A likely explanation is that in that earlier study, the reference group was healthcare workers using no personal protection equipment (PPE) while only a proportion of the new brand respirators used by the reference group of the current study was defective. The protective effect is, on the other hand, comparable with that seen for respirators during later stages of the pandemic when widespread PPE use was well established (Khalil *et al.*, 2020; Lentz *et al.*, 2021). The infection rate among users of a regular respirator in this study is comparable with the self-reported positive PCR testing rate among frontline healthcare workers who reported that they always had the PPE they needed, with no further specification (Nguyen *et al.*, 2020).

A major strength of this study is the comparison group of users of a defective respirator that may be regarded a sham intervention. This allowed assessing the separate effect of the regular respirators independently of other preventive measures that should be evenly

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distributed between users of regular and defective respirators. However, only a proportion of the new brand respirators was defective, and it is unclear if its use was completely at random with respect to the background SARS-CoV-2 infection risk, and therefore the study does not fulfil the criteria for a natural experiment (Ogilvie *et al.*, 2020). Other strengths are exposure and PCR testing information that was obtained day-by-day in a follow-up design that accounted for the incubation period for SARS-CoV-2, and a high PCR testing rate. Matching on day accounted for change in the underlying infection rate during study follow-up.

Limitations include modest participation, self-reported information on care for COVID-19 patients, and respirator use obtained at a point in time when participants already had the result of their PCR tests and were informed about the problems with the new brand respirator which may have biased findings by differential recall. We therefore abstained from including information on respirator seam breaks in the analyses. Participants had to recall care for COVID-19 patients and respirator use for every day 3 weeks back and information may have been non-differentially misclassified. However, during the study period, the healthcare workers were at high alert because of high numbers of COVID-19 patients, the new brand respirator was easily distinguished from a regular respirator, and we judge that our findings reflect a true effect but the strength of the association should be interpreted with caution.

The testing rate was higher among users of the new brand respirator as recommended by the hospitals. However, number of earlier (negative) PCR tests should not be causally associated with SARS-CoV-2 infection as detected by a positive PCR test on a given day at risk and should thus not bias the current findings.

The healthcare workers of the Central Denmark Region were instructed how to do a respirator seal check but no fit tests were conducted, e.g. as required by the Occupational Safety and Health Administration (OSHA) of the United States, and this may have affected the general infection control, but should not have biased the current comparisons within this population.

Participants working at departments of medicine and surgery more often used the new brand than a regular respirator and are expected to have higher risk of SARS-CoV-2 infection due to longer and closer contact with COVID-19 patients and this may have exaggerated our findings. Physicians with expected shorter and more distant COVID-19 patient contact used the new brand respirator less often and this may have had a similar confounding effect. On the other hand, nurses with the expected highest risk of infection constituted two thirds of the study population and used the new brand respirator as often as a regular respirator. Awareness of infection control measures and respirator fit may vary across participants but we have no reason to believe that this was associated with use of the new brand respirator. Only 15 cases of SARS-CoV-2 infection were included, which did not allow for adjustment for potential confounders beyond day of follow-up, and estimates were obtained with considerable uncertainty as illustrated by the wide CIs.

To conclude, this study, despite limitations, provides further evidence for the protective effect of respirators when caring for COVID-19 patients.

Supplementary data

Supplementary data are available at *Annals of Work Exposures and Health* online.

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Conflict of interest

The authors declare no conflict of interest relating to the material presented in this Article. Its contents, including any opinions and/or conclusions expressed, are solely those of the authors.

Data availability

The data underlying this paper cannot be shared publicly due to the privacy of the individuals who participated in the study, but data can be shared in an anonymized form on reasonable request to the corresponding author.

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Healthcare workers' SARS-CoV-2 infection rates during the second wave of the pandemic: follow-up study

by Würtz AM, Kinnerup MB, Pugdahl K, Schlünssen V, Vestergaard JM, Nielsen K, Cramer C, Bonde JP, Biering K, Carstensen O, Hansen KK, Dalbøge A, Flachs EM, Hansen ML, Thulstrup AM, Würtz ET, Kjærsgaard M, Christensen MW, Kolstad HA

During the second wave of the COVID-19 pandemic, despite a strong focus on preventive measures, healthcare workers were still at increased risk of SARS-CoV-2 infection following close contact with patients and co-workers as well as persons outside work with COVID-19. Intensified preventive actions to secure healthcare workers' health during ongoing and future waves of SARS-CoV-2 and other infections are thus needed.

Affiliation: Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, Palle Juul-Jensens Boulevard 99, 8200 Aarhus N, Denmark. henkol@rm.dk

Key terms: coronavirus; COVID-19; epidemiology; healthcare worker; infectious disease; longitudinal study; loss of taste and smell; occupational safety; pandemic; PCR; polymerase chain reaction; risk factor; SARS-CoV-2

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Healthcare workers' SARS-CoV-2 infection rates during the second wave of the pandemic: follow-up study

by Anne Mette Würtz, PhD,[1] Martin B Kinnerup, PhD,[2,3] Kirsten Pugdahl, PhD,[2] Vivi Schlünssen, MD,[1] Jesper Medom Vestergaard, Master of IT,[2] Kent Nielsen, PhD,[3] Christine Cramer, MD,[1,2] Jens Peter Bonde, MD,[4] Karin Biering, PhD,[3] Ole Carstensen, MD,[3] Karoline Kærgaard Hansen, PhD,[2] Annett Dalbøge, PhD,[2] Esben Meulengracht Flachs, PhD,[4] Mette Lausten Hansen, MD,[2] Ane Marie Thulstrup, MD,[2] Else Toft Würtz, PhD,[2] Mona Kjærsgaard, MD,[5] Mette Wulf Christensen, PhD,[2,6] Henrik Albert Kolstad, MD [2,6]

Würtz AM, Kinnerup MB, Pugdahl K, Schlünssen V, Vestergaard JM, Nielsen K, Cramer C, Bonde JP, Biering K, Carstensen O, Hansen KK, Dalbøge A, Flachs EM, Hansen ML, Thulstrup M, Würtz ET, Kjærsgaard M, Christensen MW, Kolstad HA. Healthcare workers' SARS-CoV-2 infection rates during the second wave of the pandemic: follow-up study. *Scand J Work Environ Health* – online first. doi:10.5271/sjweh.4049

Objectives This study aimed to assess if, during the second wave of the COVID-19 pandemic, healthcare workers had increased severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection rates, following close contact with patients, co-workers and persons outside work with COVID-19.

Methods A follow-up study of 5985 healthcare workers from Denmark was conducted between November 2020 and April 2021 and provided day-to-day information on COVID-19 contacts. SARS-CoV-2 infection was defined by the first positive polymerase chain reaction (PCR) test ever. Data was analyzed in multivariable Poisson regression models.

Results The SARS-CoV-2 infection rates following close contact 3–7 days earlier with patients, co-workers and persons outside work with COVID-19 were 153.7, 240.8, and 728.1 per 100 000 person-days, respectively. This corresponded with age, sex, month, number of PCR tests and mutually adjusted incidence rate ratios of 3.17 [40 cases, 95% confidence interval (CI) 2.15–4.66], 2.54 (10 cases, 95% CI 1.30–4.96) and 17.79 (35 cases, 95% CI 12.05–26.28). The risk of SARS-CoV-2 infection was thus lower, but the absolute numbers affected was higher following COVID-19 contact at work than COVID-19 contact off work.

Conclusions Despite strong focus on preventive measures during the second wave of the pandemic, healthcare workers were still at increased risk of SARS-CoV-2 infection when in close contact with patients or co-workers with COVID-19. There is a need for increased focus on infection control measures in order to secure healthcare workers' health and reduce transmission into the community during ongoing and future waves of SARS-CoV-2 and other infections.

Key terms coronavirus; COVID-19; epidemiology; infectious disease; longitudinal study; loss of taste and smell; occupational safety; PCR; polymerase chain reaction; risk factor.

The first wave of the SARS-CoV-2 pandemic was globally characterized by widespread lack of personal protective equipment (PPE), confusing PPE guidelines and lack of SARS-CoV-2 testing and contact tracing (1). Healthcare workers were at highly increased risk and mortality of COVID-19 (2–6). From January to October 2020, healthcare workers from four UK teaching hospitals exposed to patients and healthcare workers infected with SARS-CoV-2 had infection rates of 0.8 and 0.6 per 1000 person-days at risk, respectively, well above the

1 Department of Public Health, Work, Environment and Health, Danish Ramazzini Centre, Aarhus University, Aarhus C, Denmark.
2 Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, Denmark.
3 Department of Occupational Medicine, Danish Ramazzini Centre, Goedstrup Hospital, Herning, Denmark.
4 Department of Occupational and Environmental Medicine, Bispebjerg and Frederiksberg Hospital, University of Copenhagen, Copenhagen, Denmark.
5 Department of Clinical Microbiology, Aarhus University Hospital, Aarhus, Denmark.
6 Institute of Clinical Medicine, Aarhus University, Aarhus, Denmark.

Correspondence to: Henrik A Kolstad, Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, Palle Juul-Jensens Boulevard 99, 8200 Aarhus N, Denmark. [E-mail: henkol@rm.dk]

background rate of 0.1 per 1000 person-days at risk (7). From March to April 2020, front-line healthcare workers in the UK and USA reporting adequate PPE use when in direct contact with COVID-19 patients showed a five-fold increased self-reported positive polymerase chain reaction (PCR) testing rate for SARS-CoV-2 of 553 per 100 000 (2). Increased SARS-CoV-2 seropositivity was reported among healthcare workers in close contact with patients (8–11), co-workers (8, 9), household members and other persons outside work with COVID-19 (8, 9, 12–15), but not consistently (13–16).

A considerable increase in preventive measures was initiated in multiple countries including Denmark (13), and it was expected that the pandemic afflicting so many healthcare workers was brought under control during the second wave. Our main objective was to study if, during the second wave of the COVID-19 pandemic, healthcare workers had increased SARS-CoV-2 infection rates following close contact with patients, co-workers and persons outside work with COVID-19.

Methods

Study design and population

This is a dynamic follow-up study with day-to-day self-reported information on COVID-19 contacts. Outcome is incident SARS-CoV-2 infection. Person-day at risk is the unit of analysis. The study population comprised healthcare workers at hospitals and related technical, administrative and other staff of the Central Denmark Region (hereafter referred to as healthcare workers).

General surveillance and infection control recommendations

PCR testing for SARS-CoV-2 was freely accessible at no cost for all Danish citizens independent of symptoms. All hospital workers with any patient contact were urged to be PCR tested bi-weekly until 26 January 2021, thereafter weekly. PCR test results were provided on average 24–36 hours after sample collection. SARS-CoV-2 infection rates in the second wave of the pandemic peaked in Denmark on 16 December 2020, with 4387 PCR-verified cases in a population of 5 771 877 citizens.

All healthcare workers were instructed to follow general guidelines for infection control and wear surgical masks in all indoor areas with public or patient access and maintain physical distance to other persons whenever possible. All workers with non-critical functions were sent home on 11 December 2021, and for the remaining study period.

During care for patients diagnosed with or under suspicion of COVID-19, all staff were instructed to wear a fluid-repellent disposable gown with long sleeves, disposable medical gloves, surgical mask and protective glasses or visor. Moreover, during procedures with risk of aerosol generation (eg, high flow oxygen therapy) the surgical mask should be replaced by a filtering face piece 2 or 3 (FFP2, FFP3) respirator. The healthcare workers were instructed how to do a positive pressure seal check of the respirators, but no formal fit test was done as recommended by Center for Disease Control (18). There was sufficient supply of PPE during the study period.

Following close contact with persons diagnosed with COVID-19 without prescribed PPE for ≥15 minutes, individuals were required to go into self-isolation and be PCR tested at day four and six. Self-isolation could be cancelled following two negative tests or, in case of a positive test, 48 hours after symptom cessation or seven days after the positive test if asymptomatic. Detailed infection control for COVID-19 for employees of the Central Denmark Region during the COVID-19 pandemic can be found in the supplementary material (www.sjweh.fi/article/4049).

Exposure assessment of COVID-19 contacts

Each day during follow-up at 15:30 hours, study participants received a text message linking to a questionnaire. They were asked to report any incident of close contact within a one-meter distance with patients and persons outside work with COVID-19 during the current and the previous 1–2 and 3–4 days. Participants were also asked to report incidents of close contact with co-workers with COVID-19 during the previous 1–2 and 3–4 days, but not the current day, because co-workers with known COVID-19 would not be present at work.

We classified each day of follow-up as exposed to contact with COVID-19 patients if participants reported such contact at least once during the previous 3–7 days. Otherwise, each day of follow up was classified with no close contact with COVID-19 patients if participants reported this for ≥3 days during the previous 3–7 days. Days of follow-up not fulfilling these two criteria were classified with unknown close contact with COVID-19 patients. A similar approach was used to assign exposure status following close contact with co-workers and persons outside work. Thus, each day of follow-up was classified as exposed (yes, no, unknown) to patients, co-workers and persons outside work with COVID-19. To account for the incubation period, we decided to focus on the 5-day exposure window 3–7 days earlier (19).

SARS-CoV-2 infection, vaccination and COVID-19 symptoms

The primary outcome measure was incident SARS-CoV-2 infection defined as the first positive PCR test

ever recorded in a regional register with complete coverage of all tests conducted in the population since 27 February 2020. A regional register also provided information about all COVID-19 vaccinations since 27 December 2020. As a secondary outcome measure, we included first report of loss of taste and smell as asked for in the daily questionnaire because this was a key symptom of COVID-19 during the early waves of the pandemic and should be unaffected by potential biases related to being PCR tested for SARS-CoV-2 (20).

Population characteristics

Information on age, sex, occupation and department of employment was obtained from the personnel records of the Central Denmark Region. At baseline, participants reported information on smoking, height and weight that allowed calculation of body mass index (BMI), airways disease (chronic obstructive pulmonary disease, asthma, rhinitis). Participants reported non-compliance with PPE guidelines in the daily questionnaire by responding to the following two questions: "Has there within the last 24 hours been situations where you did not use the recommended personal protective equipment? If yes, during which tasks did you not use the recommended personal protective equipment?".

Statistical analyses

Study participants were followed daily from seven days after the first daily questionnaire response – 25 November 2020 – at the earliest, until first positive test for SARS-CoV-2, seven days after full vaccination (21) or 30 April 2021. Each day of follow-up was classified according to close contact (yes, no, unknown) with patients, co-workers and persons outside work with COVID-19 according to the previously defined criteria. Participants may have experienced all contact forms several times during follow-up and thus move in and out of exposures.

Study population characteristics were described for the person-days at risk. Sex, age, occupation, department, smoking, BMI, and lung disease were reported at baseline and did not vary during follow up. PCR testing, on the other hand like close contact with patients, co-workers and persons outside work with COVID-19, varied day-to-day, and we therefore reported PCR testing for three time windows: 1–2, 3–7 and ≥8 days earlier reflecting time after, during, and before the 5-day COVID-19 exposure window.

We used generalized linear models with log-link assuming a Poisson distribution with person-days as offset representing the time at risk to derive incidence rate ratios (IRR) with 95% confidence intervals (CI) for SARS-CoV-2 infection following close contact versus no close contact with patients, co-workers and persons outside work with COVID-19. Adjusted IRR were mutually adjusted for the other types of COVID-19 contact, sex, age (continuous) and month (6 categories, November 2020–April 2021) as decided a priori. We furthermore adjusted for number of PCR tests made before, during, and after the 5-day exposure window (≥8, 3–7 and 1–2 days previously). However, this only affected IRR estimates marginally, and in the final models, we included the cumulative number of earlier PCR tests as a continuous variable. In the analyses, number of previous PCR tests and contact with patients, co-workers and persons outside work were treated as time-varying day-to-day.

We excluded person-days with missing information on close contact with patients, co-workers and persons outside work diagnosed with COVID-19. We abstained from imputing the missing values. This was because a high fraction of participants worked part time or irregular shifts with at least two days off work with no close contact with patients or co-workers at unpredictable days during a given week. Information on the covariates of the adjusted models were complete.

In a sub-analysis, we restricted the data to person-days at risk with close contact either with patients, co-workers or persons outside work with COVID-19, excluding person-days with combined close contacts. Based on this data, we estimated the IRR of SARS-CoV-2 infection following close contact with either patients or co-workers using close contact with persons outside work as the reference.

Analyses of loss of taste and smell followed a similar setup as analyses of SARS-CoV-2 infection, but we did not censor subjects when testing PCR positive for SARS-CoV-2 and did not include number of earlier PCR tests in the adjusted models.

In sensitivity analyses of possible differential recall of close COVID-19 contacts, we excluded contact information obtained after a given day of follow-up (ie, based on questionnaire reports for the previous 1–2 and 3–4 days), when PCR test results were available for the participants. This excluded all information on close contact with co-workers with COVID-19 because this was only reported for the previous 1–2 and 3–4 days.

Results

A total of 26 089 healthcare workers were invited to the study on 17 November 2020. After excluding 724 who tested positive for SARS-CoV-2 before the start of follow-up, 25 365 healthcare workers (3 253 671 person-days) were candidates for inclusion and 6337 (753 607 person-days) participated (table 1). After excluding

person-days with missing information on close contact with patients, co-workers or persons outside work with COVID-19, the study population included 5985 healthcare workers providing 514 165 person-days at risk. The daily testing rates were 5.5% for the invited population and 7.1% for the study population. Altogether, 448 748 daily questionnaire responses were collected from the study population during follow-up, corresponding with an 87.3% coverage. SARS-CoV-2 infection rates in the invited population and the study population were 28.6 and 30.9 per 100 000 person-days.

Table 2 presents characteristics (person-days) of the invited population and the study population by COVID-19 contacts 3–7 days earlier. The study population included 88.6% women and the mean age was 48.0 years compared with 83% women and a mean age of 43.6 years for the invited population. Compared to the invited healthcare workers, more study participants had been PCR tested earlier. Only minor occupation and department differences between the invited and the participating populations were seen, except for relatively more participants from departments with less frequent patient contact.

Participants who reported one type of close COVID-19 contact more often reported the other types of close COVID-19 contact. All types of COVID-19 contact were associated with more frequent PCR testing, especially during the previous 1–2 days. More nurses had close contact with patients and co-workers with COVID-19 than other occupations. Only small differences were seen for department, smoking status, BMI and lung diseases.

After having close contact with COVID-19 patients 3–7 days earlier, 40 participants tested positive for SARS-CoV-2, while 119 tested positive after no such known contact (table 3). This corresponded with infection rates of 153.7 and 24.4 per 100 000 person-days and an adjusted IRR of 3.17 (95% CI 2.15–4.66). After having close contact with co-workers and persons outside work with COVID-19 3-7 days earlier, 10 and 35 participants tested positive corresponding with infection rates of 240.8 and 728.1 per 100 000 person-days, respectively. The infection rates among those with no such known contacts were 29.2 and 24.3 per 100 000 person-days and the adjusted IRR were 2.54 (95% CI 1.30–4.96) and 17.79 (95% CI 12.05–26.28), respectively.

When comparing the risk of SARS-CoV-2 infection following close contact with either patients or co-workers with close contact with persons outside work with COVID-19, excluding person-days and cases with combined exposures, we observed IRR of 0.17 (34 cases, 95% CI 0.10–0.28) for patients and 0.21 (5 cases, 95% CI 0.08–0.54) for co-workers (table 4). This analysis included 34 cases in the reference group with COVID-19 contact outside work.

A total of 24 participants with incident loss of taste and smell had experienced close contact with COVID-19 patients (table 5). This corresponded with an IRR of 41.4 per 100 000 person-days and an adjusted IRR of 1.48 (95% CI 0.95–2.29). Following close contact with co-workers and persons outside work with COVID-19, the adjusted IRR of loss of taste and smell were 2.56 (95% CI 1.24–5.30) and 10.82 (95% CI 7.33–15.98). Among those reporting loss of taste and smell, 36% had a positive PCR test earlier.

The infection rate in the study population declined from January to April 2021, increased by number of PCR tests 3–7 days earlier and were higher for departments of medicine and among nurses compared with other departments and occupations. No clear infection rate patterns were seen for the other population characteristics (supplementary table S1).

Participants reported an overall 2% non-compliance with PPE guidelines during 187 413 daily procedures. For respiratory procedures with potential for higher exposure levels, this percentage was 4.8% (supplementary table S2).

Sensitivity analyses that only included COVID-19 contact information obtained before results of the PCR tests were available, showed an infection rate of 155.2 per 100 000 person-days and an adjusted IRR of 3.52

Table 1. Study profile.

Populations	Persons (N)	Person-days (N)	Daily questionnaire responses (N)	Fully vaccinated persons (N)	Negative PCR tests (N)	Positive PCR tests (N)	Daily testing rate (%)	SARS-CoV-2 infection rate per 100 000 person-days
Invited with follow-up data [a]	25 365	3 253 671		17 815	177 511	929	5.5	28.6
Participants [b]	6337	753 607	471 986	5082	53 266	213	7.1	28.3
Missing data on COVID-19 contact [c]	352	239 442	23 238	261	17 270	54	7.1	22.6
Study population	5985	514 165	448 748	4821	35 996	159	7.1	30.9

[a] Follow-up from 25 November 2020 until the first positive PCR test, 7 days after full vaccination or 30 April 2021.

[b] Follow-up from 7 days after first questionnaire response until first positive PCR test, 7 days after full vaccination or 30 April 2021.

[c] Person-days at risk with missing information on close contact 3–7 days earlier with patients, co-workers or persons outside work with COVID-19 that were not included in the analyses.

Table 2. Population characteristics (person-days) according to participation status and contact 3–7 days earlier with patients, co-workers and persons outside work with COVID-19. [COPD=chronic obstructive pulmonary disease]

Characteristics	Invited population	COVID-19 contact among participants					
		Patients		Co-workers		Persons outside work	
	N=3 253 671 Mean age 43.4 (SD 12.1) years	No (N=488 147) Mean age 49.5 (SD 10.3) years	Yes (N=26 018) Mean age 47.3 (SD 11.1) years	No (N=510 012) Mean age 49.4 (SD 10.4) years	Yes (N=4153) Mean age 49.2 (SD 10.6) years	No (N=509 358) Mean age 49.4 (SD 10.4) years	Yes (N=4 807) Mean age 48.4 (SD 10.5) years
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Women	2 708 710 (83)	435 986 (89)	22 650 (87)	455 003 (89)	3633 (87)	454 360 (89)	4276 (89)
COVID-19 contact							
Patients				24 658 (5)	1360 (33)	25 504 (5)	514 (11)
Co-workers		2793 (1)	1360 (5)			4039 (1)	114 (2)
Persons outside work		4293 (1)	514 (2)	4693 (1)	114 (3)		
Months							
November	760 392 (23)	15 286 (3)	922 (4)	16 039 (3)	169 (4)	16 005 (3)	203 (4)
December	571 757 (18)	129 414 (27)	9527 (37)	136 712 (27)	2229 (54)	135 885 (27)	3056 (64)
January	535 177 (16)	126 987 (26)	11 459 (44)	136 899 (27)	1547 (37)	137 437 (27)	1009 (21)
February	456 640 (14)	85 888 (18)	2507 (10)	88 306 (17)	89 (2)	88 222 (17)	173 (4)
March	152 046 (5)	73 007 (15)	913 (4)	73 861 (14)	59 (1)	73 759 (14)	161 (3)
April	777 659 (24)	57 565 (12)	690 (3)	58 195 (11)	60 (1)	58 050 (11)	205 (4)
PCR tests (1–2 days earlier)							
0	2 909 178 (89)	421 861 (86)	21 117 (81)	440 408 (86)	2570 (62)	439 936 (86)	3042 (63)
1–2	343 106 (11)	66 108 (14)	4808 (19)	69 362 (14)	1554 (38)	69 176 (14)	1740 (37)
PCR tests (3–7 days earlier)							
0	2 460 903 (76)	334 339 (68)	15 461 (59)	347 771 (68)	2029 (49)	347 449 (68)	2351 (49)
1	753 731 (23)	147 119 (30)	9269 (36)	154 621 (30)	1767 (43)	154 484 (30)	1904 (40)
≥2	39 037 (1)	6 689 (1)	1288 (5)	7620 (1)	357 (9)	7425 (1)	552 (11)
PCR tests (≥ 8 days earlier)							
0	647 158 (20)	53 070 (11)	1921 (7)	54 586 (11)	405 (10)	54 415 (11)	576 (12)
1–4	1 346 111 (41)	215 792 (44)	11 404 (44)	224 818 (44)	2378 (57)	224 339 (44)	2857 (59)
5–9	861 939 (26)	141 699 (29)	9720 (37)	150 303 (29)	1116 (27)	150 374 (30)	1045 (22)
≥10	398 463 (12)	77 586 (16)	2973 (11)	80 305 (16)	254 (6)	80 230 (16)	329 (7)
Occupation							
Nursing staff [a]	1 264 494 (39)	180 659 (37)	13 532 (52)	192 065 (38)	2126 (51)	192 077 (38)	2114 (44)
Medical doctors	451 218 (14)	43 574 (9)	3092 (12)	46 275 (9)	391 (9)	46 184 (9)	482 (10)
Biomedical Laboratory	156 073 (5)	36 657 (8)	3398 (13)	39 788 (8)	267 (6)	39 769 (8)	286 (6)
Medical secretaries	277 011 (9)	61 854 (13)	864 (3)	62 357 (12)	361 (9)	62 091 (12)	627 (13)
Other	1 094 735 (34)	165 260 (34)	5127 (20)	169 379 (33)	1008 (24)	169 089 (33)	1298 (27)
Missing	10 140 (0)	143 (0)	5 (0)	148 (0)	0 (0)	148 (0)	0 (0)
Department							
Emergency	120 912 (4)	9 413 (2)	2509 (10)	11 602 (2)	320 (8)	11 686 (2)	236 (5)
Medicine [b]	776 923 (24)	123 542 (25)	6557 (25)	128 932 (25)	1167 (28)	128 827 (25)	1272 (26)
Surgery [c]	603 097 (19)	86 542 (18)	2897 (11)	88 877 (17)	562 (14)	88 581 (17)	858 (18)
Biochemistry	184 158 (6)	38 959 (8)	3273 (13)	42 018 (8)	214 (5)	41 942 (8)	290 (6)
Service [d]	109 284 (3)	6 509 (1)	651 (3)	7104 (1)	56 (1)	7 137 (1)	23 (0)
Anaesthesiology	123 557 (4)	16 121 (3)	3325 (13)	19 169 (4)	277 (7)	19 246 (4)	200 (4)
Radiology and nuclear medicine	134 114 (4)	21 574 (4)	1500 (6)	22 826 (4)	248 (6)	22 821 (4)	253 (5)
Psychiatry	427 205 (13)	61 721 (13)	1266 (5)	62 474 (12)	513 (12)	62 343 (12)	644 (13)
Departments with less frequent patient contact [e]	455 684 (14)	92 302 (19)	2483 (10)	94 281 (18)	504 (12)	94 051 (18)	734 (15)
Other [f]	308 597 (9)	31 321 (6)	552 (6)	32 581 (6)	292 (7)	32 576 (6)	297 (6)
Missing	10 140 (0)	143 (0)	5 (0)	148 (0)	(0)	148 (0)	0 (0)
Smoking							
Current smoker		26 498 (5)	1951 (7)	28 222 (6)	227 (5)	28 150 (6)	299 (6)
Previous smoker		142 411 (29)	7660 (29)	148 682 (29)	1389 (33)	148 549 (29)	1522 (32)
Never smoker		315 544 (65)	16 251 (62)	329 287 (65)	2508 (60)	328 822 (65)	2973 (62)
Missing		3694 (1)	156 (1)	3821 (1)	29 (1)	3837 (1)	13 (0)
BMI (kg/m^2)							
<20		32 317 (7)	1710 (7)	33 764 (7)	263 (6)	33 715 (7)	312 (6)
20–24		228 612 (47)	11 608 (45)	238 506 (47)	1714 (41)	237 771 (47)	2449 (51)
25–29		146 236 (30)	7777 (30)	152 586 (30)	1427 (34)	152 662 (30)	1351 (28)
≥30		77 116 (16)	4734 (18)	81 143 (16)	707 (17)	81 168 (16)	682 (14)
Missing		3 866 (1)	189 (1)	4013 (1)	42 (1)	4042 (1)	13 (0)
Lung disease							
Hay fever		100 096 (21)	4827 (19)	104 107 (20)	816 (20)	103 924 (20)	999 (21)
Asthma		34 659 (7)	1668 (6)	36 036 (7)	291 (7)	35 900 (7)	427 (9)
COPD		3091 (1)	188 (1)	3232 (1)	47 (1)	3231 (1)	48 (1)

[a] Nurses, social- and healthcare assistants and radiographers
[b] Internal medicine, paediatrics, oncology and neurology
[c] All surgical departments, including: obstetrics and gynaecology; otorhinolaryngology, head and neck surgery; and ophthalmology
[d] Cleaning services; hospital porters; clothing and waste management; depot and archive; telephone switchboard; and guidance for patients, relatives and staff
[e] Occupational and social medicine; physio- and occupational therapy; administration; department of technical services; and kitchen
[f] Administrative, technical and pedagogical staff

Table 3. Close contact 3–7 days earlier with patients, co-workers and persons outside work with COVID-19 and incidence rate ratios (IRR) of SARS-CoV-2. [CI=confidence interval.]

Contact with persons with COVID-19	Person-days	First positive SARS-CoV-2 PCR tests	Infection rate per 100,000 person-days	Model 1	Model 2 [a]	Model 3 [b]	Model 4 [c]
				IRR (95% CI)	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Patients							
No contact	488 147	119	24.4	Reference	Reference	Reference	Reference
Contact	26 018	40	153.7	6.31 (4.41–9.02)	4.62 (3.21–6.65)	3.72 (2.55–5.44)	3.17 (2.15–4.66)
Co-workers							
No contact	510 012	149	29.2	Reference	Reference	Reference	Reference
Contact	4153	10	240.8	8.24 (4.34–15.63)	5.44 (2.86–10.35)	2.68 (1.37–5.24)	2.54 (1.30–4.96)
Persons outside work							
No contact	509 358	124	24.3	Reference	Reference	Reference	Reference
Contact	4807	35	728.1	29.91 (20.55–43.52)	21.75 (14.75–32.06)	18.87 (12.78–27.88)	17.79 (12.05–26.28)

[a] Model 1 adjusted for age (continuous), sex and month (6 categories, November 2020-April 2021)
[b] As model 2 and additionally adjusted for the other types of COVID-19 contact
[c] As model 3 and additionally adjusted for number of previous PCR tests.

Table 4. Incidence rate ratios (IRR) of SARS-CoV-2 following close contact 3-7 days earlier with either patients or co-workers compared with contact with persons outside work with COVID-19.[a] [CI=confidence interval.]

Contact with persons with COVID-19	Person-days	First positive SARS-CoV-2 PCR tests	Infection rate per 100 000 person-days	Model 1	Model 2 [b]	Model 3 [c]
				IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Patients	24 203	34	140.5	0.18 (0.11–0.28)	0.16 (0.10–0.27)	0.17 (0.10–0.28)
Co-workers	2 738	5	182.6	0.23 (0.09–0.58)	0.21 (0.08–0.54)	0.21 (0.08–0.54)
Persons outside work	4 238	34	802.3	Reference	Reference	Reference

[a] Only person-days at risk with contact either with patients, co-workers or persons outside work with COVID-19 are included
[b] Model 1 adjusted for age (continuous), sex and month (6 categories, November 2020-April 2021)
[c] As model 2 and additionally adjusted for number of previous PCR tests.

Table 5. Close contact 3–7 days earlier with patients, co-workers and persons outside work with COVID-19 and incidence rate ratios (IRR) of loss of taste and smell. [CI=confidence interval.]

Close contact with persons with COVID-19	Person-days [a]	Incident loss of taste and smell	Incidence rate per 100,000 person-days	Model 1	Model 2 [b]	Model 3 [c]
				IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Patients						
No contact	488 451	202	41.4	Reference	Reference	Reference
Contact	26 748	24	89.7	2.17 (1.42–3.31)	1.70 (1.11–2.61)	1.48 (0.95–2.29)
Co-workers						
No contact	511 010	218	42.7	Reference	Reference	Reference
Contact	4189	8	191.0	4.48 (2.21–9.07)	3.20 (1.57–6.49)	2.56 (1.24–5.30)
Persons outside work						
No contact	510 123	195	38.2	Reference	Reference	Reference
Contact	5076	31	610.7	15.98 (10.94–23.34)	11.21 (7.60–16.54)	10.82 (7.33–15.98)

[a] This population was slightly different from that of table 3 because of the different outcome.
[b] Adjusted for age (continuous), sex and month (6 categories, November 2020-April 2021).
[c] As model 2 and additionally adjusted for the other types of COVID-19 contact.

(95% 2.41–5.13) following close contact with COVID-19 patients (supplementary table S3). The IRR following close contact with persons outside work with COVID-19 was 14.19 (95% CI 8.27–24.33). No results were available for close contact with co-workers with COVID-19 because this information was obtained after PCR test results were available for those tested.

Discussion

Principal findings

This follow-up study of healthcare workers was conducted from 25 November 2020 to 30 April 2021 during the second wave of the pandemic in Denmark. The SARS-CoV-2 infection rates following close contact with patients, co-workers, and persons outside work with COVID-19 were, respectively, 153.7, 240.8 and 728.1 per 100 000 person-days. This corresponded to about 3, 2.5 and 18-fold increased adjusted IRR when compared with no such contacts representing the background risk. When compared with close contacts outside work, the adjusted IRR of close contacts with patients and co-workers with COVID-19 were about 5-fold decreased. Among all healthcare workers, the absolute numbers affected following close contact with patients or co-workers was higher than the absolute numbers following close contact with persons outside work with COVID-19. Comparable patterns of increased risks of loss of taste and smell were seen for all three types of COVID-19 contact. Participants reported high but not complete day-to-day compliance with PPE guidelines.

Strengths and limitations

Strengths of this study are the follow-up design with day-to-day information that allowed precise account for incubation period and daily change in exposure, the complete follow-up for PCR test results, and information on incident loss of taste and smell that was a key symptom of SARS-CoV-2 infection (22). During spring 2020, in this population, persistent loss of taste and smell was strongly associated with a positive PCR test for SARS-CoV-2 with an odds ratio of 57.16 (95% CI 16.71–195), corresponding with a specificity of 98% and a positive predictive value of 84% (16). Other strengths are the free access to PCR testing and the high testing rate. The decision to be PCR tested was therefore unlikely to be strongly associated with COVID-19 contact and result of the PCR test, and we regard collider bias a minor problem (23).

Participants reporting one type of close COVID-19 contact (patients, co-workers or persons outside work) more often experienced the other types of contact and the mutually adjusted IRR estimates were substantially reduced and are expected to provide the best estimates of the separate effects, supported by our finding in the direct comparison between the three types of contact.

Participants with close COVID contacts had been PCR tested for SARS-CoV-2 infection more often than those with no such contacts. However, earlier PCR tests (all negative) should not be causally associated with SARS-CoV-2 infection as detected by a positive PCR test on a given day of follow-up but may be indicators of unobserved risk factors of SARS-CoV-2 infection that may confound associations. Our analyses indicated no such confounding. Furthermore, analyses of loss of taste and smell, which is a key symptom of SARS-CoV-2 infection unaffected by PCR testing frequency, showed results in line with those seen for SARS-CoV-2 infection.

Participants were about five years older than the invited population. The risk of SARS-CoV-2 infection has been suggested to increase with age, but we previously observed the highest SARS-CoV-2 sero-prevalence among the young participants of 18 000 healthcare workers from the source population of this study (24, 25). Participation was higher among healthcare workers from departments with less frequent patient contact, and we thus have no obvious explanation for the slightly higher incidence rate of SARS-CoV-2 infection in the study compared to source population.

Analyses were mutually adjusted for other COVID-19 contact forms, sex, age, month and number of PCR tests. The likelihood of exposure to patients and co-workers with COVID-19 varied across departments and occupations, but because we had individual information on contact with patients and co-workers with COVID-19 for each day of follow-up, department and occupation were not included in the adjusted models.

COVID-19 contact information was partly obtained after the results of the PCR test results were available for the tested participants, which may have introduced recall bias and inflated results. However, sensitivity analyses relying only on contact information obtained before results of the PCR tests were available indicated no substantial recall bias. Knowledge of PCR test results as well as COVID-19 contact may, on the other hand, have inflated results for loss of taste and smell.

Being classified with no close COVID-19 contact during the 5-day exposure window allowed missing information for two of the five days. Because there may have been COVID-19 contact during these days, this may have attenuated IRR.

Our study population included mainly hospital healthcare workers, and findings may be less representative for healthcare workers in primary care because overall incidence of SARS-CoV-2 infection has been reported lower for general practitioners (3.50%) and

nursing home staff (3.92%) than for hospital workers (5.32%) when the second wave of the pandemic peaked in Denmark in December 2020 (26).

Comparisons with other studies

Numerous studies during the last two years have documented increased risk and mortality of COVID-19 as well as hospitalization among healthcare workers as shown by several reviews (4, 6, 16). Lower risk for healthcare workers during the second than the first wave of the pandemic has been shown (27).

This study showed an overall SARS-CoV-2 infection rate of 30.9 per 100 000 person-days during the second wave, which was well below the self-reported positive PCR testing rate of 132 per 100 000 person-days observed in a prospective cohort of frontline healthcare worker during the first wave by Nugyen et al (2). Our observed infection rates of 153.7 and 240.8 per 100 000 person-days following contact with patients and colleagues with COVID-19 were, however, slightly higher than the infection rates of about 90 and 70 per 100 000 person-days reported by Mo et al (7) for healthcare workers with similar contacts at UK hospitals during the first wave. On the other hand, Nguyen et al (2) reported a higher infection rate of 553 per 100 000 person-days following contact with COVID-19 patients for healthcare workers reporting that they always had the PPE they needed (with no further specification).

We observed a SARS-CoV-2 infection rate of 728.1 per 100 000 person-days following close contact with persons outside work with COVID-19, which was half the average household infection rate of 1660 per 100 000 person-days reported for the first wave (12). This may partly reflect that we included any close contact with a person outside work with COVID-19 and not only household contacts that are expected to be closer and last longer.

Several serological studies have provided results in line with ours for contact with patients (8–11), co-workers (8, 9) and persons outside work with COVID-19 (8, 9, 12–15). But there are also findings of no association (13–16).

The findings of these studies are, however, not directly comparable because of differences in population compositions, background incidence rates, definitions of COVID-19 contact and SARS-CoV-2 infection. We are not aware of other studies comparing the incidence rates of SARS-CoV-2 infection following exposure to patients or co-workers at work with persons outside work with COVID-19.

During a 17-day period around New Year 2021, a subset of the healthcare workers of the current study had used a new respirator with frequent defects during contact with COVID-19 patients that may partly have contributed to the increased risk we observed (28).

Concluding remarks

During the second wave of the pandemic, this healthcare worker population was at increased risk of SARS-CoV-2 infection when in close contact with patients and colleagues with COVID-19, but the risk was not as high as after contact with persons outside work with COVID-19. However, the absolute numbers affected following contact with patients and co-workers were higher than the absolute numbers affected following COVID-19 contact outside work. PPE was not in shortage in the healthcare sector, guidelines for PPE use and other infection control measures were implemented but did not include a fit test. Compliance with required PPE was high but not complete.

The current findings thus stress the need for increased focus on use of recommended PPE, correct donning, doffing, fit test and other procedures (18, 29–31), training (32) and ventilation (33). The aim is to secure healthcare workers' health and reduce transmission into the community (34) during ongoing and future waves of SARS-CoV-2 and other infections.

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The authors declare no conflicts of interest.

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Risk of SARS-CoV-2 infection in healthcare workers with insufficient use of personal protective equipment in Denmark

Ane Berger Bungum[1], Sandra Søgaard Tøttenborg[1,2], Luise Mølenberg Begtrup[1,2], Kajsa Ugelvig Petersen[1], Maja Søndergård Worm[1], Jens Peter Bonde[1,2], Annett Dalbøge[3], Martin Byskov Kinnerup[3], Else Toft Würtz[3], Henrik Albert Kolstad[3,5], Vivi Schlünssen[6], Christine Cramer[3,6], Karin Biering[4], Kent Jacob Nielsen[4], Esben Meulengracht Flachs[1,*]

[1]Department of Occupational and Environmental Medicine, Copenhagen University Hospital—Bispebjerg and Frederiksberg, Copenhagen, Bispebjerg Bakke 23, 2400 København NV, Denmark
[2]Department of Public Health, University of Copenhagen, Øster Farimagsgade 5, 1353 København K, Copenhagen, Denmark
[3]Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, Palle Juul-Jensens Boulevard 99, 8200 Aarhus N, Aarhus, Denmark
[4]Department of Occupational Medicine, Danish Ramazzini Centre, Goedstrup Hospital, Hospitalsparken 15, 7400 Herning, Herning, Denmark
[5]Institute of Clinical Medicine, Aarhus University, Palle Juul-Jensens Boulevard 99, 8200 Aarhus N, Aarhus, Denmark
[6]Department of Public Health, Research Unit for Environment, Occupation and Health, Danish Ramazzini Centre, Aarhus University, Bartholins Allé 2, 8000 Aarhus C, Aarhus, Denmark

A.B.B. and S.S.T. shared first authorship.
*Corresponding author: Email: esben.meulengracht.flachs@regionh.dk

Abstract

Aim: The aim was to evaluate the role of insufficient use of personal protective equipment (PPE) in SARS-CoV-2 transmission risk for healthcare workers (HCW) during the COVID-19 pandemic.

Methods: Prospective study within the COBRA cohort, including 15,127 HCW. Daily assessment of insufficient use of PPE, defined as self-reported PPE failure or noncompliance, in relation to SARS-CoV-2 infection ascertained by polymerase chain reaction (PCR) test. Statistical analysis involved calculating incidence rate ratios with 95% confidence intervals (CI).

Results: The included HCW contributed to 780,515 risk days including 67,723 d (8.7%) with insufficient PPE use and 133 events (positive PCR test). Self-reported insufficient use of PPE was slightly associated with infection with COVID-19 in HCW, but the data were statistically consistent with parameter values ranging from a protective effect to a to a doubling in risk (IRR 1.3, 95% CI 0.8; 2.3). Sensitivity analyses restricted to high-risk departments and to a period with a sufficient supply of PPE and a fully developed testing system, respectively, confirmed these findings.

Conclusion: Insufficient use of PPE among HCW during the pandemic in Denmark was uncommon but associated with a slightly increased risk of COVID-19 among HCW. However, the findings are uncertain due to the limited number of cases and the potential for misclassification bias stemming from the self-reported nature of the exposure.

Key words: compliance; COVID-19; face masks; healthcare workers; occupational safety; personal protective equipment.

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What's Important About This Paper

Personal protective equipment (PPE) is essential in preventing COVID-19 among healthcare workers (HCWs), but the impact of insufficient PPE usage on COVID-19 risk remains uncertain. By analyzing daily self-reported PPE use and polymerase chain reaction test results, we found that insufficient PPE use is rare but was associated with a marginally increased risk of COVID-19 among Danish HCWs.

Background

Throughout the pandemic, healthcare workers (HCW) faced a significantly higher risk of contracting COVID-19 than the general population (Iversen *et al.* 2020; Nguyen *et al.* 2020; Reuter *et al.* 2022; Van Der Plaat *et al.* 2022). In Denmark, HCW experienced a 1.6- to 3.6-fold risk of COVID-19-related hospital admissions, making them the occupational group with the highest risk (Bonde *et al.* 2022). This is likely due to the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) within the hospital environment, including person-to-person transmission, contaminated surfaces, and airborne aerosols generated during medical procedures. In this regard, personal protective equipment (PPE) such as medical face masks, surgical masks, respirators, visors, and medical gloves have been considered key tools against transmission, but the evidence of their effectiveness in the real-world setting is scarce (Iversen *et al.* 2020; Liu *et al.* 2020; Nguyen *et al.* 2020; Verbeek *et al.* 2020; Schmitz *et al.* 2021; Kolstad *et al.* 2023). We aimed to determine the consequences of insufficient use of PPE in the transmission the SARS-CoV-2 among HCW with patient-related work tasks.

Methods

Setting and study population

This study was a prospective follow-up study among HCW working in the Central Denmark Region and Capital Region of Denmark nested in the COVID-19 among Danish healthcare workers (COBRA) cohort (Cramer *et al.*, 2023). COBRA has previously been described in detail (Cramer *et al.* 2023), but in brief, all HCW in the 2 regions were invited to fill out daily questionnaires during the first (spring-early summer 2020) and second (winter 2020–2021) waves of the COVID-19 pandemic in Denmark. Upon informed consent, all participants received a daily electronic questionnaire at 3:30 pm on patient-related work tasks (conversations and other work tasks with less than 2 m distance, physical contact, surgical procedures, patient transport, and preparation and cleaning of patient rooms) and use and failure of PPE in the past 24 h. Questionnaire data were collected using a secured Research Electronic Data Capture database (REDCap) (Harris *et al.* 2009). We included HCW with information on age, sex, and COVID-19 vaccination, no prior SARS-CoV-2 infection, and who reported at least one patient-related work task. A flow chart of included and excluded participants can be seen in Fig. 1.

Insufficient use of PPE (exposure)

In the daily questionnaire, HCW were asked "Have there been any accidents with this protective equipment within the last 24 hours? (e.g., broken glove, dropped face shield or respirator)" reflective of PPE failure and "Has there within the last 24 hours been situations where you did not use the recommended personal protective equipment?" reflective of PPE noncompliance. To both questions, they could answer "yes," "no," or "don't know." HCW who answered "yes" to one or both questions were categorized as having insufficient use of PPE with the reference group consisting of those answering "no" to both questions. A full copy of the original questionnaire can be found in Supplementary material.

SARS-CoV-2 infection (outcome)

During the study period, the included hospitals had free access to positive polymerase chain reaction (PCR) tests for all HWC, who were urged to be tested bi-weekly until 26 January 2021, thereafter weekly, with results provided within 24–36 h (Würtz et al. 2022). For the present study, the test results were obtained by crosslinking the participants' unique personal identification number to The Danish Microbiology Database (MiBa) that holds records on all positive and negative tests performed (Pedersen 2011; Schmidt *et al.* 2014). For a day-at-risk to be ascribed to the exposed group, the person should at least have had one day of insufficient use during the preceding exposure trailing window. For a day-at-risk to be ascribed to the unexposed group, the person should have no reporting of insufficient use during the preceding exposure trailing window and a maximum of 2 d with missing information to limit the risk that they had failures on the remaining days. If the person had more 2 d missing information, the day-at-risk would be assigned to exposure missing and not be included for analysis (Fig. 2).

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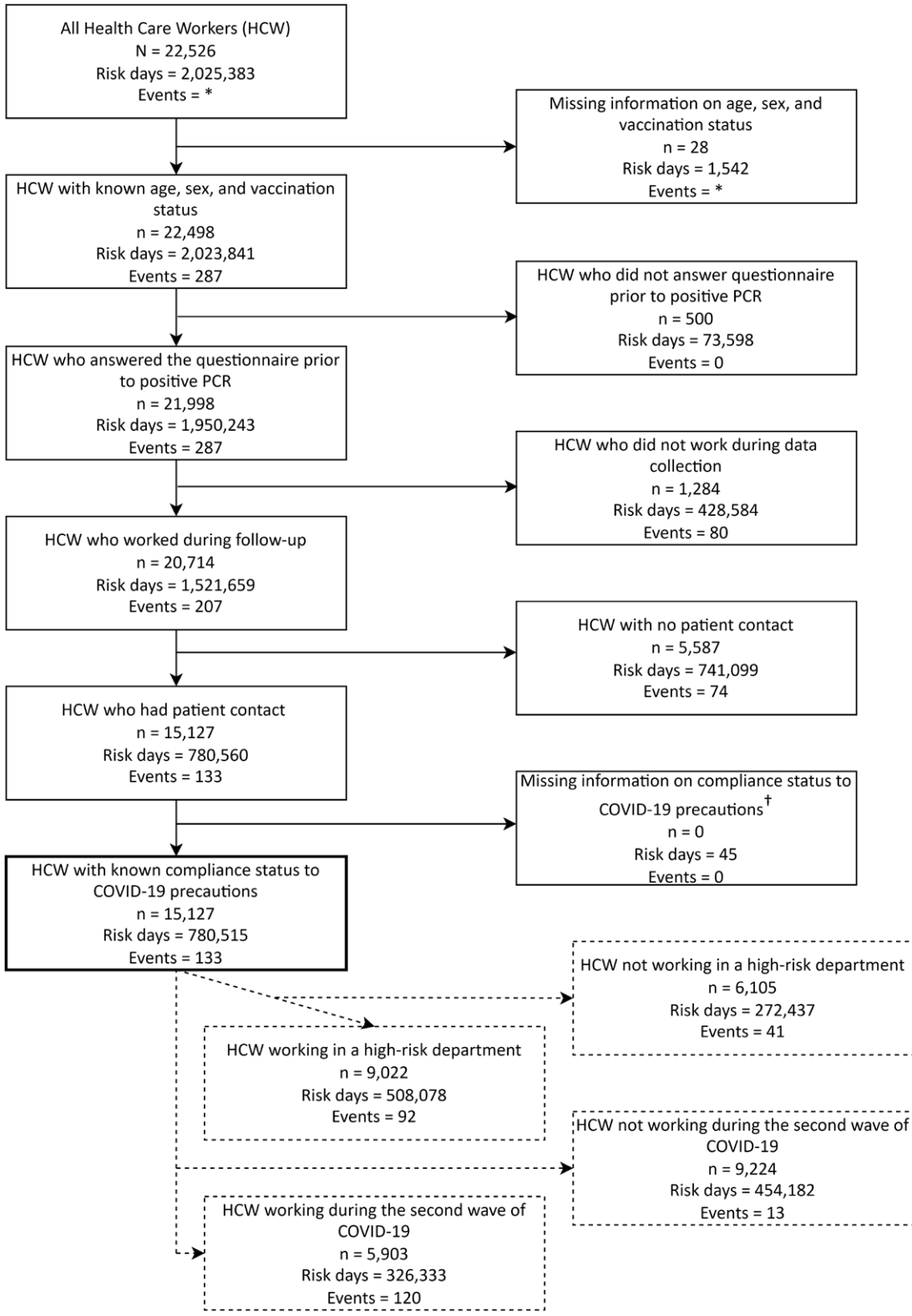

Fig. 1. Flow chart with exclusion criteria for main analyses (solid bold line—*n* = 15,127) and sensitivity analyses (dashed lines—restriction to high-risk departments and second wave, respectively). * In accordance with General Data Protection Regulation (GDPR)

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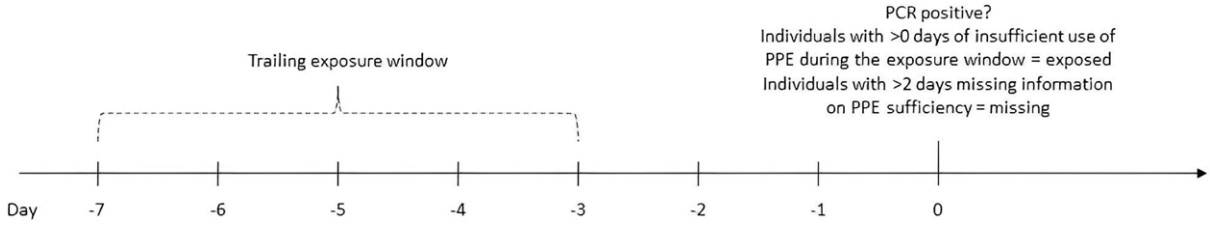

Figure 2. Determining insufficient use of PPE in a 3–7-day trailing exposure window.

Covariates

Data on sex, age, occupation (*biomedical lab scientists; medical doctors; nursing staff; and medical secretaries*), and department (*emergency; anesthesiology; biochemistry; surgical; medical; radiology and nuclear medicine; psychiatry; and service section*) was provided by the regions. Information on COVID-19 vaccinations was obtained from the National Organization for Disease Control and Vaccines, Statens Serum Institut, using the personal identification number. Individuals were considered vaccinated after 2 vaccinations.

Statistical analysis

Risk of SARS-CoV-2 infection in HCW with insufficient PPE use relative to HCW with sufficient PPE use was estimated using Poisson regressions to calculate incidence rate ratios (IRR) with 95% confidence intervals (CI). PPE-sufficiency was included in a time-dependent manner each day by seeing the participant's PCR test status and then ascribing that status to sufficient (0 d failure and noncompliance and <2 d missing information) or insufficient (at least 1 d of failure and noncompliance) use of PPE in the 3–7 d trailing exposure window. Hence, HCW contributed to risk time from 3 dafter the first questionnaire until censored 7 d after the last questionnaire, on the day of the incident positive PCR test, loss to follow-up, or the end of follow-up on 30 April 2021. No one contributed risk time between study periods as we had no exposure data in this period. All analyses were adjusted for vaccination status (time-dependent) adding age and sex in a separate step. As PCR testing of HCW was first fully up and running in early winter 2020 and spring-early summer 2020 was characterized by some degree of PPE shortage, we performed a sensitivity analysis restricted to data from winter 2020/2021. Furthermore, as patient-related work tasks range from short conversations with low transmission risk to surgery with higher transmission risk, we performed a sensitivity analysis restricted to HCW belonging to emergency, anesthesiology, surgical, and medical departments that all entail high-risk patient-related work tasks. Analyses were performed in Stata (version 17.0; StataCorp, College Station, TX, USA) and SAS studio (3.8, version 9.04, SAS Institute Inc., Cary, NC, USA).

Results

From a total of 22,526 respondents, we included 15,127 HCW with full information on age, sex, and vaccination status and who reported at least one patient-related work task on the same day as reporting on PPE use and failure (Fig. 1). The most frequent PPE failures involved medical gloves, II2R masks, medical coats, and visors, and the most frequently omitted PPE were medical gloves, visors, II2R masks, and aprons (Table 1).

The included HCW contributed with 780,515 risk days including 67,723 d (8.7%) with PPE insufficiency and 133 positive PCR tests when trailing exposure windows with missing information were accounted for (Table 2). The participants were predominantly females (87%), in the age range 30–60 (76%), nurses (52%), and employed in medical (27%), surgical (18%), and psychiatric departments (17%). Exposed participants were slightly younger and more likely to work as nurses and in anesthesiology. Besides that, no major differences in participant characteristics were observed between exposed and unexposed participants.

In analyses adjusted for vaccination status, HCW with patient-related work tasks and insufficient use of PPE had an increased risk of COVID-19 compared to HCW with sufficient PPE use, but the data were statistically consistent with parameter values ranging from a protective effect to a doubling in risk (IRR 1.3, 95% CI 0.8; 2.3) (Table 3). Adjusting for age and sex did not change the results substantially. Neither did restrictions to data from winter 2020/2021 nor HCW working in departments with high-risk patient-related work tasks.

Discussion

Main results

In this prospective follow-up study of HCW with patient-related work tasks, we found an increased

guidelines, numbers under 5 are not shown. † All HCW who reported a patient contact had reported failure or compliance for at least 3 d in a 5-d period, and thus no one was excluded. However, the contribution of risk time varies a lot.

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Table 1. Number of days reported of types of PPE failure and noncompliance.

Failure	Days	Noncompliance	Days
Total no. of days with any failure	4,117	Total no. days with noncompliance	19,373
Medical gloves	2,727	Medical gloves	6,221
II2R mask	477	Visor	5,347
Medical coat	373	II2R mask	4,451
Visor	344	Apron, plastic	3,143
Medical safety goggles	167	Medical safety goggles	2,843
FFP2 mask	105	Medical coat	2,302
Unspecified mask	83	Unspecified mask	1,917
FFP3 mask	64	FFP2 mask	1,511
Apron, plastic	51	Mask with visor	1,142
Other	26	FFP3 mask	785
Mask with visor	18	Plexiglass/plastic screen[a]	454
High isolation suit	6	High isolation suit	327
Plexiglass/plastic screen[a]	0	Other	15

[a]Only an available questionnaire option during data collection winter 2020/2021.

risk of COVID-19 following self-reported insufficient use of PPE, albeit with confidence levels ranging from protective to a doubling in risk. PPE has been demonstrated to effectively reduce nosocomial transmission of other respiratory diseases, as indicated in a Cochrane systematic review (Verbeek *et al.* 2020). In addition, a US observational study involving over 2,000,000 individuals from the general community of which more than 99,000 were front-line HCW, showed that HCW with inadequate availability of PPE faced an increased risk of COVID-19 compared to their counterparts who reported adequate availability of PPE (Nguyen *et al.* 2020). While the discrepancy between our findings and the findings of previous studies could be explained by contextual differences in the organization of the healthcare setting, level of PPE training, testing availability for patients and HCW, and more, it could also be explained by study-specific limitations, for example, the reliance on self-reported insufficient use of PPE, that may have diminished differences between HCW with and without insufficient use of PPE. This may be particularly relevant for HCW who accurately perceive a patient-related work task as lower risk (e.g. a brief conversation with less than 2 m distance, patient wearing PPE or briefly stepping halfway into a room to check on sleeping patients) and, therefore, choose not to comply with recommendations or the HCW who incorrectly assesses the risk as low and, based on this perception, believe they follow recommendations. Furthermore, studies have shown that self-contamination when putting on or removing PPE is high (Nguyen *et al.* 2020), and as this risk only pertains to HCW wearing PPE this would further attenuate results by attributing more cases to the group with sufficient use. Categorizing breach of medical gloves, which was the most frequently reported failure, in the insufficient PPE use group, could also have led to an attenuation of results, as gloves can quickly be replaced and transmission through skin is unlikely. Studying failure separately from noncompliance would have limited these uncertainties, but the relatively small number of cases in the failure group did not allow for separate assessment. However, the protective effect, as indicated by the lower limit of the confidence interval, could also be real as HCW experiencing a failure in PPE dramatic enough for them to remember may take more precautions in the days after than those who did not.

General strengths and limitations pertaining to COBRA such as the prospective design with daily collection of information regarding PPE failure and compliance, zero loss to follow-up of SARS-CoV-2 testing and vaccination, inclusion of all hospitals in 2 geographically well-defined regions, and risk of selection bias have been thoroughly discussed in a previous paper on PPE use in the cohort (Cramer *et al.* 2023). For this study, a key strength was the use of PCR tests rather than hospital diagnoses to identify SARS-CoV-2 infection, reducing the likelihood of underestimating infection in our relatively young and healthy-enough-to-work population. Since testing positive depends on taking a test, equal access and motivation for PCR tests are crucial for limiting systematic detection bias. In favor of this, PCR testing was freely accessible for all HCW in Denmark, who were urged to be PCR tested bi-weekly until 26 January 2021 (Würtz *et al.* 2022), thereafter weekly, with results provided within 24–36 h. Restriction to test results in winter 2020/2021

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Table 2. Characteristics of 15,127 health care workers from COBRA with patient-related work tasks, and full information on sex, age, and vaccine status, according to exposure status.

							Sufficient PPE use		Insufficient PPE use	
	All (*N*)	%	Risk days	%	Events (*n*)	%	Risk days	%	Risk days	%
Total	15,127	100	780,515	100	133	100	712,792	100	67,723	100
Sex										
Men	1,927	13	93,326	12	12	9	84,745	12	8,581	13
Women	13,200	87	687,189	88	121	91	628,047	88	59,142	87
Age										
20–29	1,282	8	47,873	6	8	6	41,508	6	6,365	9
30–39	3,146	21	136,396	17	30	23	121,828	17	14,568	22
40–49	4,142	27	215,491	28	31	23	196,788	28	18,703	28
50–59	4,190	28	240,943	31	48	36	222,548	31	18,395	27
60–79	2,367	16	139,812	18	16	12	130,120	18	9,692	14
Vaccinated										
No	–	–	630,581	81	119	89	574,422	81	56,159	83
Yes	–	–	149,934	19	14	11	138,370	19	11,564	17
Noncompliance										
No	–	–	712,792	91	118	89	712,792	100		–
Yes	–	–	67,723	9	15	11		–	67,723	100
Occupations										
Other	3,281	22	153,508	20	19	14	140,487	20	13,021	19
Biomedical lab scientists	675	4	42,443	5	10	8	39,624	6	2,819	4
Medical doctors	2,081	14	109,036	14	13	10	100,383	14	8,653	13
Nursing staff	7,894	52	437,846	56	82	62	397,043	56	40,803	60
Medical secretaries	899	6	23,428	3	–[a]	–[a]	22,432	3	996	1
Missing	297	2	14,254	2	–[a]	–[a]	12,823	2	1,431	2
Department										
Departments with limited patient contact[b]	1,103	7	46,156	6	10	8	42,848	6	3,308	5
Emergency departments	601	4	28,133	4	–[a]	–[a]	24,403	3	3,730	6
Anesthesiology	1,642	11	100,767	13	9	7	88,963	12	11,804	17
Department of biochemistry	593	4	34,111	4	8	6	31,751	4	2,360	3
Surgical departments	2,738	18	152,944	20	26	20	139,175	20	13,769	20
Medical departments	4,041	27	226,234	29	52	39	208,507	29	17,727	26
Radiology and Nuclear Medicine	685	5	37,099	5	6	5	34,758	5	2,341	3
Service section	362	2	18,517	2	–[a]	–[a]	17,411	2	1,106	2
Psychiatry	2,520	17	96,378	12	6	5	88,382	12	7,996	12
Other	545	4	25,922	3	–[a]	–[a]	23,771	3	2,151	3
Missing	297	2	14,254	2	–[a]	–[a]	12,823	2	1,431	2

[a]Numbers less than 5 not reported, due General Data Protection Regulation (GDPR), The European Union (EU), 2016/679 of 25 May 2018.
[b]Occupational and social medicine; physio- and occupational therapy.

did not change results substantially, indicating minimal bias from shortage and a less developed testing system in the beginning of the pandemic. Another strength was our ability to adjust for the potential confounding factors vaccination status, age, and sex.

Although it would have been ideal to restrict to HCW in contact with confirmed COVID-19 patients to ascertain true exposure, we were unable to do so due to power constraints. Instead, we used a question on patient-related work tasks including conversations

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Table 3. Adjusted IRR of COVID-19 for HCW reporting insufficient use of PPE compared to HCW reporting sufficient use of PPE for all (n = 15,127) and restricted to winter 2020/2021 (n = 5,903) or high-risk departments[a] (n = 9,022).

	PPE use	Risk time	Events	Crude rate (per 10,000 days)	IRR	95% CI
Adjusted for vaccination status	Sufficient	712,792	118	1.7	(ref)	
	Insufficient	67,723	15	2.2	1.3	0.8; 2.3
Adjusted for vaccination status, age, and sex	Sufficient	712,792	118	1.7	(ref)	
	Insufficient	67,723	15	2.2	1.3	0.8; 2.2
Restricted to wave 2 and adjusted for vaccination status	Sufficient	300,786	108	3.6	(ref)	
	Insufficient	25,547	12	4.7	1.3	0.7; 2.3
Restricted to wave 2 and adjusted for vaccination status, age, and sex	Sufficient	300,676	108	3.6	(ref)	
	Insufficient	25,547	12	4.7	1.3	0.7; 2.3
Restricted to high-risk departments[a] and adjusted for vaccination status	Sufficient	461,048	82	1.8	(ref)	
	Insufficient	47,030	10	2.1	1.2	0.6; 2.3
Restricted to high-risk departments[a] and adjusted for vaccination status, age, and sex	Sufficient	461,048	82	1.8	(ref)	
	Insufficient	47,030	10	2.1	1.2	0.6; 2.3

[a]Emergency, anesthesiology, surgical, and medical departments.

and other work tasks with less than 2 m distance, physical contacts, surgical procedures, patient transport, and preparation and cleaning of patient rooms. To minimize noise from the many patient-related work tasks with limited SARS-CoV-2 exposure, we instead performed a sensitivity analysis restricting to HCW working at emergency, medical, anesthesiologic, and surgical departments more likely to perform high-risk patient procedures. While we would have expected this to strengthen our estimates slightly, they remained essentially unchanged. This may be because HCW in these departments are generally more meticulous in their use of PPE, as previously reported (Cramer *et al.* 2023), and those reporting insufficient use are HCW with the lowest-risk tasks.

A previous study of the current study population has indicated that the increased risk among HCW was partly attributed to close contact with coworkers in the common areas where PPE was used less frequently (Würtz *et al.* 2022). While we did collect information on close contacts with non-patients with confirmed COVID-19 (e.g. family, friends, and coworkers), small numbers hindered us in accounting for this. If HCW with insufficient use of PPE are generally less risk averse, cases in this group may to a larger extent stem from other contacts than patient-related work tasks, leading to an overestimation of the association.

Conclusion

Insufficient use of PPE among HCW during the pandemic in Denmark was uncommon but associated with a slightly increased risk of COVID-19 among HCW. However, the findings are uncertain due to the limited number of cases and the potential for misclassification bias stemming from the self-reported nature of the exposure.

Author contributions

Ane Bungum Berger and Sandra Søgaard Tøttenborg drafted the manuscript. Esben Meulengracht Flachs performed statistical analyses. All authors contributed to the data collection, design, and analyses plan and commented on the scientific content of several versions of the manuscript. All authors approved of the final manuscript.

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Conflict of interests

None declared.

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Data availability

The data underlying this paper cannot be shared publicly due to the privacy of the individuals who participated in the study, but COBRA data can be shared in pseudonymized form on reasonable request to the corresponding author. Data on PCR tests and vaccines can be applied for via The Danish Health Data Authority.

Supplementary material

Supplementary material is available at *Annals of Work Exposures and Health* online.

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Use, failure, and non-compliance of respiratory personal protective equipment and risk of upper respiratory tract infections—A longitudinal repeated measurement study during the COVID-19 pandemic among healthcare workers in Denmark

Karin Biering[1,*], Martin Kinnerup[1,2], Christine Cramer[2,3], Annett Dalbøge[2], Else Toft Würtz[2,4], Anne Mette Lund Würtz[3], Henrik Albert Kolstad[2], Vivi Schlünssen[3], Esben Meulengracht Flachs[5] and Kent J. Nielsen[1]

[1]Department of Occupational Medicine, University Research Clinic, Danish Ramazzini Centre, Goedstrup Hospital, 7400 Herning, Denmark
[2]Department of Occupational Medicine, Danish Ramazzini Centre, Aarhus University Hospital, 8200 Aarhus N, Denmark
[3]Department of Public Health, Research Unit for Environment, Occupation and Health, Danish Ramazzini Centre, Aarhus University, 8000 Aarhus C, Denmark
[4]Department of Occupational and Environmental Medicine, Danish Ramazzini Centre, Aalborg University Hospital, 9000 Aalborg, Denmark
[5]Department of Occupational and Environmental Medicine, Bispebjerg and Frederiksberg Hospital, University of Copenhagen, 2400 Copenhagen NV, Denmark

[*]Corresponding author: Department of Occupational Medicine, University Research Clinic, Danish Ramazzini Centre, Goedstrup Hospital, Hospitalsparken 15, 7400 Herning, Denmark. Email: karbie@rm.dk

Abstract

Introduction: Upper respiratory tract infections (URTI) are common and a common cause of sick-leave for healthcare workers, and furthermore pose a threat especially for patients susceptible to other diseases. Sufficient use of respiratory protective equipment (RPE) may protect both the workers and the patients. The COVID-19 pandemic provided a unique opportunity to study the association between use of RPE and URTI in a real-life setting. The aim of this study was to examine if failure of RPE or non-compliance with RPE guidelines increases the risk of non-COVID-19 URTI symptoms among healthcare workers.

Methods: In a longitudinal cohort study, we collected self-reported data daily on work tasks, use of RPE, and URTI symptoms among healthcare workers with patient contact in 2 Danish Regions in 2 time periods during the COVID-19 pandemic. The association between failure of RPE or non-compliance with RPE guidelines and URTI symptoms was analyzed separately by generalized linear models. Persons tested positive for severe acute respiratory syndrome coronavirus 2 were censored from the analyses. The 2 waves of data collection were analyzed separately, as there were differences in recommendations of RPE during the 2 waves.

Results: We found that for healthcare workers performing work tasks with a risk of transmission of viruses or bacteria, failure of RPE was associated with an increased risk of URTI symptoms, RR: 1.65[0.53–5.14] in wave 1 and RR: 1.30[0.56–3.03] in wave 2. Also non-compliance with RPE guidelines was associated with an increased risk of URTI symptoms compared to the use of RPE in wave 1, RR: 1.28[0.87–1.87] and wave 2, RR: 1.39[1.01–1.91]. Stratifying on high- versus low-risk tasks showed that the risk related to failure and non-compliance was primarily associated with high-risk tasks, although not statistically significant.

Discussion: The study was conducted during the COVID-19 pandemic and thus may be affected by other preventive measures in society. However, this gave the opportunity to study the use of RPE in a real-life setting, also in departments that did not

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previously use RPE. The circumstances in the 2 time periods of data collection differed and were analyzed separately and thus the sample size was limited and affected the precision of the estimates.

Conclusion: Failures of RPE and non-compliance with RPE guidelines may increase the risk of URTI, compared to those who reported use of RPE as recommended. The implications of these findings are that the use of RPE to prevent URTI could be considered, especially while performing high-risk tasks where other prevention strategies are not achievable.

Key words: cohort study; compliance; failures; health care workers; non-compliance; personal protective equipment (PPE); prevention; respiratory protective equipment (RPE); upper respiratory tract infections (URTI); work hazard

What's important about this paper

Upper respiratory tract infections (URTI) pose a special risk to healthcare workers (HCWs) and their patients and may be prevented by the use of respiratory protective equipment (RPE). Using longitudinal data collected during the COVID-19 pandemic, this study found that RPE equipment failure and non-compliance increased the risk of URTI. These findings suggest the value of RPE to prevent URTI symptoms in healthcare settings, and RPE use may be especially important for HWCs performing high-risk tasks where other prevention strategies are not achievable.

Introduction

Upper respiratory tract infections (URTI) are common especially during the winter months and impose an economic burden on society due to both direct and indirect costs, especially related to costs of work absenteeism (Bertino 2002; Fendrick *et al.* 2003). URTI pose a special risk to healthcare workers (HCW) and their patients. As most pathogens causing URTI are highly transmissible, protecting HCW is crucial. Strategies to prevent infections include early recognition, source control, environmental control, vaccination, and use of personal protective equipment (PPE) (WHO 2014).

The role of PPE, particularly respiratory protective equipment (RPE), is of significant interest and several systematic reviews have targeted the effectiveness of RPE against respiratory infectious diseases. A recent systematic review concluded that the effectiveness of RPE differed between studies, and that wearing N95 respirators (filtering face piece respirators filtering at least 95% of particles in the air) during the whole shift seemed to be most effective against respiratory infectious diseases (Yin *et al.* 2021). A Cochrane review based on pre-COVID-19 studies found no difference between the use of face masks compared to respirators to reduce respiratory infectious disease, however, the included studies were too heterogeneous for meta-analysis (Jefferson *et al.* 2020). A recent meta-analysis found no difference between N95 respirators and face masks against common respiratory viruses, clinical respiratory illness, influenza-like illness, and pandemic H1N1. However, by network meta-analysis they found that N95 respirators had a significantly stronger protection for HCW from beta-coronaviruses of severe acute respiratory syndrome, Middle East respiratory syndrome, and respiratory syndrome coronavirus 2 (SARS-CoV-2) (Li *et al.* 2021b). A similar network meta-analysis was performed with the aim of comparing different types of face masks, but again the conclusion was that the quality and size of studies were low, however, they concluded that N95 face masks provided the best protection against respiratory infectious diseases, especially if the N95 mask was fit-tested (Tran *et al.* 2021). In addition, an umbrella review based on 10 systematic reviews concluded that N95 was slightly superior to face masks against COVID-19, but the evidence was insubstantial and other factors such as compliance, side effects to the HCW, and the morbidity of the disease should be taken into account (Lu *et al.* 2023). This highlights the complexity of effective protection against UTRI and that it extends beyond effectiveness of the protective equipment.

Building on this, previous studies have shown that using RPE correctly, including donning and doffing is challenging, and failures during these procedures may result in limited effectiveness and risk of self-contamination (Kang *et al.* 2017; Suen *et al.* 2018; Baloh *et al.* 2019; Phan *et al.* 2019; Houghton *et al.* 2020; McCarthy *et al.* 2020). Compliance with RPE recommendations may be reduced due to an individual risk perception as well as organizational and environmental factors (Harrod *et al.* 2020), but also due to discomfort e.g., heat, moisture, perceived breathing difficulties, and skin problems (Fan *et al.* 2020; Harrod *et al.* 2020; Li *et al.* 2021a). However, compliance with standard precautions increased in an Italian study during the COVID-19 pandemic (Dobrina *et al.* 2023).

This increase in compliance underlines the heightened risk perception and awareness of the vulnerability of the healthcare system. Ensuring a healthy workforce and protecting HCW became crucial during the COVID-19 pandemic, as HCW were reported to be at the highest risk of hospital admission related to SARS-CoV-2 infection at the beginning of the pandemic (Reilev *et al.* 2020; Wauthier *et al.* 2021). As the

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exposure cannot be eliminated when performing tasks in close contact with patients, one must rely on the use of PPE, especially RPE.

The COVID-19 pandemic provided a unique opportunity to study if the use of RPE could reduce the risk of not only COVID-19 but also other types of URTI in a real-life setting, and to investigate how to the improve prevention of URTI to the benefit of both HCW and patients. The aim of this study was to examine if failure of RPE or non-compliance with RPE guidelines resulted in an increased risk of non-COVID-19 URTI.

Methods

The COBRA (COVID-19 among Danish healthcare workers) study is a prospective follow-up study among HCW working in the Capital or the Central Region of Denmark (2 out of 5 regions in Denmark covering 55% of the population). Data were collected during the first 2 Danish COVID-19 waves. In the Capital Region of Denmark, data was collected between May 6, 2020 and June 30, 2020 (wave 1), and December 15, 2020 to February 28, 2021 (wave 2). In the Central Denmark Region, data was collected between April 24, 2020 and June 30, 2020 (wave 1), and November 17, 2020 to April 30, 2021 (wave 2).

All healthcare workers (HCW) were invited to participate through an email sent to their work email addresses. Following informed consent, participants answered an electronic initial questionnaire providing information on symptoms since February 2020 (wave 1 only), weight, height, and presence of chronic diseases (i.e., hay fever, asthma, or chronic obstructive lung disease) (wave 2 only). Subsequently, all participants received a daily questionnaire on symptoms of COVID-19 (coughing, sore throat, headache, sore muscles, fever, shortness of breath, reduced sense of smell and taste and from wave 2 also: unusual fatigue, running or congested nose, diarrhea or stomach pain, chest pain, concentration or memory problems and sadness), work tasks (details below), contact with patients, colleagues, or persons outside work with confirmed or suspected COVID-19, use and failure of PPE(details below). All questions were asked regarding the past 24 hours. All questionnaire data was collected using REDCap (Research Electronic Data Capture) (Harris *et al.* 2009) and stored, combined with register data (see below), and analyzed at the Danish Health Data Authority's Research Services' secure research server. The data collection including specification of work tasks and use of RPE are described in detail elsewhere (Cramer *et al.* 2023).

Although the 2 data collection waves were very similar, a few important differences in the setting and the data collection should be noted. First, non-use of all types of RPE decreased from 18.1% during the first wave to only 0.3% in the second wave. Second, the first wave was initiated when the first infection wave in Denmark was decreasing, while the second wave was initiated when the number of infected persons increased. Third, the questionnaire in the second wave included a few additional questions on symptoms (i.e. stuffy or congested nose, headache, diarrhea, stomach pain, chest pain, concentration or memory problems, and sadness) and more detailed questions regarding contact with persons outside work. The differences between the 2 waves have previously been described (Cramer *et al.* 2023). Due to these differences, the data from the 2 waves were analyzed separately, as described in more detail in the methods section below.

The questionnaire data was supplemented with register-based information, provided by the Danish Health Data Authority. Information on infection with SARS-CoV-2 (positive polymerase chain reaction (PCR) test) among HCW was obtained from the Danish Microbiology Database (Voldstedlund *et al.* 2014). Information regarding SARS-CoV-2 vaccines was obtained from the national organization for disease control and vaccines ("Statens Serum Institut"). These vaccines were provided to a majority of the participants during wave 2 and included the following types: Comirnaty® from Pfizer-BioNTech, Spikevax® from Moderna and Vaxzevria® from AstraZeneca. We did not distinguish between the brands of vaccines in the analyses. Information about children <10 years in the household was obtained from the register of relations in the household at the beginning of the calendar year of the wave, provided by the Danish Health Data Authority.

Inclusion and exclusion

Work tasks were divided into 9 categories: (i) consultations with patients or relatives within 2 m distance, (ii) physical contact with patients (e.g. treatment, examination, personal care, or patient transfer), (iii) surgical procedures or birth giving, (iv) respiratory procedures (e.g. continuous positive airway pressure, positive expiratory pressure, intubation or resuscitation), (v) transport of patients, (vi) other tasks with a distance less than 2 m, (vii) cleaning of patient room, (viii) at work but doing none of the mentioned tasks, or (ix) not at work (sick leave, day off, or working from home). We only included HCW working with tasks involving contact with patients, thus excluding HCW (ix) working from home during the data collection and those (viii) at work but doing none of the mentioned tasks. Inclusion criteria were at least one day of reporting working tasks involving contact with patients. Data on PCR tests were used to censor persons with symptoms related to COVID-19 3 days before a positive test and

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onwards. This was done as we were interested in how use of RPE caused by the pandemic influenced the risk of other types of URTI than COVID-19, which is not usually tested for, although the study was performed during the COVID-19 pandemic.

Exposure

Participants were asked about their use of PPE. We considered different types of masks, visors, and high isolation suits as RPE. We utilized a 3-day exposure window to classify the use of RPE. Given that there could be days with missing questionnaires, we only defined the exposure, if there was data for at least 1 day out of the 3-day exposure window. The RPE addressed in the questionnaires were divided into the following 8 categories: (i) high isolation suit, (ii) filtering face piece (FFP2 and FFP3) respirator, (iii) face mask (fluid resistant (type IIR) mask, mask with visor (typically type IIR), and other unspecified face masks) and (iv) visor.

We defined the exposure in 2 different ways; one focusing on RPE failure and one focusing on non-compliance with RPE guidelines (defined as deliberate non-use, where the respondents reported knowing that they had not used the recommended RPE). These 2 groupings of exposure were analyzed separately. In both exposure definitions, we defined an exposure to HCWs who had performed relevant tasks, but not reported any use of RPE; the "non-use" group.

Failure of RPE was defined as a combination of a breach in the barrier of RPE (e.g. mask or visor falling off) and damage to RPE (e.g. teared mask) during work tasks. The participants were only asked questions regarding failure if they had reported the use of any RPE during the past 24 h.

The RPE failure exposure was categorized into 3 groups: (i) days with reporting of one or more failures (named "failure"), (ii) days without reports of any failures, but reports of having performed relevant tasks, and no reporting of use of RPE (named "non-use"), and (iii) days without reporting of any failures, and with reports of having performed relevant tasks, and use of RPE (named "use").

Participants were asked whether they used the recommended PPR when they reported relevant tasks and non-compliance with PPE guidelines was defined by participants reporting that they had not used the recommended PPE during work tasks. For non-compliance with RPE guidelines we had a similar approach with categorization in 3 groups: (i) days with reporting of deliberate non-compliance (named "non-compliance"), (ii) days without reports of deliberate non-compliance, but with reports of having performed relevant tasks and no reporting of use of RPE (named "non-use") and (iii) days without reporting non-compliance, and with reports of having performed relevant tasks, and having used RPE (named 'use').

If more than one type of exposure was reported during a 3-day exposure window, then we assigned the exposure in the following, prioritized order: (i) failure/non-compliance, (ii) non-use, and (iii) use.

Outcome

We considered the presence of at least 2 of the following symptoms on a given day to define URTI: cough, sore throat, fever, and stuffy or congested nose (only wave 2) (Heikkinen and Ruuskanen 2006).

In wave 2, where vaccines were administered, we excluded symptoms reported in the first 7 days following any SARS-CoV-2 vaccine, to avoid side effects similar to the URTI symptoms. If symptoms continued after 7 days, we extended the period until zero symptoms were registered.

We excluded 14 days of reporting following a day with URTI symptoms to ensure that each infection was only counted once, as symptoms could disappear and re-appear. If symptoms continued after 14 days, we extended this period until zero symptoms were registered.

Co-variates

We divided work tasks in high-risk and low-risk work tasks. High-risk tasks were physical contact with patients (e.g. treatment, examination, personal care, or other direct physical contact with patients), surgical procedures, or assisting at birth and respiratory procedures (e.g. continuous positive airway pressure (CPAP), positive expiratory procedures (PEP), intubation, or resuscitation). Low-risk work tasks were consultation with patients or relatives within 2 m distance, transportation of patients, cleaning of patient's room, or other patient–related tasks with a distance below 2 m. Each person could report several tasks each day, but was categorized as high risk, if just one of those tasks were high risk. When failure or non-compliance with RPE guidelines occurred, participants were able to report during which procedure the failure or non-compliance occurred. If the participant did not have either type of exposure, the risk was defined based on their work task during that particular day.

Information on relevant comorbidities (yes/no to asthma, chronic obstructive pulmonary disease, or hay fever) was obtained from the initial questionnaire (wave 2 only). To account for missing data, we assumed that if respondents answered any questions in the initial questionnaire in wave 2 but did not fill out the questions on the chronic diseases of interest, then this was interpreted as if they did not have these diseases.

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Information on sex and age was derived from the civil registration number (Schmidt *et al.* 2014). Information on profession was retrieved from employee data from the Central Denmark Region and the Capital Region of Denmark. The professions of the participants were provided from the regions in the beginning of each round. Profession was categorized into the following groups: nursing staff (e.g. social- and healthcare assistants and radiographers), medical doctors, biomedical laboratory scientists, medical secretaries and other (e.g. administrative, technical, cleaning, educational staff, and therapists).

Statistical analysis

To be included in the analysis, participants should have data of both the exposure and the outcome within each analysis window. We excluded participants with insufficient questionnaire response defined as (i) only the initial questionnaire or less than 3 days with reporting, (ii) participants without relevant work tasks. Subsequently we censored days based on the following criteria (i) 3 days leading to a positive COVID-19 test and all days after, (ii) 7 days following a COVID-19 vaccination and if symptoms persisted then until the first day without symptoms, (iii) 14 days following an outcome was registered and until the first day without outcome, and (iv) days where exposure or outcome could not be determined. The censoring of days led to further participant exclusions. Demographic data is provided on individual level whereas use of RPE, failure, non-use, and non-compliance with RPE guidelines, and URTI symptoms are provided as person-days. We applied generalized linear models for the binomial family with a log link function using bootstrapping of resampling of individual (with 100 repetitions) to provide 95% confidence intervals due to the repeated measurements of exposure and URTI symptoms. We adjusted the model using a range of baseline and time dependent data. Baseline data comprised age, sex, profession, relevant comorbidity, younger children (<10 years) in the household, and region, while time dependent data comprised calendar time, and work task (high- versus low risk). All analyses were stratified by wave. We furthermore examined if there was any interaction between work tasks in relation to exposure categories by stratifying on high- versus low-risk tasks.

All data management and analyses were conducted in Stata 17.1.

Results

From the original 2 waves with 21 683/10 097 participants and 953 122/933 628 days of observation, we ended up with 12 564/5,164 persons with 202 425/122 267 person-days for analysis (Fig. 1).

Most participants were women (87.6%), nurses (55.9%), and persons who did not have children in the household (70.4%) (Table 1). Wave 1 had the most participants (70.9%), but the data collection period was longer in wave 2 and thus provided more person days for observation. Many participated in both waves (85% of those in wave 2 had participated in wave 1). Details regarding the COBRA study in general are presented in Cramer *et al.* (2023).

Table 2 shows the person-days related to the outcome and their distribution over the different types of RPE use. Both non-compliance with RPE guidelines and especially failure of RPE were rare exposures. In the first wave, HCW with relevant work tasks reported 1,066 days with failure of RPE and 15 183 days with non-compliance with RPE guidelines. On 35% of the reported days with relevant tasks, participants reported use of at least one type of RPE, whereas 58% did not report use of any RPE, despite having performed patient related tasks. In the second wave, the use of RPE increased to 93% and reports of non-use nearly disappeared (0.4%), whereas reporting non-compliance with RPE guidelines and failures was somewhat comparable to wave 1.

Table 3 shows number of days with symptoms. The majority of the participants did not report any URTI symptoms during follow-up in neither wave 1 nor 2. The number of symptoms reported in wave 2 was relatively larger than in wave 1, but please note that in wave 2, we added stuffy or congested nose as a possible category. Stuffy or congested nose was a frequent symptom, resulting in more cases being defined in wave 2. The URTI symptoms days translated to 390 persons in wave 1 and 482 persons in wave 2.

Table 4a and 4b shows the associations between RPE use, non-use, non-compliance/failure of RPE, and URTI. We found that failure of RPE was associated with an increased risk of URTI symptoms, RR: 1.65[0.53–5.14] in wave 1 and RR: 1.30[0.56–3.03] in wave 2 (Table 4a). Non-compliance with RPE guidelines in HCW performing work tasks with risk of transmission of viruses or bacteria was associated with increased risk of URTI symptoms compared to use of RPE in wave 1, RR:1.28[0.87–1.87] and in wave 2, RR: 1.39[1.01–1.91] (Table 4b). Stratification on days with low-risk tasks versus high-risk tasks, resulted in some empty cells as failure was rare in wave 1 in the low-risk tasks, whereas non-use was rare in wave 2, especially in the high-risk tasks. This implies that the increased risk of URTI related to non-use was primarily related to low-risk tasks in wave 2, whereas the increased risk related to both non-compliance to guidelines and to failure was identified in both waves, but strongest in high-risk tasks in wave 2.

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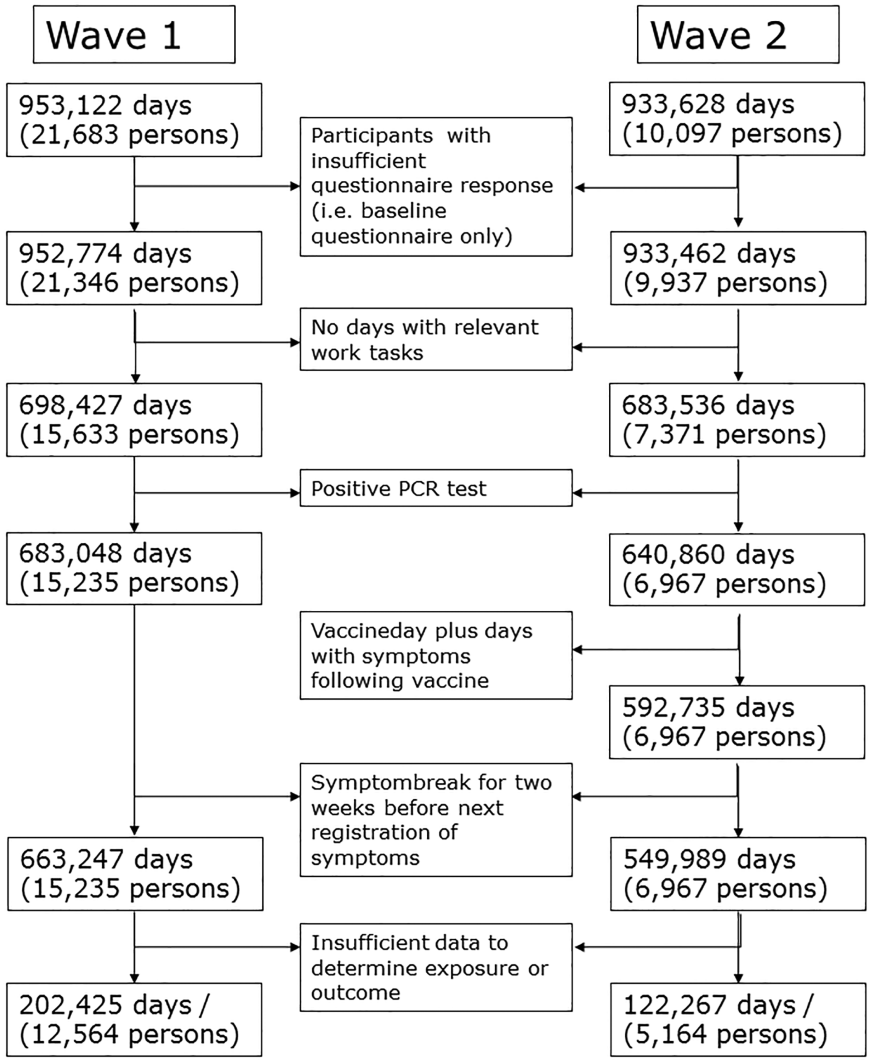

Figure 1. Flowchart with exclusions and reasons in both data collection waves (details are provided in the methods section).

Discussion

Main results

We found that both failure of RPE and non-compliance to RPE guidelines in HCW performing work tasks with risk of transmission of viruses or bacteria was associated with increased risk of non-COVID-19 URTI symptoms compared to use of RPE in wave 1 and 2, however, the associations were not all statistically significant. Non-use was comparable to use in wave 1, but in wave 2, where this was less frequent, it was associated with slightly higher risk compared to use. Risk-level of the task; as expected those reporting having performed the tasks with the highest risk, were also more prone to report symptoms if they were in one of the exposed groups, primarily in wave 2.

Strength and limitations

The major strength of this study is the prospective design with daily collection of information regarding use, failure, non-compliance, and non-use of RPE as well as UTRI symptoms. The cohort design assured that the measurement of exposure was separated from the outcome. Also, the cohort was large, covering all hospitals in 2 geographical well-defined regions in Denmark. We had access to complete data on vaccination and PCR-tests from registers. Although the participation rate was limited and there was some attrition and non-response during the data collection, many participated in both waves and all main types of healthcare professions were represented in the study (Cramer *et al.* 2023).

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Our study has some limitations. First of all, both exposure and outcome was self-reported, and for the exposure, HCWs may have had limited knowledge regarding RPE recommendations and types, especially in Wave 1. Factors influencing exposure (in terms of use, recommendations, perception of importance, and availability of RPE), changed during the study period. Especially the mandatory use of face masks in many public settings during wave 2 (established in October 2020), may have influenced both the use of RPE at work as well as the risk of infections outside work, as COVID-19 incidence in Denmark varied over time (highest during wave 2). In general, all measures targeting reducing COVID-19 in society, may have caused a decrease in URTI cases during the study.

Not only failures of RPE and non-compliance with RPE guidelines may pose a risk of infection but also inappropriate use, especially in relation to donning and duffing, and lack of knowledge of correct use may reduce the effect of the RPE. We did not include questions regarding these matters, but previous observational field studies have shown that this may be an important matter, as even HCW trained in the use of PPE, commonly make mistakes especially while donning and doffing (Kang *et al.* 2017; Suen *et al.* 2018; Baloh *et al.* 2019; Phan *et al.* 2019; McCarthy *et al.* 2020). If incorrect use was a problem in our study for those reporting that they used RPE, it may have underestimated the true effect of the use of RPE. In the situation where newly established COVID-19 units as well as other units were treating COVID-19 patients, many members of the staff had to learn the correct use of RPE and be familiar with the recommendations. The

Table 1. Participants and demographic information.

	Mean	SD
Age at entry in study	46	11.4
	Frequency	Percent
Sex		
Male	2,200	12.4
Female	15 528	87.6
Job		
Biomedical lab scientists	876	4.9
Medical doctors	2,462	13.9
Nursing staff	9,913	55.9
Medical secretaries	689	3.9
Other	3,788	21.4
Wave		
1	12 564	70.9
2*	5,164	29.1
Children (<10 years) in the household		
No children in the household	12 479	70.4
Children in the household	5,249	29.6
Region		
Capital	7,219	40.7
Central	10 509	59.3

*85.1% of responders in wave 2 also responded in wave 1.

Table 2. Groups of exposure (failure and non-compliance) in person-days in the 2 waves.

	Wave 1		Wave 2	
	Days	Percent	Days	Percent
Failure of RPE				
Use of RPE	76 330	38.8%	117 525	98.7%
Non-use of RPE	119 461	60.7%	639	0.5%
Failure of RPE	1,066	0.5%	940	0.8%
Other exposure than failure	5,568		3,163	
	Wave 1		**Wave 2**	
	Days	**Percent**	**Days**	**Percent**
Non-compliance				
Use of RPE	69 920	34.6%	113 594	93.1%
Non-use of RPE	117 072	57.9%	532	0.4%
Non-compliance	15 183	7.5%	7,880	6.5%
Other exposure than non-use	250		261	

Observation days does not match since reporting a failure require having used RPE, whereas non-compliance does not.
Other exposure: 2 exposures may occur at the same time.

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hospitals quality departments established education and introduction, but whether this was sufficient and attended by all staff is unknown. We did not distinguish between the different types of RPE, although they provide very different protection, where the surgical mask and visors provided less protection compared to a self-filtering mask (FFP2 and FFP3). Some would use different types of RPE during the workday, some would use both visor and face mask, while others may not have been able to name the type and thus provided the answer 'mask of unknown type' in the daily questionnaire. This could especially be the case for HCWs from departments that does not usually use RPE, and more common in wave 1 than wave2. This may cause information problems regarding the type of RPE, but not regarding failure, non-compliance, and non-use, which was the main exposures in this study.

The respondents did not report their perception of the severity of the failures. Thus, a possible failure could be the elastic band on a mask getting loose while donning, where the mask could easily be replaced, while the similar situation could be defined as high risk, if it happened while caring for the patient. Furthermore, we did not have information on the time used with RPE versus without and the relation between use of specific RPE and specific tasks, so a registration of use of RPE may not necessarily cover the whole workday and is not necessarily worn during the work task with the highest risk of infection. The possible parallel exposure outside the given work tasks was unknown, i.e., having a break with colleagues, being close to others outside work in the household, or other activities during time off. This may influence our estimates as a study has shown that many HCW were infected

Table 3. Number of person days with reported symptoms.

	Wave 1	Wave 2
Number of symptoms		
0	187 226	111 153
1	9,225	7,396
2	387	509
3	19	41
4	-*	5

*In wave 2, the maximum number of possible symptoms was 4 as compared to 3 in wave 1.

Table 4a. Associations among RPE use, non-use, and RPE failure and symptoms of upper respiratory tract infections.

	Wave 1				Wave 2			
	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR -high-risk tasks	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR -high-risk tasks
Use of RPE (reference)	1	1	1	1	1	1	1	1
Non-use of RPE	0.94 (0.75 1.16)	0.94 (0.74 1.20)	1.19 (0.64 2.21)	0.90 (0.73 1.11)	1.35 (0.41 4.51)	1.31 (0.46 3.75)	1.86 (0.60 5.77)	(insufficient data)
Failure of RPE	1.76 (0.59 5.26)	1.65 (0.53 5.14)	(insufficient data)	1.71 (0.53 5.52)	1.61 (0.63 4.11)	1.30 (0.56 3.03)	(Insufficient data)	1.59 (0.71 3.55)

Table 4b. Associations between RPE use, non-use, and non-compliance and symptoms of upper respiratory tract infections.

	Wave 1				Wave 2			
	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR-high-risk tasks	Unadjusted RR	Adjusted RR	Adj. RR-low-risk tasks	Adj. RR-high-risk tasks
Use of RPE (reference)	1	1	1	1	1	1	1	1
Non-use of RPE	0.94 (0.76 1.18)	0.95 (0.78 1.16)	1.10 (0.54 2.25)	0.91 (0.72 1.13)	1.24 (0.35 4.32)	1.25 (0.41 3.83)	1.71 (0.53 5.58)	(Insufficient data)
Non-compliance	1.37 (1.02 1.84)	1.28 (0.87 1.87)	1.85 (0.68 5.07)	1.20 (0.82 1.76)	1.56 (1.12 2.18)	1.39 (1.01 1.91)	0.98 (0.53 1.83)	1.52 (1.03 2.26)

Adjusted: children in the household, gender, age, profession, region and calendar time (and in wave 2 also chronic disease).
Low-risk tasks: consultations with patients or relatives within 2 m distance, transport of patients, cleaning of patients room or other tasks with a distance below 2 m.
High-risk tasks: physical contact with patients (e.g. treatment, examination, personal care, or patient transfer), surgical procedures or birth giving and respiratory procedures.

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outside work (Würtz *et al.* 2022). On the same note, we do not have information about the HCW habits in relation to the use of face masks in public, which was mandatory in most indoor public settings in Denmark during wave 2. It is possible that those reluctant to the use of RPE in relation to work task, may also be less likely to use masks in public.

We considered missing information on exposure data as if the person had not experienced any failure or non-compliance that day, as respondents would be highly motivated to report failures and non-compliance and thus with low-risk of recall bias. Missing data was most likely also related to days off, especially weekends, where no failures could occur. Missing data on the reporting of use of RPE was also possible if the respondent did not make the effort to report the details regarding RPE despite having answered the previous questions. For that reason, we divided the data in those who reported not having used RPE (non-compliance) and those who did not report it (non-use). This categorization was applied in both the analyses concerning failure and the analyses concerning non-compliance.

Missing data on the outcome is more complex, since participation and thus reporting of URTI symptoms may decrease as severity of symptoms increase. In this case, we could only rely on the motivation from the participants to participate and report the relevant symptoms. Also, we cannot rule out that some of the symptoms were due to COVID-19 infection, for persons not tested, but since this was probably not related to the exposure, it may cause only non-differential misclassification and thus cause bias towards the null. Also, false negative tests may be a problem to our study, since we aimed to study non-Covid-19 symptoms. On the other hand, the false negative tests are most likely evenly distributed over the exposure groups, and may thus underestimate the true associations.

Another possible limitation is confounding by indication, if those performing the highest risk tasks (higher than our rather rough categorization) were more likely to use RPE and to use it for a longer duration than others. We could not register this in the questionnaires, as they would have become extremely complex to answer, but we tried to accommodate this by adjusting for both work task and profession. Although we did have information regarding the department where each HCW were employed, we did not have sufficient statistical power to include this information.

Interpretation

Our results were in line with the findings in the systematic review from Tran *et al.* (2021), however, we did not distinguish between types of masks and we did not conduct a randomized, controlled trial, but examined the use in a real-life large-scale observational study. We have not identified other studies examining the effect of RPE in relation to URTI during the COVID-19 pandemic, although this was a golden opportunity to study this in a real-life setting. However, a Chinese survey among HCW during the 2009 H1N1 influenza found low knowledge and compliance with PPE guidelines, even though many had received training (Hu *et al.* 2012). We were also surprised by the low compliance, especially in wave 1 as only few reported that RPE was unavailable as a reason for non-compliance when our data collection took place (Cramer *et al.* 2023).

Generalizability

The study findings can be generalized with caution, as the situation during the COVID-19 pandemic included a range of other measures to prevent SARS-CoV-2 infections, that may have influenced the general exposure to other viruses and bacteria causing URTI. The preventive measures in society were for example increased focus on hand hygiene and social distancing, use of face masks in public, as well as different types of lockdowns, that may have reduced other types of infections as well (Nielsen *et al.* 2022). However, this study was also conducted in a setting where close contacts to patients continued, and thus the effect of RPE could be studied, also for future use in periods without general preventive measures, and thus generalizable to other settings in healthcare.

Conclusion

Failures of RPE and non-compliance with RPE guidelines may increase the risk of URTI, compared to those who reported use of RPE as recommended. The implications of these findings are that the use of RPE to prevent URTI could be considered, especially while performing high-risk tasks where other prevention strategies are not possible.

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Conflict of Interest

The authors declare no conflict of interest

Ethics

The study was approved by the Central Denmark Region, Data protection office (ref. number: 684166) and the Capital Region, Data protection office (ref.

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number: P-2020-455). The Regional Scientific Ethics Committee of the Capital Denmark Region concluded that this study did not require scientific ethical approval (H-20027931). All participants gave informed consent before answering the first questionnaire and could withdraw at any time during the study.

Data Availability

Questionnaire data was supplemented with data obtained from registers. The pseudonymized database used for the presented analyses is hosted by The Danish Health Data Authority and is not publicly available. Permission to access the database can be granted by researchers at a research institution authorized by The Danish Health Data Authority. On request, the corresponding author can assist interested researchers to gain access.

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Bilag 2: Første bølge, dokumenter

1. Invitationsmail og samtykke erklæring, Region Midt
2. Baseline spørgeskema og dagligt spørgeskema
3. Invitationsmail og samtykke erklæring. Region Hovedstaden

INVITATIONSMAIL

Invitation: Forskningsprojekt om COVID-19 blandt ansatte i Region Midtjylland

Kære medarbejder i Region Midtjylland
Formålet med dette forskningsprojekt er at finde ud af, om ansatte i Region Midtjylland er tilstrækkeligt beskyttet mod COVID-19.

Det er vigtigt, at medarbejdere både med og uden patientkontakt deltager.

Vi håber, at du dagligt vil besvare et to-minutters spørgeskema via din mobiltelefon eller computer. Hvis du siger ja til at deltage, vil vi bede om dit mobilnummer. På den måde kan du med et link på sms hurtigt besvare det daglige spørgeskema.

Du vil blive spurgt til symptomer på COVID-19, dine arbejdsopgaver og brug af værnemidler. Dine besvarelser kobles bl.a. med resultat af COVID-19-tests.

Vi beder dig og 25.000 andre ansatte på hospitaler, i psykiatrien og præhospitalet i Region Midtjylland om at deltage, uanset hvilken jobfunktion du har lige nu, også hvis du har administrativt arbejde eller arbejder hjemme. Alle data behandles fortroligt i henhold til gældende lovgivning. Der videregives ingen oplysninger om dig til din afdeling eller Region Midtjylland. Det vil ikke være muligt at identificere dine eller andre enkeltpersoners resultater i undersøgelsen.

Der er fuld opbakning til forskningsprojektet i Regionens MED-udvalg (RMU), fra regionens direktion og fra samtlige hospitalsledelser.

Læs mere om forskningsprojektet og tilmeld dig her:
https://redcap.au.dk/surveys/XXXXXXXX
OBS: Linket er kun til dig og må ikke sendes til andre. Hvis linket ikke virker, kan du kopiere det og sætte det ind i din browser.

Har du spørgsmål om forskningsprojektet kan du sende en mail til: COBRA@rm.dk eller ringe på telefonnr. 2943 5466.

Med venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

COBRA-projektet: COVID-19 Blandt Regions Ansatte i Midtjylland

SAMTYKKEERKLÆRING

Velkommen til forskningsprojektet COBRA om COVID-19 og arbejde i Region Midtjylland.

Dato _____

FORMÅL
Formålet er at finde ud af, om ansatte i Region Midtjylland i deres arbejde er tilstrækkeligt beskyttet mod at blive smittet med COVID-19.

Resultaterne skal ruste Region Midtjylland endnu bedre til en næste bølge af COVID-19 og andre epidemier.

OM FORSKNINGSPROJEKTET
Hvis du deltager, vil du hver dag til og med 30. juni 2020 modtage en sms med link til et spørgeskema, som tager ca. to minutter at besvare. Sms'en kommer ca. kl. 15.30, og du skal svare indenfor 24 timer.

Det er vigtigt for projektet, at der kommer besvarelser fra medarbejdere både med og uden patientkontakt. Derfor beder vi dig om at deltage, uanset hvilken jobfunktion du har lige nu, også hvis du har administrativt arbejde, arbejder hjemme eller ikke har været på arbejde. Er du forhindret i at svare en dag, gør det ikke noget, at du springer den over.

Forskningsprojektet udføres af Arbejdsmedicin ved Aarhus Universitetshospital og Hospitalsenheden Vest i samarbejde med Aarhus Universitet. Professor Henrik Kolstad er projektansvarlig.

Det er frivilligt at deltage i projektet. For at deltage er det nødvendigt, at du giver dit samtykke. Du vil modtage en kopi af samtykket på din regions-mail. Du kan til enhver tid trække dit samtykke tilbage ved at sende en mail til COBRA@rm.dk.

Vi vil koble dine spørgeskemabesvarelser med resultat af eventuel COVID-19 test fra Sundhedsdatastyrelsen. Vi vil også indhente oplysninger om din ansættelse fra Region Midtjyllands lønsystemer, din brug af lægemidler og hospitalsdiagnoser af betydning for COVID-19 fra Lægemiddelstatistikregisteret og Landspatientregisteret. Der vil kun blive indhentet nødvendige og relevante oplysninger.

Alle data behandles fortroligt i henhold til gældende lovgivning. Region Midtjylland er dataansvarlig. Kobling med registerdata finder sted hos Sundhedsdatastyrelsen, hvor forskerne kun har adgang til pseudonymiserede data og hvor data vil blive samlet med tilsvarende forskningsprojekter i andre danske regioner. Der videregives ingen oplysninger om dig til din afdeling eller Region Midtjylland. Det vil ikke være muligt at identificere dine eller andre enkeltpersoners data i undersøgelsens resultater.

Med venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest
COBRA-projektet: COvid-19 Blandt RegionsAnsatte

SAMTYKKE
Jeg giver hermed mit samtykke til deltagelse, herunder at Region Midtjylland behandler personoplysninger om mig til brug for dette forskningsprojekt.

Jeg er orienteret om, at jeg til enhver tid kan trække mit samtykke til behandling af mine personoplysninger tilbage.

◯ Jeg er indforstået og ønsker at deltage

MOBILNUMMER
Vi har brug for dit mobilnummer for at kunne sende dig link til de daglige spørgsmål. Hvis du ikke oplyser dit mobilnummer, får du linket tilsendt på din regions-mail. Det anbefaler vi dog ikke, da du så skal have adgang til din arbejdsmail efter 15:30 for at kunne besvare.
Når projektet afsluttes 30. juni 2020, sletter vi dit mobilnummer.

_____
(Indtast mobilnummer)

_____

MAIL MED KOPI AF SAMTYKKE

Kent Jacob Nielsen

Fra: redcap@clin.au.dk
Sendt: 22. april 2020 09:38
Til: Kent Jacob Nielsen
Emne: Kopi af samtykke til deltagelse i COBRA-projektet

Kære medarbejder i Region Midtjylland

Vi er rigtig glade for, at du vil deltage i projektet om COVID-19 blandt regionsansatte i Region Midtjylland.

Vedhæftet er en kopi af dit samtykke til deltagelse.

Undersøgelsen kører frem til 30. juni.

Hvis du har spørgsmål, så kan de sendes til COBRA@rm.dk eller du kan ringe til os på 2943-5466 hver dag fra kl. 7-19.

Med venlig hilsen

Henrik Kolstad, Professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, Seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

COBRA-projektet: **CO**vid-19 **B**landt **R**egions**A**nsatte

Oplysningspligten
Når vi håndterer oplysninger om dig, har vi en oplysningspligt. Du kan læse mere om hvordan vi behandler dine oplysninger via dette link:
http://intranet.rm.dk/organisation/Informationssikkerhed/databeskyttelsesforordning/rettigheder-og-pligter/oplysningspligt-til-borgere/

COvid-19 Blandt RegionsAnsatte (COBRA)

DET FØRSTE SPØRGESKEMA

Disse spørgsmål handler om symptomer siden midten af februar.

De skal kun besvares denne ene gang.

Har du haft ét eller flere af følgende symptomer i mindst 4 dage i træk siden midten af februar?	☐ Hoste ☐ Ondt i halsen ☐ Hovedpine ☐ Muskelømhed ☐ Feber ☐ Åndenød ☐ Nedsat eller manglende smags- og lugtesans ☐ Jeg har ikke haft nogen af symptomerne
Kontaktede du din praktiserende læge eller lægevagten på grund af disse symptomer?	◯ Nej ◯ Ja
Har andre i din husstand haft hoste, ondt i halsen, hovedpine, muskelømhed, feber, åndenød eller nedsat smags- og lugtesans i mindst 4 dage i træk siden midten af februar?	◯ Nej ◯ Ja ◯ Ved ikke
Er du ryger?	◯ Ja ◯ Nej - men jeg har tidligere røget ◯ Nej - jeg har aldrig røget

COvid-19 Blandt RegionsAnsatte (COBRA)

DET DAGLIGE SPØRGESKEMA

OBS: Spg1-3 er de eneste faste, som alle får. Resten afhænger af, hvilke svar der angives.

Disse spørgsmål handler om symptomer, arbejdsopgaver og evt. brug af værnemidler i de seneste 24 timer og skal besvares daglig til og med 30. juni

---

1 Har du haft ét eller flere af følgende symptomer i løbet af de seneste 24 timer? (afkryds gerne flere felter)

- ☐ Hoste
- ☐ Ondt i halsen
- ☐ Hovedpine
- ☐ Muskelømhed
- ☐ Feber
- ☐ Åndenød
- ☐ Nedsat eller manglende smags- og lugtesans
- ☐ Jeg har ikke haft nogen af symptomerne

1a Har du indenfor de seneste 24 timer kontaktet din praktiserende læge eller lægevagten på grund af disse symptomer?

- ◯ Nej
- ◯ Ja

---

2 Har andre i din husstand haft hoste, ondt i halsen, hovedpine, muskelømhed, feber, åndenød eller nedsat smags- og lugtesans i løbet af de seneste 24 timer?

- ◯ Nej
- ◯ Ja
- ◯ Ved ikke

---

3 Har du i de seneste 24 timer udført nogen af følgende arbejdsopgaver? (afkryds gerne flere felter)

- ☐ Fri/syg/hjemmearbejde de sidste 24 timer
- ☐ Samtaler med patienter eller pårørende med en afstand under 2 meter
- ☐ Fysisk patientkontakt (fx behandling, undersøgelse, personlig pleje, forflytning)
- ☐ Kirurgiske indgreb eller fødsler
- ☐ Procedurer i luftvejene (fx CPAP, PEP-fløjte, intubation eller genoplivning)
- ☐ Patienttransport
- ☐ Andre opgaver med nærhed under 2 meter til patienter eller pårørende
- ☐ Klargøring af patientstue eller rengøring
- ☐ Jeg har været på arbejde, men ikke udført nogen af de nævnte opgaver

---

4 Har du ved udførelsen af dine arbejdsopgaver de seneste 24 timer været i kontakt med personer, der enten var mistænkt for at have COVID-19 eller var testet positiv for COVID-19?

- ☐ Nej
- ☐ Ja, personer testet positiv for COVID-19
- ☐ Ja, personer med mistanke om COVID-19
- ☐ Ved ikke

---

5 Hvilke værnemidler har du anvendt de seneste 24 timer? (afkryds gerne flere felter)

- ☐ Jeg har ikke anvendt værnemidler
- ☐ Handsker
- ☐ Overtrækskittel med ærmer
- ☐ Plastforklæde
- ☐ Højisolationsdragt
- ☐ Maske kirurgisk/type IIR
- ☐ Maske - type FFP2
- ☐ Maske - type FFP3
- ☐ Maske - ukendt type
- ☐ Visir
- ☐ Mundbind med visir
- ☐ Beskyttelsesbriller
- ☐ Andre værnemidler

Hvilke værnemidler drejede det sig om?

_____

5a Har der været uheld med dine værnemidler i de seneste 24 timer?
(fx hul i handske, tabt visir eller maske)

- ◯ Nej
- ◯ Ja
- ◯ Ved ikke

5b Hvilke værnemidler skete uheldet med ? (afkryds gerne flere)

- ◯ Handsker
- ◯ Overtrækskittel med ærmer
- ◯ Plastforklæde
- ◯ Højisolationsdragt
- ◯ Maske kirurgisk/type IIR
- ◯ Maske - type FFP2
- ◯ Maske - type FFP3
- ◯ Maske - ukendt type
- ◯ Visir
- ◯ Mundbind med visir
- ◯ Beskyttelsesbriller
- ◯ Andre værnemidler

Hvilke værnemidler drejede det sig om? _____

5c Ved hvilke arbejdsopgaver skete uheldet med dine værnemidler? (afkryds gerne flere)

- ◯ Samtaler med patienter eller pårørende med en afstand under 2 meter
- ◯ Fysisk patientkontakt (fx behandling, undersøgelse, personlig pleje, forflytning)
- ◯ Kirurgiske indgreb eller fødsler
- ◯ Procedurer i luftvejene (fx CPAP, PEP-fløjte, intubation eller genoplivning)
- ◯ Patienttransport
- ◯ Andre opgaver med nærhed under 2 meter til patienter eller pårørende
- ◯ Klargøring af patientstue eller rengøring

		◯ Det var en anden arbejdsopgave
	Skriv hvilken arbejdsopgave det var, uheldet med dine værnemidler skete ved:	_____
	Beskriv evt. hvordan uheldet skete:	_____
5d	Skete uheldet med dine værnemidler ved en arbejdsopgave med personer, der enten var mistænkt for at have COVID-19 eller var testet positiv for COVID-19?	☐ Nej ☐ Ja, personer testet positiv for COVID-19 ☐ Ja, personer med mistanke om COVID-19 ☐ Ved ikke
6	Har der i de seneste 24 timer været situationer, hvor du ikke har anvendt de anbefalede værnemidler?	◯ Nej ◯ Ja ◯ Ved ikke
	Hvad er årsagen til, at du ikke ved, om du har anvendt de anbefalede værnemidler?	_____
6a	Hvilke værnemidler var der tale om? (afkryds gerne flere felter)	☐ Handsker ☐ Overtrækskittel med ærmer ☐ Plastforklæde ☐ Højisolationsdragt ☐ Maske kirurgisk/type IIR ☐ Maske - type FFP2 ☐ Maske - type FFP3 ☐ Maske - ukendt type ☐ Visir ☐ Mundbind med visir ☐ Beskyttelsesbriller ☐ Andre værnemidler
	Hvilke værnemidler drejede det sig om?	_____
6b	Ved hvilke arbejdsopgaver anvendte du ikke de anbefalede værnemidler? (afkryds gerne flere)	
		◯ Samtaler med patienter eller pårørende med en afstand under 2 meter
		◯ Fysisk patientkontakt (fx behandling, undersøgelse, personlig pleje, forflytning)
		◯ Kirurgiske indgreb eller fødsler
		◯ Procedurer i luftvejene (fx CPAP, PEP-fløjte, intubation eller genoplivning)
		◯ Patienttransport
		◯ Andre opgaver med nærhed under 2 meter til patienter eller pårørende

		◯ Klargøring af patientstue eller rengøring
		◯ Det var en anden arbejdsopgave
	Skriv hvilken arbejdsopgave det var, du ikke anvendte de anbefalede værnemidler ved:	_____
6c	Arbejdede du med personer, der enten var mistænkt for at have COVID-19 eller var testet positiv for COVID-19, da du ikke anvendte de anbefalede værnemidler?	☐ Nej ☐ Ja, personer testet positiv for COVID-19 ☐ Ja, personer med mistanke om COVID-19 ☐ Ved ikke
6d	Hvad var grunden til, at du ikke anvendte de anbefalede værnemidler? (afkryds gerne flere felter)	☐ Jeg glemte det ☐ Værnemidlerne var ikke til rådighed ☐ Kunne ikke nå det/Havde ikke tid ☐ For at spare på værnemidler ☐ Jeg var ikke opmærksom på/klar over, at jeg skulle anvende værnemidler ☐ Anden årsag
	Hvad var årsagen til, at du ikke anvendte de anbefalede værnemidler:	_____
	Vi sætter stor pris på din deltagelse. Du vil modtage et skema dagligt frem til 30. juni. Ønsker du på nuværende tidspunkt at stoppe i undersøgelsen, så angiv det her.	◯ Jeg ønsker at stoppe i undersøgelsen nu
	Vi vil gerne være helt sikre på, at du gerne vil stoppe i undersøgelsen, så bekræft dit svar her	◯ Ja, jeg ønsker at stoppe i undersøgelsen nu ◯ Nej, jeg ønsker ikke at stoppe i undersøgelsen
	Vi har registreret dit stop, og du vil ikke få flere sms'er. Vi er kede af, at du stopper og håber, at du vil fortælle os hvorfor	☐ Det tager for lang tid at svare ☐ Det er for meget at skulle svare hver dag ☐ Spørgsmålene er ikke relevante for mig ☐ Jeg arbejder ikke længere i Region Midtjylland ☐ Andet
	Skriv gerne hvad årsagen til at du ønsker at stoppe er:	_____

Invitation: Forskningsprojekt om brug af værnemidler og smitte med COVID-19 blandt ansatte i Region Hovedstaden

Kære kollega
Formålet med dette forskningsprojekt er at finde ud af, om ansatte i Region Hovedstaden i deres arbejde er tilstrækkeligt beskyttede mod at blive smittet med COVID-19.

Hvorfor?
Med den igangværende pandemi har vi et akut behov for vished om, at vores hygiejniske forholdsregler og værnemidler er tilstrækkelige. Ny viden om risikofaktorer er afgørende for at kunne minimere arbejdsrelateret COVID-19 smitte og sygdom.

Vi har brug for dig
Vi beder dig og 35.000 andre ansatte på hospitaler og i distriktspsykiatrien i Region Hovedstaden om at deltage. Vi har brug for dig, uanset hvilken jobfunktion du har lige nu, også hvis du har administrativt arbejde eller arbejder hjemme. Vi beder dig også deltage, selv om du tidligere har fået konstateret COVID-19.

Der er fuld opbakning til forskningsprojektet i Regionens direktion og MED-udvalg.

Hvordan?
Vi håber, at du dagligt vil besvare et to-minutters spørgeskema via din mobiltelefon eller computer. Hvis du siger ja til at deltage, vil vi bede om dit mobilnummer. På den måde kan du med et link på sms hurtigt besvare det daglige spørgeskema. Du vil blive spurgt til symptomer på COVID-19, dine arbejdsopgaver og brug af værnemidler.

Hvis du har flere aktive mailadresser, får du denne invitation flere gange. Det beklager vi. Du behøver kun at tilmelde dig en enkelt gang, og når vi har dit mobilnummer vil al fremtidig kommunikation foregå via sms.

Læs mere om forskningsprojektet og tilmeld dig her: link
OBS: Linket er kun til dig og må ikke sendes til andre. Hvis linket ikke virker, kan du kopiere det ind i din browser: survey_url.

Har du spørgsmål om forskningsprojektet, kan du finde de fleste svar i vores FAQ. Du kan også sende en mail til: bfh-fp-cobra@regionh.dk eller ringe på telefonnummer 23 35 58 85 hverdage kl. 9-17 og weekender kl. 14-17.

Venlig hilsen

Professor og overlæge Susanne Wulff Svendsen og biostatistiker Esben Meulengracht Flachs
Arbejds- og Miljømedicinsk Afdeling, Bispebjerg og Frederiksberg Hospital

COBRA-projektet: **CO**VID-19 **B**landt **R**egions**A**nsatte i Hovedstaden

Information om og samtykke til forskningsprojekt om COVID-19 blandt ansatte i Region Hovedstaden

Om projektet
Formålet er at finde ud af, om ansatte i Region Hovedstaden i deres arbejde er tilstrækkeligt beskyttede mod at blive smittet med COVID-19. Resultaterne fra undersøgelsen skal være med til at sikre et forsvarligt arbejdsmiljø for alle i det danske sundhedsvæsen under den igangværende pandemi.

Hvis du svarer ja til at deltage, vil du hver dag til og med d. 30. juni 2020 modtage en sms med et link til et spørgeskema, som tager ca. to minutter at besvare. Spørgeskemaet sendes hver dag ca. kl. 15.30, og du skal svare inden for 24 timer. Får du ikke svaret en dag, kan du sagtens genoptage din deltagelse næste dag.
Det er vigtigt for projektet, at der kommer besvarelser fra både medarbejdere med patientkontakt og medarbejdere uden patientkontakt. Vi beder dig også svare, selvom du nogle dage ikke har været på din arbejdsplads.

Undersøgelsen udføres af Arbejds- og Miljømedicinsk Afdeling, Bispebjerg og Frederiksberg Hospital. Professor og overlæge Susanne Wulff Svendsen er projektansvarlig.

Samtykke
Det er frivilligt at deltage i undersøgelsen, og du kan til enhver tid trække dit samtykke tilbage ved at sende en mail til bfh-fp-cobra@regionh.dk.

Vi beder dig om tilladelse til at koble dine spørgeskemabesvarelser med oplysninger om din arbejdstid fra Regionens HR-afdeling, resultat af COVID-19-test fra Sundhedsdatastyrelsens registre samt oplysninger om kronisk somatisk sygdom (Landspatientsregisteret), husstandsoplysninger (CPR-registeret) og behandling med immunsupprimerende, anti-inflammatoriske og blodtrykssænkende lægemidler (Lægemiddelstatistikregisteret). Der vil kun blive indhentet nødvendige og relevante oplysninger.

Datasikkerhed
Region Hovedstaden er dataansvarlig. De indsamlede oplysninger behandles fortroligt og der videregives ingen oplysninger om dig til Region Hovedstaden eller andre uden for projektgruppen. Kobling med registerdata og tilsvarende projekter fra andre regioner finder sted hos Sundhedsdatastyrelsen, hvor forskerne kun har adgang til pseudonymiserede data, så det ikke vil være muligt at identificere enkeltpersoner.

Erklæring fra deltager
Jeg giver hermed mit samtykke til deltagelse, herunder at Region Hovedstaden behandler personoplysninger om mig til brug for dette forskningsprojekt. Jeg er orienteret om, at jeg til enhver tid kan trække mit samtykke til behandling af mine personoplysninger tilbage ved at sende en mail til bfh-fp-cobra@regionh.dk.

Jeg giver samtykke til at deltage i forskningsprojektet.
□ (Sæt kryds)

Mobilnummer
Vi har brug for dit mobilnummer for at kunne sende dig link til de daglige spørgsmål. Hvis du ikke oplyser dit mobilnummer, får du linket tilsendt på mail. Når projektet afsluttes d. 30. juni 2020, sletter vi dit mobilnummer.

Mobilnummer_____

Venlig hilsen

Professor og overlæge Susanne Wulff Svendsen og biostatistiker Esben Meulengracht Flachs
Arbejds- og Miljømedicinsk Afdeling
Bispebjerg og Frederiksberg Hospital

COBRA-projektet: **CO**VID-19 **B**landt **R**egions**A**nsatte i Hovedstaden

Oplysningspligten i medfør af Databeskyttelsesforordningens artikel 13 (når oplysningerne er indsamlet hos den registrerede) i forbindelse med COBRA projektet (**CO**vid-19 **B**landt **R**egions**A**nsatte) ved Arbejds- og Miljømedicinsk Afdeling, Bispebjerg og Fredriksberg Hospital, forår og sommer 2020.

1. Kontaktoplysninger på den dataansvarlige og den primærprojektansvarlige

Region Hovedstaden er dataansvarlig for behandlingen af de personoplysninger, som vi har modtaget om dig. Du finder vores kontaktoplysninger nedenfor:

Region Hovedstaden/v. Videnscenter for Dataanmeldelser
Blegdamsvej 9
2100 København Ø
Mail: videnscenterfordataanmeldelser.rigshospitalet@regionh.dk

Den primærprojektansvarlige er den person, som er ansvarlig for udførelsen af det projekt, som du deltager i. Du finder kontaktoplysninger på vedkommende nedenfor:

Susanne Wulff Svendsen
Arbejds- og Miljømedicinsk Afdeling, Bispebjerg Hospital
Telefon: 23 35 58 85
Email: bfh-fp-cobra@regionh.dk

2. Kontaktoplysninger på databeskyttelsesrådgiveren

Hvis du har spørgsmål til vores behandling af dine oplysninger, er du altid velkommen til at kontakte vores databeskyttelsesrådgiver.

Du kan kontakte vores databeskyttelsesrådgiver på følgende link:
https://www.regionh.dk/kontakt/henvendelser/Sider/Kontakt-Region-Hovedstadens-databeskyttelsesraadgiver-(DPO).aspx

Vi vil altid anbefale, at du anvender den sikreste løsning som er E-boks. Det skyldes, at mails såsom hotmail, gmail, yahoo eller lignende ikke har den tilstrækkelige kryptering og sikkerhed.

3. Formålene og retsgrundlaget for behandlingen af dine personoplysninger

Vi behandler dine personoplysninger til følgende formål:

- Med den igangværende pandemi med COVID-19 har vi et akut behov for vished om, at vores hygiejniske forholdsregler og værnemidler er tilstrækkelige. Ny viden om risikofaktorer er afgørende for at kunne minimere arbejdsrelateret COVID-19 smitte og sygdom. Formålet med dette forskningsprojekt er at finde ud af, om ansatte i Region Hovedstaden i deres arbejde er tilstrækkeligt beskyttede mod at blive smittet med COVID-19.

Retsgrundlaget for vores behandling af dine personoplysninger følger af:

- Databeskyttelsesforordningens artikel 6 og artikel 9.

4. Kategorier af personoplysninger og datakilder

Vi behandler følgende kategorier af personoplysninger om dig:

- Personlige oplysninger (personnummer, tjenestenummer, mailadresse, køn, alder, anciennitet, afdeling, komme-gåtid fra 1.1-2020-30.6.2020 fra HR i Region Hovedstaden efter tilladelse fra Region Hovedstadens direktion og Regionale Medarbejderudvalg (RMU) samt mobilnummer oplyst af dig selv)
- COVID testresultater og oplysning om kronisk sygdom (hjertekar-, lunge-, kræft-, nyre-, lever og blodsygdomme, diabetes, sklerose, svær overvægt, gigtlidelser samt muskelsygdomme med nedsat evne til at hoste sekret op) fra Sundhedsdatastyrelsen
- Behandling med immunsupprimerende, antiinflammatoriske og blodtrykssænkende midler fra Lægemiddelstatistikregisteret
- Medlemmer af husstanden fra personnummerregisteret

5. Ekstern databehandler

Compaya A/S, er ekstern databehandler, som får tilsendt det mobilnummer, du har oplyst til projektet og på basis heraf dagligt i projektperioden udsender SMS med link til spørgeskemaer. Compaya A/S får ikke indsigt i spørgeskemabesvarelser.

Kontaktperson: Martin Schrøder
Adresse: Palægade 4, 2. tv, 1261 København K
Telefonnummer: +45 8838 9000

6. Opbevaring af dine personoplysninger

Mobilnumre slettes ved udgangen af juni måned. Øvrige pseudonymiserede data opbevares i Sundhedsdatastyrelsens forskermaskine til senest udgangen af 2025.

7. Retten til at trække samtykket tilbage

Du har til enhver tid ret til at trække dit samtykke tilbage. Dette kan du gøre ved at kontakte os på de kontaktoplysninger, der fremgår ovenfor i punkt 1.

Hvis du vælger at trække dit samtykke tilbage, påvirker det ikke lovligheden af vores behandling af dine personoplysninger på baggrund af dit tidligere meddelte samtykke og op til tidspunktet for tilbagetrækningen. Hvis du tilbagetrækker dit samtykke, har det derfor først virkning fra dette tidspunkt.

8. Dine rettigheder

Du har efter databeskyttelsesforordningen en række rettigheder i forhold til vores behandling af oplysninger om dig.

Hvis du vil gøre brug af dine rettigheder skal du kontakte den projektansvarlige.

Ret til sletning

Der gælder særlige regler for statistiske og videnskabelige undersøgelser, herunder forskning jf. databeskyttelsesforordningens artikel 17, stk. 3, litra d. Det betyder, at vi forsat gerne må opbevare og anvende de data, som vi allerede har behandlet på dig. Men al fremtidig behandling af dataene vil blive indstillet. Såfremt du beder om at få dine data slettet, får du en bekræftelse på, at vi indstiller behandlingen af disse.

Ret til at transmittere oplysninger (dataportabilitet)

Du har i visse tilfælde ret til at modtage dine personoplysninger i et struktureret, almindeligt anvendt og maskinlæsbart format samt at få overført disse personoplysninger fra én dataansvarlig til en anden uden hindring.

Nogle rettigheder er undtaget i forbindelse med statistiske og videnskabelige undersøgelser, herunder forskning

Du kan læse mere om dine rettigheder i Datatilsynets vejledning om de registreredes rettigheder, som du finder på www.datatilsynet.dk.

For en god ordens skyld vil vi bemærke, at en række rettigheder er undtaget i medfør af Databeskyttelseslovens § 22, stk. 5. Det er Databeskyttelsesforordningens artikel 15 (Indsigtsret), artikel 16 (Ret til berigtigelse), artikel 18 (Ret til begrænsning af behandling) og artikel 21 (Indsigelsesret). Det skyldes, at alle forskningsprojekter i Region Hovedstaden er undersøgelser, der foretages i statistiske eller videnskabelige øjemed af væsentlig samfundsmæssig betydning, hvor databehandlingen er nødvendig af hensyn til undersøgelsen jf. artikel 89 i Databeskyttelsesforordningen.

9. Klage til Datatilsynet

Du har ret til at indgive en klage til Datatilsynet, hvis du er utilfreds med den måde, vi behandler dine personoplysninger på. Du kan finde Datatilsynets kontaktoplysninger her:

https://www.datatilsynet.dk/kontakt/

Projekt COBRA

- **CO**VID-19 **B**landt **R**egions **A**nsatte i Hovedstaden

Under den igangværende pandemi er mange hospitalsansatte i risiko for COVID-19 smitte under udførelse af deres arbejde. En ny spørgeskemaundersøgelse skal være med til at afklare, om ansatte i Region Hovedstaden er tilstrækkeligt beskyttede.

Projektets formål

Det er vigtigt, at alle ansatte i Region Hovedstaden kan tilbydes et sundt og sikkert arbejdsmiljø. Formålet med denne undersøgelse er derfor at afklare, om vores nuværende hygiejnemæssige forholdsregler og værnemidler yder tilstrækkelig beskyttelse mod arbejdsrelateret smitte med COVID-19.

I det omfang konkrete risikofaktorer for smittespredning identificeres, vil undersøgelsen desuden kunne medvirke til at målrette forebyggelsesindsatsen både i forhold til COVID-19 og andre smitsomme sygdomme inden for hospitalsvæsenet.

Ansatte i Region Hovedstaden inviteres

Vi inviterer godt 35.000 ansatte i Region Hovedstaden til at deltage i undersøgelsen. Vi har brug for din deltagelse - uanset om du har patientkontakt eller ej.

Fakta om deltagelse

- Ansatte inviteres via deres Region-H mail.
- Deltagere vil dagligt blive bedt om at besvare et 2 minutters spørgeskema enten via sms på mobiltelefon eller via mail på computer. Spørgeskemaet sendes ud hver dag kl. 15.30 og kan besvares inden for 24 timer. Spørgsmålene omhandler eventuelle symptomer på COVID-19, arbejdsopgaver og brug af værnemidler.
- Hvis du har dage, hvor du ikke får svaret på spørgeskemaet, kan du genoptage din deltagelse dagen efter eller snarest muligt.
- Vi håber, at du også vil svare, selvom du nogle dage ikke er på din arbejdsplads (f.eks. i weekender og under ferie).
- Vi indsamler svar fra deltagere hver dag i perioden fra **den 5. maj til og med den 30. juni 2020**.
- Det er frivilligt at være med, og du kan til enhver tid vælge at trække dig ud af undersøgelsen ved at tilkendegive dette i spørgeskemaet eller via mail til projektgruppen.

Øvrige data og datasikkerhed

Udover at svare på spørgeskemaet, anmoder vi også om din tilladelse til at kunne tilgå nødvendig og relevant information fra Regionens HR-afdeling (arbejdssted og -tid) samt Sundhedsdatastyrelsens registre.

Al information behandles fortroligt og opbevares efter gældende sikkerhedsforskrifter og forskningsprojektet er registreret i Forskningsfortegnelsen af Videnscenter for dataanmeldelser (P-2020-455). Databehandling foregår pseudonymiseret, og der videregives ingen oplysninger om dig til din arbejdsgiver eller andre uden for projektgruppen. Det vil ikke være muligt at identificere dine eller andre enkeltpersoners data i resultater fra undersøgelsen.

Ny viden skal være med til at bryde smittekæder

For hospitalsansatte vil smitte med COVID-19 have betydning både for eget helbred og for risikoen for at bringe smitte videre til sårbare patienter, kollegaer og nære pårørende. De indhentede svar fra ansatte vil derfor blive analyseret løbende under og efter projektperioden med henblik på at kunne iværksætte konkrete tiltag for at minimere arbejdsrelateret sygdom og smittespredning så tidligt som muligt under den igangværende pandemi.

Data fra undersøgelsen vil desuden blive samlet med tilsvarende fra søsterprojekter i andre danske regioner for at sikre en bred arbejdsmiljøindsats til gavn for alle hospitalsansatte i Danmark.

Opbakning fra direktion og MED-udvalg

Der er opbakning til forskningsprojektet fra Region Hovedstadens direktion og MED-udvalg (RMU).

Har du spørgsmål eller kommentarer til forskningsprojektet, er du velkommen til at kontakte os på mail bfh-fp-COBRA@regionh.dk. Du kan også ringe til os dagligt fra kl. 9-17 på hverdage og fra kl. 14-17 i weekender/på helligdage på telefonnummer 23 35 58 85 i hele projektperioden.

Vi har stor forståelse for, at mange ansatte netop nu har ekstra travlt og i høj grad skal omstille sig til nye udfordringer. Vi håber meget, at du alligevel har mod på at være med i undersøgelsen.

Tak for din tid.

Med venlig hilsen

Professor og overlæge Susanne Wulff Svendsen og biostatistiker Esben Meulengracht Flachs
Arbejds- og Miljømedicinsk Afdeling, Bispebjerg og Frederiksberg Hospital

Version 2, 11. maj 2020.

Bilag 3: Anden bølge, dokumenter

1. Baseline spørgeskema
2. Dagligt spørgeskema
3. Symptom spørgeskema
4. FFP3 spørgeskema

SAMTYKKEERKLÆRING

Velkommen til forskningsprojektet COBRA om COVID-19 og arbejde i Region Midtjylland.

Dato _____

FORMÅL
Formålene er at finde ud af, om ansatte i Region Midtjylland er tilstrækkeligt beskyttet mod COVID-19, beskrive smitte på og uden for arbejdet og senfølger efter COVID-19.

Resultaterne skal ruste Region Midtjylland endnu bedre mod COVID-19 og andre epidemier.

OM FORSKNINGSPROJEKTET
Hvis du deltager, vil du hver dag til og med 31. januar 2021 modtage en SMS med et link til et spørgeskema, som tager ca. 2 minutter at besvare. SMS'en kommer ca. kl. 15.30, og linket er aktivt i 24 timer.

Det er vigtigt for projektet, at der kommer besvarelser fra medarbejdere både med og uden patientkontakt. Derfor beder vi dig om at deltage, uanset hvilket job du har lige nu, også hvis du har administrativt arbejde, arbejder hjemme, er i karantæne eller ikke har været på arbejde. Er du forhindret i at svare en dag, gør det ikke noget, at du springer den over.

Forskningsprojektet udføres af Arbejdsmedicin ved Aarhus Universitetshospital og Hospitalsenheden Vest i samarbejde med Aarhus Universitet. Professor Henrik Kolstad er projektansvarlig.

Det er frivilligt at deltage i projektet. For at deltage er det nødvendigt, at du giver dit samtykke. Du vil modtage en kopi af samtykket på din regions-mail. Du kan til enhver tid trække dit samtykke tilbage ved at sende en mail til COBRA@rm.dk.

Vi vil koble dine besvarelser med eventuelle besvarelser fra foråret, resultater af COVID-19 tests og oplysninger om din ansættelse fra Region Midtjyllands medarbejdersystemer. Hos Sundhedsdatastyrelsen vil vi få adgang til pseudonymiserede oplysninger om din brug af lægemidler og hospitalsdiagnoser af betydning for COVID-19 fra Lægemiddelstatistikregisteret og Landspatientregisteret. Der vil kun blive indhentet nødvendige og relevante oplysninger.

Alle data behandles fortroligt i henhold til gældende lovgivning. Region Midtjylland er dataansvarlig. Data vil blive samlet med et tilsvarende forskningsprojekt i Region Hovedstaden.

Der videregives ingen oplysninger om dig til din afdeling eller Region Midtjylland. Det vil ikke være muligt at identificere dine eller andre enkeltpersoners data i undersøgelsens resultater.

Med venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest
COBRA-projektet: COvid-19 Blandt RegionsAnsatte

SAMTYKKE
Jeg giver hermed mit samtykke til deltagelse, herunder at Region Midtjylland behandler personoplysninger om mig til brug for dette forskningsprojekt.

Jeg er orienteret om, at jeg til enhver tid kan trække mit samtykke til behandling af mine personoplysninger tilbage.

◯ Jeg er indforstået og ønsker at deltage

MOBILNUMMER Vi har brug for dit mobilnummer for at kunne sende dig link til de daglige spørgsmål. Hvis du ikke oplyser dit mobilnummer, får du linket tilsendt på din regions-mail. Det anbefaler vi dog ikke, da du så skal have adgang til din arbejdsmail efter 15:30 for at kunne besvare.	_____ (Indtast mobilnummer)

_____

COvid-19 Blandt RegionsAnsatte (COBRA)

Disse spørgsmål skal kun besvares denne ene gang.

Tjek af telefonnummer

Du indtastede, at dit mobilnummer er: [mobiltlf]

Dobbelttjek gerne om det er korrekt.

Er det ikke korrekt, så skriv det korrekte nummer her.

Står der ikke noget mobilnummer, er det fordi, du ikke har oplyst noget nummer. Så vil du modtage det daglige link på den mailadresse, du har modtaget invitationsmailen på.

_____
(Indtast rettet mobilnummer (hvis fejl i det røde))

Er du blevet influenzavaccineret i efteråret 2020?

- ◯ Nej
- ◯ Ja

Er du ryger?

- ◯ Ja
- ◯ Nej - men jeg har tidligere røget
- ◯ Nej - jeg har aldrig røget

Har du nogen af disse sygdomme?

- ☐ Høfeber
- ☐ Astma
- ☐ Kronisk obstruktiv lungesygdom (KOL)
- ☐ Nej

Hvor høj er du?

_____
(cm)

Hvor meget vejer du?

_____
(kg)

COvid-19 Blandt RegionsAnsatte (COBRA)

Disse spørgsmål handler om symptomer, nærkontakter, arbejdsopgaver og brug af værnemidler i de seneste 24 timer og skal besvares daglig til og med 31. januar.

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1 Har du haft ét eller flere af følgende symptomer i løbet af de seneste 24 timer?

Afkryds gerne flere felter

- ☐ Jeg har ikke haft nogen af symptomerne
- ☐ Løbende eller stoppet næse
- ☐ Hoste
- ☐ Ondt i halsen
- ☐ Åndenød
- ☐ Hovedpine
- ☐ Muskelømhed
- ☐ Feber
- ☐ Diarré eller ondt i maven
- ☐ Nedsat eller manglende smags- og lugtesans
- ☐ Usædvanlig træthed
- ☐ Brystsmerter
- ☐ Koncentrations- eller hukommelsesbesvær
- ☐ Trist eller ked af det

Er du blevet testet med en hurtigtest/quicktest for COVID-19 inden for de sidste 24 timer (eller siden du sidst udfyldte skemaet)?

- ◯ Nej
- ◯ Ja - testen var negativ
- ◯ Ja - testen var positiv

Har du modtaget vaccine mod COVID-19?

- ◯ Nej
- ◯ Ja - den første fra Pfizer
- ◯ Ja - begge fra Pfizer
- ◯ Ja - den første fra Moderna
- ◯ Ja - begge fra Moderna

---

2 Har du været i nærkontakt (< 1 meter) med personer uden for din husstand i mere end 15 sammenhængende minutter de seneste 24 timer, med eller uden værnemidler?
Afkryds gerne flere felter

- ☐ Nej - kun været tæt på min husstand
- ☐ Ja - kollegaer på arbejdspladsen
- ☐ Ja - patienter/pårørende på arbejdspladsen
- ☐ Ja - ved motion, sport eller foreningsarbejde
- ☐ Ja - ved privat socialt samvær
- ☐ Ja - i offentlig tranport
- ☐ Ja - ved indkøb
- ☐ Ja - ved fritidsoplevelser (fx bar, restaurant, museer, biograf ol.)
- ☐ Ja - ved sundheds- eller service-ydelser (f.eks. tandlæge, frisør)
- ☐ Ja - i andre sammenhænge

---

3 Har du været i nærkontakt (< 1 meter) med personer, der var testet positiv for COVID-19 de seneste 24 timer, med eller uden værnemidler?

- ☐ Ja - på min arbejdsplads
- ☐ Ja - andre steder
- ☐ Nej/Ved ikke

---

4 Er du indenfor de seneste 24 timer blevet bekendt med, at du tidligere har haft nærkontakt (< 1 meter) med en person, der efterfølgende er testet positiv for COVID-19? (fx som en del af smitteopsporing)

- ☐ Nej
- ☐ Ja. 1-2 dage siden nærkontakt
- ☐ Ja. 3-4 dage siden nærkontakt
- ☐ Ja. 5-6 dage dage siden nærkontakt
- ☐ Ja. Mere end 6 dage siden nærkontakt

4a Hvor foregik nærkontakten?
Afkryds gerne flere felter

- ☐ På arbejdspladsen (smittede var kollega)
- ☐ På arbejdspladsen (smittede var patient/pårørende)
- ☐ Ved motion, sport eller foreningsarbejde
- ☐ Ved privat socialt samvær
- ☐ I offentlig tranport
- ☐ Ved indkøb
- ☐ Ved fritidsoplevelser (fx bar, restaurant, museer, biograf)
- ☐ Ved sundheds- eller service-ydelser (f.eks. tandlæge, frisør)
- ☐ I andre sammenhænge
- ☐ Ved ikke

5 Har du udført nogen af følgende arbejdsopgaver i løbet af de seneste 24 timer ? (afkryds gerne flere felter)

- ☐ Fri, syg eller hjemmearbejde
- ☐ Isolation, karantæne eller hjemsendt grundet nærkontakt
- ☐ Samtaler med patienter eller pårørende med en afstand under 2 meter
- ☐ Fysisk patientkontakt (fx behandling, undersøgelse, personlig pleje, forflytning)
- ☐ Kirurgiske indgreb eller fødsler
- ☐ Procedurer i luftvejene (fx CPAP, PEP-fløjte, intubation eller genoplivning)
- ☐ Patienttransport
- ☐ Andre opgaver med nærhed under 2 meter til patienter eller pårørende
- ☐ Klargøring af patientstue eller rengøring (inkl Sterilcentralen)
- ☐ Jeg har været på arbejde, men ikke udført nogen af de nævnte opgaver

6 Hvilke værnemidler har du anvendt på arbejde de seneste 24 timer? (afkryds gerne flere felter)
Håndvask, afstand og håndsprit skal ikke medregnes

- ☐ Jeg har ikke anvendt værnemidler
- ☐ Handsker
- ☐ Overtrækskittel med ærmer
- ☐ Plastforklæde
- ☐ Højisolationsdragt
- ☐ Maske kirurgisk/mundbind (IIR)
- ☐ Maske - type FFP2
- ☐ Maske - type FFP3
- ☐ Maske - ukendt type
- ☐ Visir
- ☐ Mundbind med visir
- ☐ Beskyttelsesbriller
- ☐ Plexiglas/plastikplade
- ☐ Andre værnemidler

Hvilke værnemidler drejede det sig om?

_____

6a Har der været uheld med dine værnemidler på arbejdet i de seneste 24 timer?
(fx hul i handske, tabt visir eller maske)

- ◯ Nej
- ◯ Ja
- ◯ Ved ikke

6b Hvilke værnemidler skete uheldet med ? (afkryds gerne flere)

- ◯ Handsker
- ◯ Overtrækskittel med ærmer

- ◯ Plastforklæde
- ◯ Højisolationsdragt
- ◯ Maske kirurgisk/mundbind (IIR)
- ◯ Maske - type FFP2
- ◯ Maske - type FFP3
- ◯ Maske - ukendt type
- ◯ Visir
- ◯ Mundbind med visir
- ◯ Beskyttelsesbriller
- ◯ Plexiglas/plastikplade
- ◯ Andre værnemidler

Hvilke værnemidler drejede det sig om? _____

6c Ved hvilke arbejdsopgaver skete uheldet med dine værnemidler? (afkryds gerne flere)

- ◯ Samtaler med patienter eller pårørende med en afstand under 2 meter
- ◯ Fysisk patientkontakt (fx behandling, undersøgelse, personlig pleje, forflytning)
- ◯ Kirurgiske indgreb eller fødsler
- ◯ Procedurer i luftvejene (fx CPAP, PEP-fløjte, intubation eller genoplivning)
- ◯ Patienttransport
- ◯ Andre opgaver med nærhed under 2 meter til patienter eller pårørende
- ◯ Klargøring af patientstue eller rengøring (inkl Sterilcentralen)
- ◯ Det var en anden arbejdsopgave

Skriv hvilken arbejdsopgave det var, uheldet med dine værnemidler skete ved: _____

Beskriv evt. hvordan uheldet skete:

_____

6d Skete uheldet med dine værnemidler ved en arbejdsopgave med personer, der enten var mistænkt for at have COVID-19 eller var testet positiv for COVID-19?

- ☐ Nej
- ☐ Ja, personer testet positiv for COVID-19
- ☐ Ja, personer med mistanke om COVID-19
- ☐ Ved ikke

7 Har der i de seneste 24 timer været situationer på arbejdet, hvor du ikke har anvendt de anbefalede værnemidler?

- ◯ Nej
- ◯ Ja
- ◯ Ved ikke

Hvad er årsagen til, at du ikke ved, om du har anvendt de anbefalede værnemidler?

_____

7a Hvilke værnemidler var der tale om? (afkryds gerne flere felter)

- ☐ Handsker
- ☐ Overtrækskittel med ærmer
- ☐ Plastforklæde
- ☐ Højisolationsdragt
- ☐ Maske kirurgisk/mundbind (IIR)
- ☐ Maske - type FFP2
- ☐ Maske - type FFP3
- ☐ Maske - ukendt type
- ☐ Visir
- ☐ Mundbind med visir
- ☐ Beskyttelsesbriller
- ☐ Plexiglas/plastikplade
- ☐ Andre værnemidler

Hvilke værnemidler drejede det sig om?

_____

7b Ved hvilke arbejdsopgaver anvendte du ikke de anbefalede værnemidler? (afkryds gerne flere)

- ◯ Samtaler med patienter eller pårørende med en afstand under 2 meter
- ◯ Fysisk patientkontakt (fx behandling, undersøgelse, personlig pleje, forflytning)
- ◯ Kirurgiske indgreb eller fødsler
- ◯ Procedurer i luftvejene (fx CPAP, PEP-fløjte, intubation eller genoplivning)
- ◯ Patienttransport
- ◯ Andre opgaver med nærhed under 2 meter til patienter eller pårørende
- ◯ Klargøring af patientstue eller rengøring (inkl Sterilcentralen)
- ◯ Det var en anden arbejdsopgave

	Skriv hvilken arbejdsopgave det var, du ikke anvendte de anbefalede værnemidler ved:	_____
7c	Arbejdede du med personer, der enten var mistænkt for at have COVID-19 eller var testet positiv for COVID-19, da du ikke anvendte de anbefalede værnemidler?	☐ Nej ☐ Ja, personer testet positiv for COVID-19 ☐ Ja, personer med mistanke om COVID-19 ☐ Ved ikke
7d	Hvad var grunden til, at du ikke anvendte de anbefalede værnemidler? (afkryds gerne flere felter)	☐ Patienten havde en negativ COVID-19 test ☐ Jeg glemte det ☐ Værnemidlerne var ikke til rådighed ☐ Kunne ikke nå det/Havde ikke tid ☐ For at spare på værnemidler ☐ Jeg var ikke opmærksom på/klar over, at jeg skulle anvende værnemidler ☐ Af hensyn til patientkontakten ☐ Jeg vurderede, at det ikke var nødvendigt ☐ Anden årsag
	Hvad var årsagen til, at du ikke anvendte de anbefalede værnemidler:	_____
	Vi sætter stor pris på din deltagelse. Du vil modtage et skema dagligt frem til 31. januar. Ønsker du på nuværende tidspunkt at stoppe i undersøgelsen, så angiv det her.	◯ Jeg ønsker at stoppe i undersøgelsen nu
	Vi vil gerne være helt sikre på, at du gerne vil stoppe i undersøgelsen, så bekræft dit svar her	◯ Ja, jeg ønsker at stoppe i undersøgelsen nu ◯ Nej, jeg ønsker ikke at stoppe i undersøgelsen
	Vi har registreret dit stop, og du vil ikke få flere sms'er. Vi er kede af, at du stopper og håber, at du vil fortælle os hvorfor	☐ Det tager for lang tid at svare ☐ Det er for meget at skulle svare hver dag ☐ Spørgsmålene er ikke relevante for mig ☐ Jeg arbejder ikke længere i Region Midtjylland ☐ Andet
	Skriv gerne hvad årsagen til at du ønsker at stoppe er:	_____

Spørgeskema om dig, dit arbejde og symptomer på COVID-19

Besvar venligst nedenstående spørgsmål

OM DIG

Hvilket postnummer bor du i?

_____

Hvad er din hovedbeskæftigelse

- ◯ Social- og Sundhedsassistent
- ◯ Sygeplejerske
- ◯ Læge
- ◯ Bioanalytiker
- ◯ Portør
- ◯ Administrativ medarbejder/lægesekretær
- ◯ Lægestuderende
- ◯ Sygeplejestuderende
- ◯ Phd.-studerende
- ◯ Paramediciner, redder eller ambulancefører
- ◯ Jordemoder
- ◯ Radiograf
- ◯ Psykolog
- ◯ Andet

Skriv hvad din beskæftigelse er:

_____

Inden for hvilket speciale er du hovedsageligt beskæftiget?

- ◯ Akutmedicin
- ◯ Almen medicin
- ◯ Anæstesi
- ◯ Arbejdsmedicin
- ◯ Børn og Unge
- ◯ Børne- og ungdomspsykiatri
- ◯ Dermatologi og venerologi
- ◯ Diagnostisk radiologi
- ◯ Endokrinologi
- ◯ Geriatri
- ◯ Gynækologi og obstetrik
- ◯ Hæmatologi
- ◯ Infektionsmedicin
- ◯ Intensivafdeling
- ◯ Kardiologi
- ◯ Karkirurgi
- ◯ Kirurgi
- ◯ Klinisk biokemi
- ◯ Klinisk farmakologi
- ◯ Klinisk fysiologi og nuklearmedicin
- ◯ Klinisk genetik
- ◯ Klinisk immunologi
- ◯ Klinisk mikrobiologi
- ◯ Lungemedicin
- ◯ Medicinsk gastroentologi
- ◯ Nefrologi
- ◯ Neurokirurgi
- ◯ Neurologi
- ◯ Oftalmologi
- ◯ Onkologi
- ◯ Operationsgang
- ◯ Ortopædkirurgi
- ◯ Patologisk anatomi
- ◯ Plastikkirurgi
- ◯ Psykiatri
- ◯ Pædiatri
- ◯ Retsmedicin
- ◯ Reumatologi
- ◯ Skadestue/akutmodtagelse
- ◯ Socialmedicin/Samfundsmedicin
- ◯ Thoraxkirurgi hjertekirurgi
- ◯ Klassisk thoraxkirurgi
- ◯ Urologi
- ◯ Øre-næse-hals-kirurgi
- ◯ Andet
- ◯ Ønsker ikke at svare

Hvad er din primære arbejdsplads?

- ◯ Aarhus Universitetshospital
- ◯ Regionshospitalet Randers
- ◯ Regionshospitalet Horsens
- ◯ Psykiatrien i Region Midtjylland
- ◯ Præhospitalet
- ◯ Hospitalsenheden Vest
- ◯ Hospitalsenhed Midt
- ◯ Hospitalsapoteket Region Midtjylland
- ◯ Anden
- ◯ Vil ikke oplyse

Hvad er din højest gennemførte uddannelse?	◯ Jeg har ingen formel uddannelse ◯ Folkeskole ◯ Ungdomsuddannelse (gymnasie, HX, etc.) ◯ Erhversuddannelse eller kort / mellemlang videregående (bachelor) ◯ Lang videregående
Hvor mange personer er du i øjeblikket typisk i kontakt med i løbet af en dag? (Vælg det udsagn der passer bedst)	◯ over 100 personer ◯ 51-100 personer ◯ 11-50 personer ◯ op til 10 ◯ Ingen af overstående
Inklusiv dig selv, hvilke af følgende aldersgrupper, bor i din husstand?	☐ 0-4 årige ☐ 5-18 årige ☐ 19-44 årige ☐ 45-64 årige ☐ 65+ årige
Hvor mange 0-4 årige bor i din husstand?	_____
Hvor mange 5-18 årige bor i din husstand	_____
Hvor mange 19-44 årige bor i din husstand	_____
Hvor mange 45-64 årige bor i din husstand	_____
Hvor mange over 65 år bor i din husstand	_____
Hvor ofte er du forkølet eller har influenza-lignende symptomer?	◯ Aldrig ◯ En til to gange om året ◯ Mellem 3 og 5 gange om året ◯ Mellem 6 og 10 gange om året ◯ Mere end 10 gange om året ◯ Det ved jeg ikke
Fik du en influenzavaccine dette efterår/vinter (2019-2020-sæsonen)?	◯ Ja ◯ Nej ◯ Det ved jeg ikke/husker det ikke
Fik du en influenzavaccine forrige efterår/vinter (2018-2019-sæsonen)?	◯ Ja ◯ Nej ◯ Det ved jeg ikke/husker det ikke

Lider du af (eller får medicin i behandlingen af) følgende kroniske sygdomme? (Vælg gerne flere udsagn)	☐ Nej ☐ Astma ☐ Sukkersyge ☐ Kronisk lungesygdomme udover astma (fx KOL, emfysem og andre tilstande der påvirker din vejrtrækning) ☐ Hjertesygdomme ☐ Nyresygdomme ☐ Svækket immunforsvar som følge af medicinsk behandling eller kroniske tilstande, såsom hel eller delvis fjernelse af milten, organtransplantation, hiv/aids, kræft, svær gigt, etc. ☐ Højt blodtryk (Hypertension) ☐ Andet
Anden sygdom	_____
Ryger du?	◯ Nej ◯ Nej, men jeg har tidligere røget ◯ Ja - sommetider ◯ Ja - dagligt, mindre end 10 gange om dagen ◯ Ja - dagligt, 10 eller flere gange om dagen ◯ Ønsker ikke at svare
Hvor høj er du i centimeter (cm)?	_____
Hvor meget vejer du i kilogram (Kg)?	_____
Hvor mange genstande alkohol drikker du om ugen?	◯ 15 eller mere ◯ 8-14 ◯ 1-7 ◯ 0 ◯ Ønsker ikke at svare
Har du én eller flere af følgende allergier, der kan forårsage luftvejssymptomer?	☐ Høfeber ☐ Husstøvmideallergi ☐ Husdyrallergi ☐ Andre allergier, der kan forsage luftvejssymptomer ☐ Jeg har ikke nogen allergier, der forårsager luftvejssymptomer
Har du kæledyr?	☐ Nej ☐ Ja - en eller flere hunde ☐ Ja - en eller flere katte ☐ Ja - en eller flere fugle ☐ Ja - et eller flere andre dyr
Har du været i udlandet i løbet af de seneste 6 måneder?	◯ Nej ◯ Ja

Har du været i nogen af disse lande de seneste 6 måneder: (Afkryds alle relevante)	☐ Belgien ☐ England ☐ Frankrig ☐ Iran ☐ Italien ☐ Kina ☐ USA ☐ Spanien ☐ Sverige ☐ Sydkorea ☐ Tyskland ☐ Østrig ☐ Nej jeg har ikke besøgt nogen af ovennævnte lande

OM DIT ARBEJDE

Arbejder du med patienter?	◯ Nej ◯ Ja - delvist ◯ Ja
Arbejder du med patienter indlagt med COVID-19?	◯ Nej ◯ Ja - delvist ◯ Ja
Arbejder du på et COVID-19 afsnit?	◯ Nej ◯ Ja - delvist ◯ Ja
Har du arbejdet hjemmefra i perioden fra 13. marts og indtil nu?	◯ Nej ◯ Ja - delvist ◯ Ja
Har du arbejdet hjemmefra de seneste 2 uger?	◯ Nej ◯ Ja - delvist ◯ Ja
Hvor mange timer har du i gennemsnit arbejdet om ugen indenfor de sidste 4 uger?	◯ Mere end 60 timer om ugen ◯ 41-60 timer om ugen ◯ 21-40 timer om ugen ◯ 1-20 timer om ugen ◯ 0 timer om ugen ◯ Jeg ved ikke
Hvor mange timer om ugen har du i gennemsnit været i kontakt med patienter indenfor de sidste 4 uger?	◯ Mere end 60 timer om ugen ◯ 41-60 timer om ugen ◯ 21-40 timer om ugen ◯ 1-20 timer om ugen ◯ 0 timer om ugen ◯ Jeg ved ikke

SYMPTOMER

Har du haft nogen af følgende symptomer siden 1. marts?
Sæt gerne flere kryds

- ☐ Ingen symptomer
- ☐ Feber
- ☐ Kulderystelser
- ☐ Løbende eller stoppet næse
- ☐ Nysen
- ☐ Ondt i halsen
- ☐ Hoste
- ☐ Åndenød
- ☐ Hovedpine
- ☐ Muskel- eller ledsmerter
- ☐ Brystsmerter
- ☐ Træt eller udmattet
- ☐ Manglende appetit
- ☐ Farvet opspyt/slim
- ☐ Rødsprængte rindende øjne
- ☐ Kvalme
- ☐ Opkast
- ☐ Diarré
- ☐ Ondt i maven
- ☐ Manglende smags/lugtesans
- ☐ Andet

Hvornår begyndte symptomerne?

_____
(dd-mm-åååå)

Har du stadig symptomer?

- ◯ Ja
- ◯ Nej

Hvornår holdt symptomerne op?

_____
(dd-mm-åååå)

Har du indenfor 14 dage før dine symptomer startede været i udlandet?

- ◯ Ja
- ◯ Nej
- ◯ Jeg ved ikke

Hvilket land?

- ◯ Afghanistan
- ◯ Albanien
- ◯ Algeriet
- ◯ Andorra
- ◯ Angola
- ◯ Antigua og Barbuda
- ◯ Argentina
- ◯ Armenien
- ◯ Aserbajdsjan
- ◯ Australien
- ◯ Bahamas
- ◯ Bahrain
- ◯ Bangladesh
- ◯ Barbados
- ◯ Belgien
- ◯ Belgien
- ◯ Belize
- ◯ Benin
- ◯ Bhutan
- ◯ Bolivia
- ◯ Bosnien-Hercegovina
- ◯ Botswana
- ◯ Brasilien
- ◯ Brunei
- ◯ Bulgarien
- ◯ Burkina Faso
- ◯ Burundi
- ◯ Cambodja
- ◯ Cameroun
- ◯ Canada
- ◯ Chad
- ◯ Chile
- ◯ Colombia
- ◯ Comorene
- ◯ Congo
- ◯ Cookøerne
- ◯ Costa Rica
- ◯ Cuba
- ◯ Cypern
- ◯ Danmark
- ◯ Den Centralafrikanske Republik
- ◯ Den Demokratiske Republik Congo
- ◯ Djibouti
- ◯ Dominica
- ◯ Dominikanske Republik
- ◯ Ecuador
- ◯ Egypten
- ◯ El Salvador
- ◯ Elfenbenskysten
- ◯ Eritrea
- ◯ Estland
- ◯ Etiopien
- ◯ Fiji
- ◯ Filippinerne
- ◯ Finland
- ◯ Forenede Arabiske Emirater
- ◯ Frankrig
- ◯ Gabon
- ◯ Gambia
- ◯ Georgien
- ◯ Ghana
- ◯ Grenada
- ◯ Grækenland
- ◯ Guatemala
- ◯ Guinea
- ◯ Guinea-Bissau
- ◯ Guyana
- ◯ Haiti
- ◯ Holland

- ◯ Honduras
- ◯ Hviderusland (Belarus)
- ◯ Indien
- ◯ Indonesien
- ◯ Irak
- ◯ Iran
- ◯ Irland
- ◯ Island
- ◯ Israel
- ◯ Italien
- ◯ Jamaica
- ◯ Japan
- ◯ Jordan
- ◯ Kap Verde
- ◯ Kasakhstan
- ◯ Kenya
- ◯ Kina
- ◯ Kirgisistan
- ◯ Kiribati
- ◯ Kosovo
- ◯ Kroatien
- ◯ Kuwait
- ◯ Laos
- ◯ Lesotho
- ◯ Letland
- ◯ Libanon
- ◯ Liberia
- ◯ Libyen
- ◯ Liechtenstein
- ◯ Litauen
- ◯ Luxembourg
- ◯ Madagaskar
- ◯ Malawi
- ◯ Malaysia
- ◯ Maldiverne
- ◯ Mali
- ◯ Malta
- ◯ Marokko
- ◯ Marshalløerne
- ◯ Mauritania
- ◯ Mauritius
- ◯ Mexico
- ◯ Mikronesien
- ◯ Moldova
- ◯ Monaco
- ◯ Mongoliet
- ◯ Montenegro
- ◯ Mozambique
- ◯ Myanmar (Burma)
- ◯ Namibia
- ◯ Nauru
- ◯ Nepal
- ◯ New Zealand
- ◯ Nicaragua
- ◯ Niger
- ◯ Nigeria
- ◯ Niue
- ◯ Nordkorea
- ◯ Nordmakedonien
- ◯ Norge
- ◯ Oman
- ◯ Pakistan
- ◯ Palau
- ◯ Palæstina
- ◯ Panama
- ◯ Papua Ny Guinea
- ◯ Paraguay
- ◯ Peru
- ◯ Polen
- ◯ Portugal
- ◯ Qatar

- ◯ Rumænien
- ◯ Rusland
- ◯ Rwanda
- ◯ Saint Kitts og Nevis
- ◯ Saint Lucia
- ◯ Saint Vincent og Grenadinerne
- ◯ Salomonøerne
- ◯ Samoa
- ◯ San Marino
- ◯ Saudi-Arabien
- ◯ Schweiz
- ◯ Senegal
- ◯ Serbien
- ◯ Seychellerne
- ◯ Sierra Leone
- ◯ Singapore
- ◯ Slovakiet
- ◯ Slovenien
- ◯ Somalia
- ◯ Spanien
- ◯ Sri Lanka
- ◯ Storbritannien
- ◯ Sudan
- ◯ Surinam
- ◯ Sverige
- ◯ Swaziland
- ◯ Sydafrika
- ◯ Sydkorea
- ◯ Sydsudan
- ◯ Syrien
- ◯ São Tomé og Príncipe
- ◯ Tadsjikistan
- ◯ Taiwan
- ◯ Tanzania
- ◯ Thailand
- ◯ Tjekkiet
- ◯ Togo
- ◯ Tonga
- ◯ Trinidad og Tobago
- ◯ Tunesien
- ◯ Turkmenistan
- ◯ Tuvalu
- ◯ Tyrkiet
- ◯ Tyskland
- ◯ Uganda
- ◯ Ukraine
- ◯ Ungarn
- ◯ Uruguay
- ◯ USA
- ◯ Usbekistan
- ◯ Vanuatu
- ◯ Vatikanstaten
- ◯ Venezuela
- ◯ Vestsahara
- ◯ Vietnam
- ◯ Yemen
- ◯ Zambia
- ◯ Zimbabwe
- ◯ Ækvatorialguinea
- ◯ Østrig
- ◯ Østtimor

I de 14 dage før dine symptomer startede, har du været i kontakt med en person, som er testet positiv for coronavirus?

- ◯ Ja
- ◯ Nej
- ◯ Jeg ved ikke

Har du været sygemeldt grundet symptomerne?	◯ Ja ◯ Nej
Er du blevet podet for coronavirus?	◯ Ja ◯ Nej
Var podningen positiv for coronavirus?	◯ Ja ◯ Nej ◯ ved ikke/afventer svar
Hvilken dato blev du testet?	_____ (dd-mm-åååå)

Bilag 4: Løbende deltagerinformation

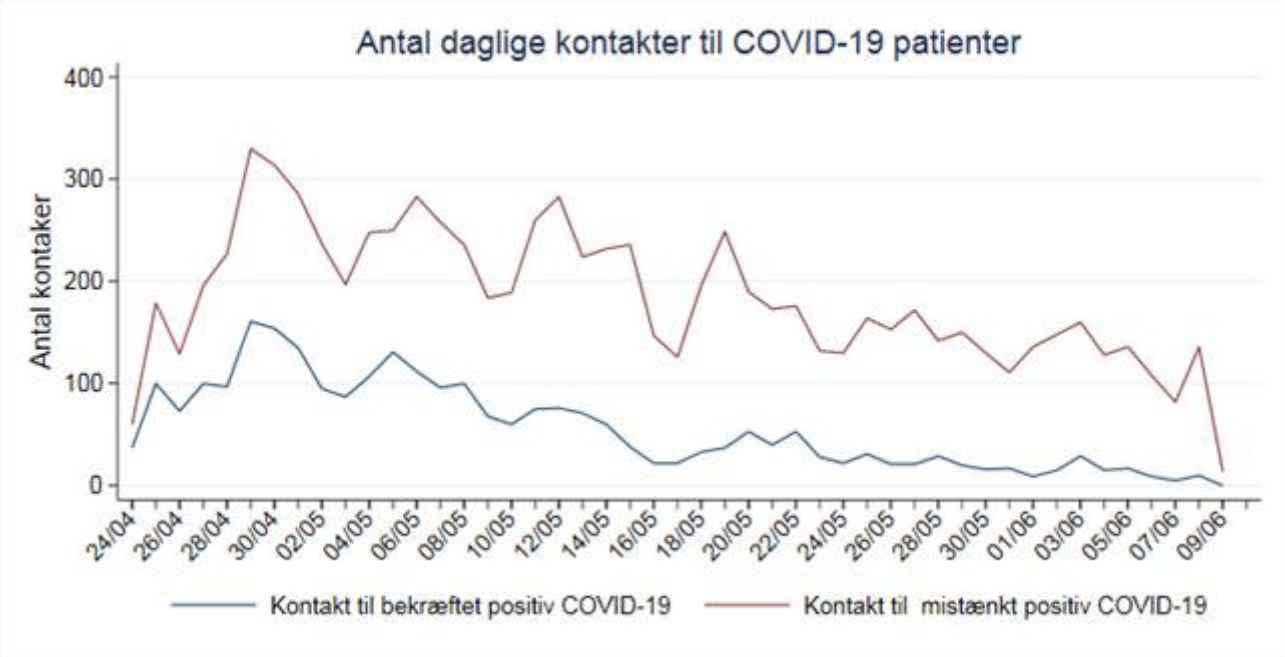
Fra: COBRA (Funktionspostkasse)
Sendt: 12. juni 2020 09:33
Emne: Status nr 2 på undersøgelsen af COVID-19 blandt regionsansatte

Kære deltager i forskningsprojektet om COVID-19 blandt regionsansatte

Gennem den sidste halvanden måned har du og 12.500 andre ansatte i Region Midtjylland dagligt besvaret SMS spørgsmål om symptomer, arbejdsopgaver og værnemidler.

Det er vi rigtig glade for, og vi vil derfor gerne dele lidt at den viden vi får med dig. Denne gang handler det om udviklingen i antallet af deltagere med kontakt med COVID-19 patienter.

Figuren nedenfor viser, at antallet af deltagere, der rapporterer at de i løbet af de seneste 24 timer haf haft med kontakt til COVID-19 patienter, er faldet siden slutningen af april. Det samme gør sig gældende for kontakter til patienter med mistanke om COVID-19. Vi kan også se, at der i hele forløbet har været færre medarbejdere som har haft kontakt med patienter mistænkt for COVID-19 i weekender.



Samfundet bliver fortsat åbnet mere op, og der er risiko for, at smittetrykket stiger. Vi håber derfor, at du vil fortsætte med at svare på de daglige SMS spørgsmål frem til undersøgelsen stopper d. 30. juni, så vi kan følge udviklingen.

Der er fortsat stor opbakning til projektet, og det er vi glade for. Dit daglige bidrag er med til at give vigtig viden om COVID-19. Mange tak for din udholdenhed.

Hvis du har spørgsmål er du som altid velkommen til at kontakte os enten via COBRA@rm.dk eller du kan ringe til os alle hverdage fra 9-15 på 2943-5466

Venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

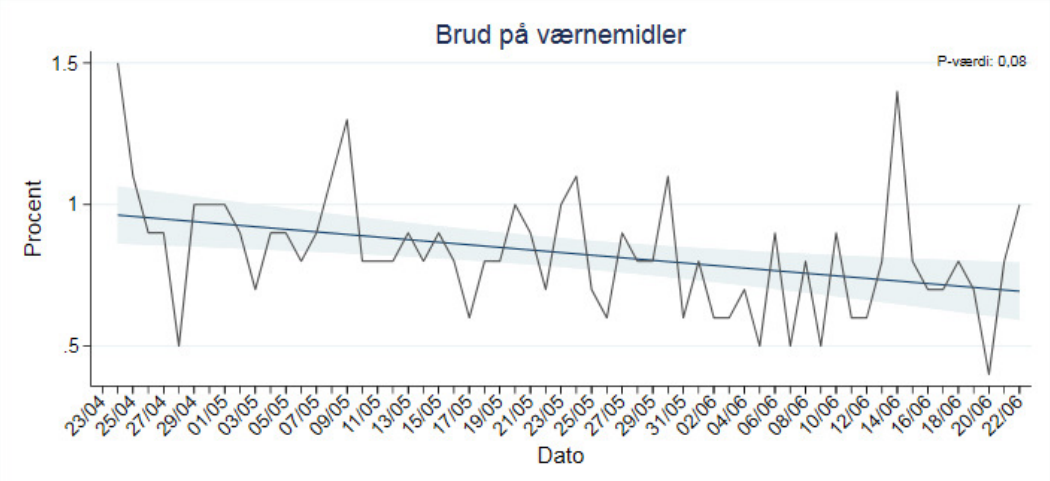
26/6-2020

Kære deltager i forskningsprojektet om COVID-19 blandt regionsansatte
Gennem de seneste to måneder har du og 12.500 andre ansatte i Region Midtjylland dagligt besvaret SMS spørgsmål om symptomer, arbejdsopgaver og værnemidler.

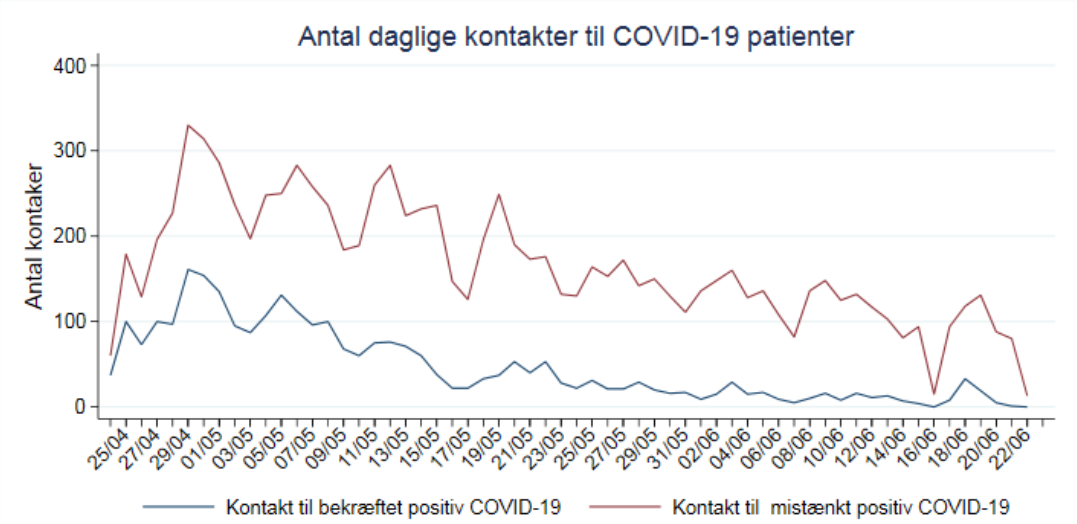
Vi er nu nået til vejs ende. Mange tak for din deltagelse i hele perioden.

Her ved afslutningen vil vi gerne dele lidt flere af de umiddelbare resultater vi kan se ud fra de daglige besvarelser.

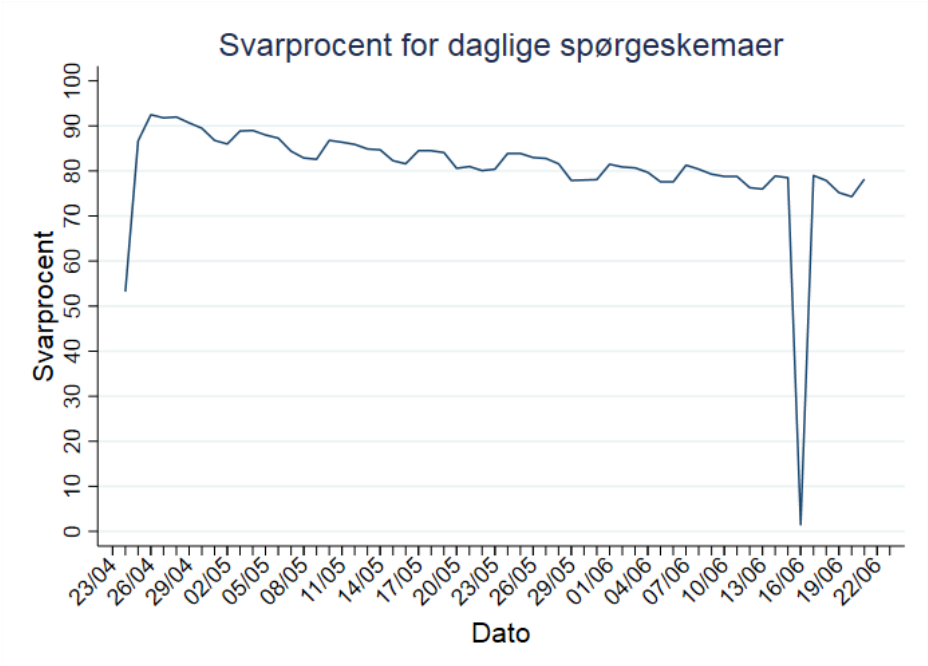
Brugen af værnemidler er afgørende for at sikre sig mod smitte. Men vi kan se, at de enkelte gange ikke fungerer efter hensigten. Figuren nedenfor viser, at der dagligt sker brud på omkring 1 % af alle de anvendte værnemidler. Derudover kan vi også se ud fra den blå linje, at siden april er andelen af værnemidlerne, som er gået i stykker faldet.



COVID-19 har heldigvis ikke været så udbredt som frygtet, da projektet startede. Figuren nedenfor viser antallet af deltagere, der har rapporteret, at de i løbet af de seneste 24 timer haf haft kontakt til patienter med bekræftet eller mistænkt COVID-19. Antallet er fortsat faldende.



Deltagerne i projektet har vist meget stor udholdenhed. Som du kan se på figuren nedenfor har omkring 80 % af alle deltagere svaret på spørgeskemaet hver eneste dag, hvilket vi er meget glade for. Det markante fald d. 16.6. skyldes et teknisk problem hos os, som gjorde at der ikke blev sendt sms'er den dag.



Vi vil nu begynde at analysere data nærmere. Vi vil kombinere spørgeskemabesvarelserne med resultaterne af COVID-19 podning og antistof-test og ser frem til at kunne præsentere resultaterne.

Som skrevet er vi kommet til vejs ende i denne omgang. Men hvis der kommer en anden bølge af COVID-19, kan det tænkes at vi starter projektet igen, for igen at kunne følge udviklingen. Vi håber, at du så vil være klar til at deltage igen.

Hvis du har spørgsmål er du som altid velkommen til at kontakte os via COBRA@rm.dk. Telefonerne er lukket fra dags dato, men mailen er fortsat åben.

Venlig hilsen

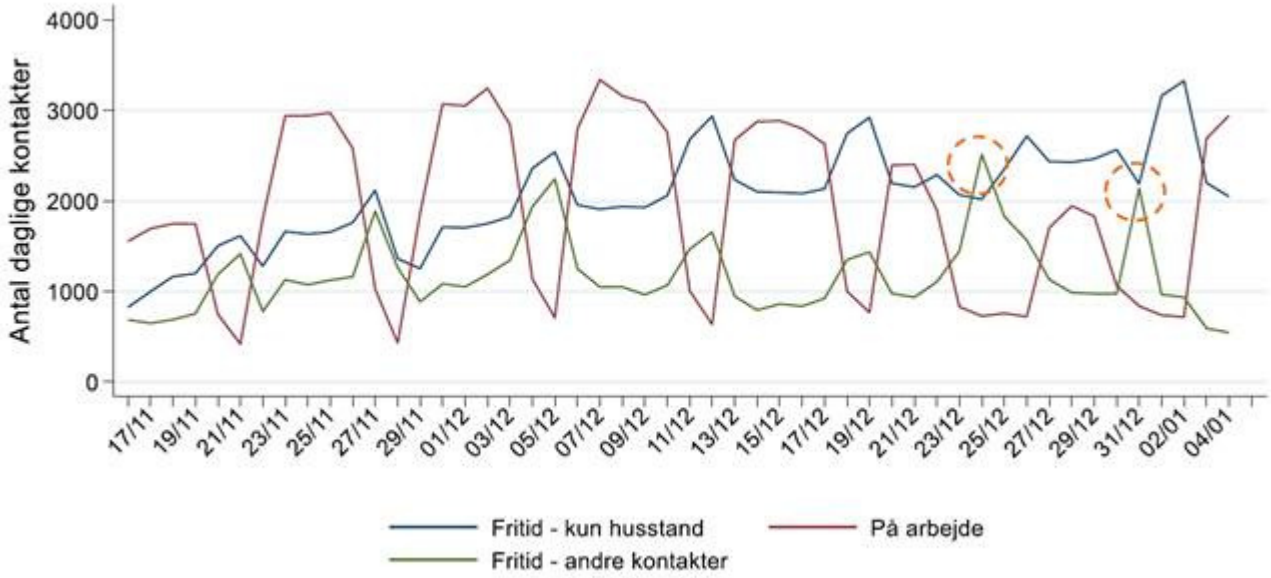
Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital

6/1-2021

Kære deltager i COVID-19 forskningsprojektet

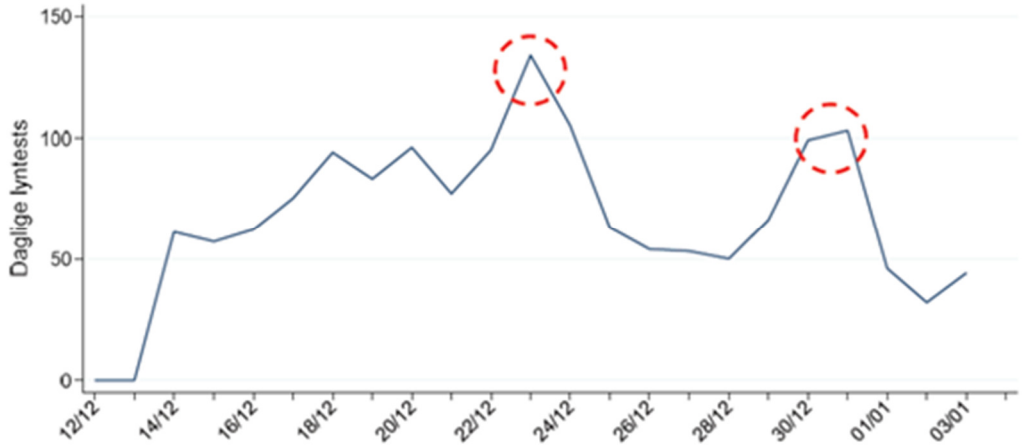
Vi har nu passeret jul og nytår og vil gerne benytte lejligheden til at give jer en status på de daglige kontakter, som I indrapporterer til os.

I figur 1 nedenfor kan vi tydeligt se, at antallet af andre kontakter i fritiden (grøn linje) topper efter juleaften og nytårsaften (), mens kontakt kun med egen hustand, stiger de øvrige dage (blå linje). Der ses også en tydelig juleferieeffekt, hvor antallet af kontakter på arbejdet falder (rød linje).



Figur 1: Kontakter i fritiden - kun i husstanden og andre kontakter - samt kontakter med patienter og kollegaer på arbejdet siden 17/11 2020

Vi er begyndt at spørge om lyntest, og vi kan se, at de toppede op til juleaften og nytårsaften ( ). 2,8% af lyntestene var positive.



Figur 2: Antallet af lyntests siden 13/12 2020

Den umiddelbare fortolkning er, at vi har været mere sammen med nogen uden for husstanden juleaften og nytårsaften, men ikke markant mere end vi var den første weekend i december, inden der kom skærpede restriktioner. Mange har fået lavet en lyntest inden samværet for at reducere risikoen for at bringe smitte videre.

Vi er også begyndt at spørge til vaccine. 551 af deltagerne er vaccineret indtil i går. Så det går den rigtige vej, men der var også 136 indlagte med COVID-19 i Region Midtjylland i går, og vi er langt fra gennem pandemien endnu. Derfor overvejer vi at forlænge undersøgelsen. Det hører I mere om senere.

Rigtig godt nytår og mange tak for din deltagelse og udholdenhed!

Venlig hilsen

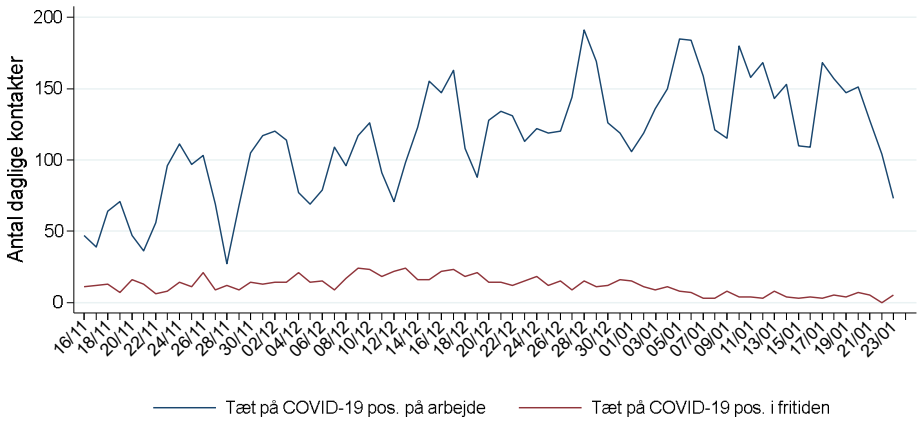
Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

25/1-2021

Titel: Status på undersøgelsen af COVID-19 blandt regionsansatte

Kære deltager i COVID-19 forskningsprojektet
Vi vil gerne give jer en opdatering på projektet – samt opfordre jer til at fortsætte i projektet efter 31. januar. Læs mere nedenfor.

Stigning i antal COVID-19 kontakter
Stigningen i COVID-19 smittede i december afspejles også i vores projekt, og kan ses i figuren nedenfor. Det er tydeligt, at der er flere ansatte, der har kontakt til COVID-19 smittede (blå kurve). Samtidig falder kontakter med smittede i fritiden (rød kurve).



Figur: Antallet af personer der har haft kontakt til mindst én COVID-19 positiv person i perioden 16. november 2020 til 23. januar 2021.

Undersøgelse af øget personalesmitte omkring jul og nytår
Nogle afdelinger i Regionen har omkring jul og nytår oplevet en stigning i antallet af smittede medarbejdere. Det kan jeres daglige data bruges til at undersøge årsagerne til. Vi har brug for ekstra oplysninger, og det håber vi, at I vil hjælpe med. Derfor vil de af jer, der har været fysisk på arbejde mindst 1 dag fra den 14. december til den 15. januar snart modtage et kort spørgeskema om dette.

Forlængelse af undersøgelsen – husk at give nyt samtykke
Vi er stadig midt i epidemien, og derfor er der fortsat behov for at samle data ind om personalets risiko for smitte med COVID-19. Vi har derfor fået grønt lys fra Regionens krisestab til at forlænge projektet frem til 30. april. Men *din deltagelse forlænges ikke automatisk, da dit samtykke udløber 31. januar.* Hvis du ønsker at fortsætte, skal du give fornyet samtykke. **Derfor sender vi dig senere i dag en invitation til at fortsætte i projektet, hvor du kan afgive nyt samtykke**. Vi håber, at alle vil bakke op om fortsættelsen af projektet.

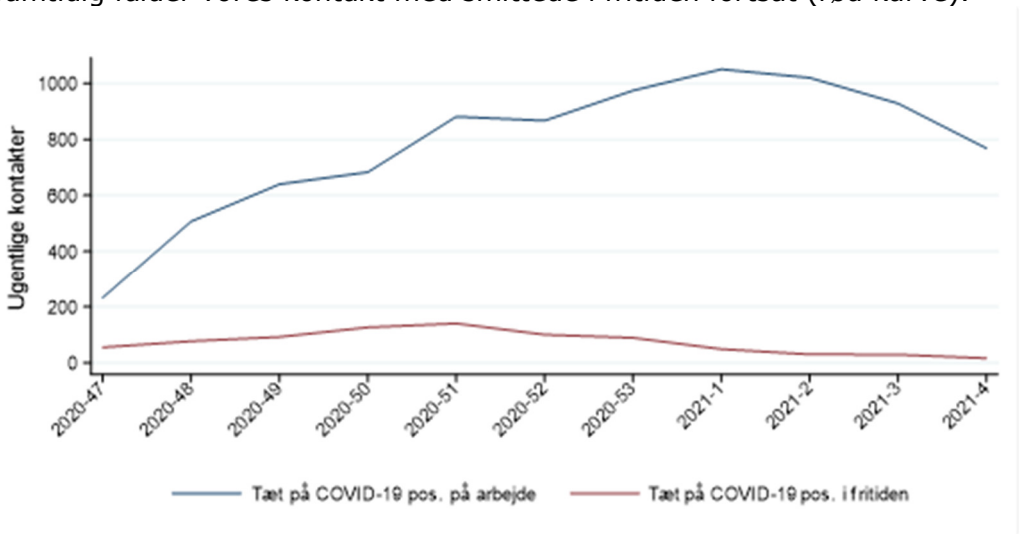
Tak for din værdifulde hjælp!

Venlig hilsen
Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

2/2-2021

Status på undersøgelsen af COVID-19 blandt regionsansatte

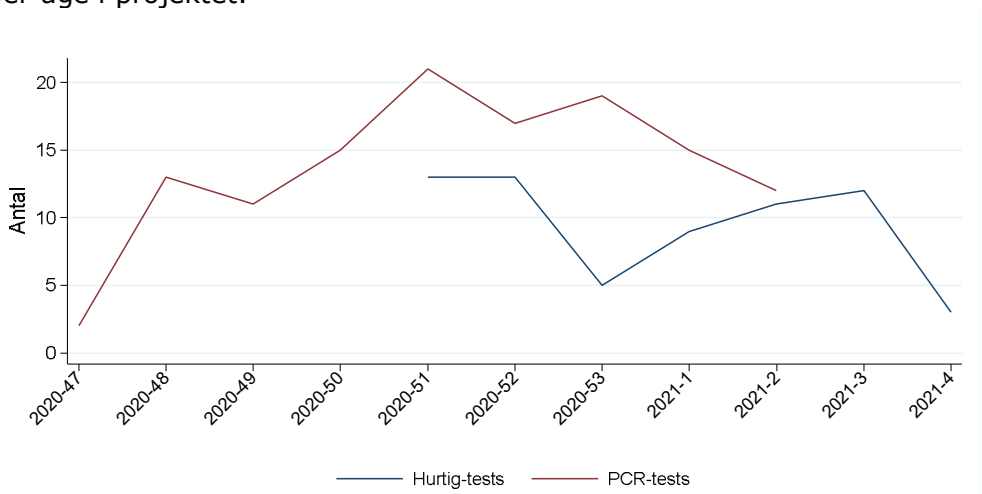
Kære deltager i COVID-19 forskningsprojektet
Tak for din fortsatte deltagelse i projektet.
Kontakt til COVID-19 smittede
Vi vil gerne give dig en sidste opdatering med nogle få data fra projektet. I figur 1 er det tydeligt at der igen bliver færre ansatte, der har kontakt til COVID-19 smittede (blå kurve). Samtidig falder vores kontakt med smittede i fritiden fortsat (rød kurve).



Figur 1: Ugentlige kontakter til COVID-19 smittede på arbejde og i fritiden

Smittede blandt ansatte
Mandag d. 1. februar var der i Region Midtjylland 80 ansatte, som aktuelt var syge med COVID-19. Heldigvis er tallet faldende, men vores projekt fortsætter nu frem til 30/4, så vi kan følge udviklingen i forhold til kontakter, brug af værnemidler mm.

Nedenfor ses antallet af 1. positive PCR-tests (rød kurve) og hurtig-tests (blå kurve) opgjort per uge i projektet.



Figur 2: Antallet af 1. positive Hurtig-test fra uge 51, 2020 til uge 4, 2021 samt antallet af 1. positive PCR-test fra uge 47, 2020 til uge 2, 2021.

Husk
Du kan fortsat ringe på tlf. 2943 5466 mellem 9-15 eller sende en mail til COBRA@rm.dk med spørgsmål til projektet.
Tusind tak for din værdifulde hjælp!

Venlig hilsen
Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

25/2-2021

Status på undersøgelsen af COVID-19 blandt regionsansatte

Kære deltager i COVID-19 forskningsprojektet

God opbakning!
Tak for din fortsatte deltagelse i projektet! Det er opmuntrende for os, at 75% valgte at forlænge deres deltagelse til d. 30. april. Den daglige svarprocent er også fortsat høj. Det er vi glade for.
Tirsdag d. 23. februar var der 20 ansatte i Region Midtjylland, som aktuelt var syge med COVID-19. Heldigvis er tallet faldende, men den begyndende genåbning af samfundet påvirker formentlig også situationen på hospitalerne i den kommende tid.

Vaccinationsstatus i projektet

Vi ser som forventet en stigning i antallet af vaccinerede blandt jer deltagere, som vist i figuren nedenfor.

Figur 1: Samlet antal vaccinerede med 1. (blå kurve) og 2. (rød kurve) vaccination mod COVID-19 blandt deltagere i COBRA projektet.

Vores data viser også, at ca. 75% af dem, der udfører arbejdsopgaver, som kan indebære en smitterisiko, nu er vaccinerede – og den andel stiger fra dag til dag.

Husk
Du kan fortsat ringe på tlf. 2943 5466 mellem 9-15 eller sende en mail til COBRA@rm.dk med spørgsmål til projektet.
Tusind tak for din værdifulde hjælp!

Venlig hilsen
Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

30/3-2021

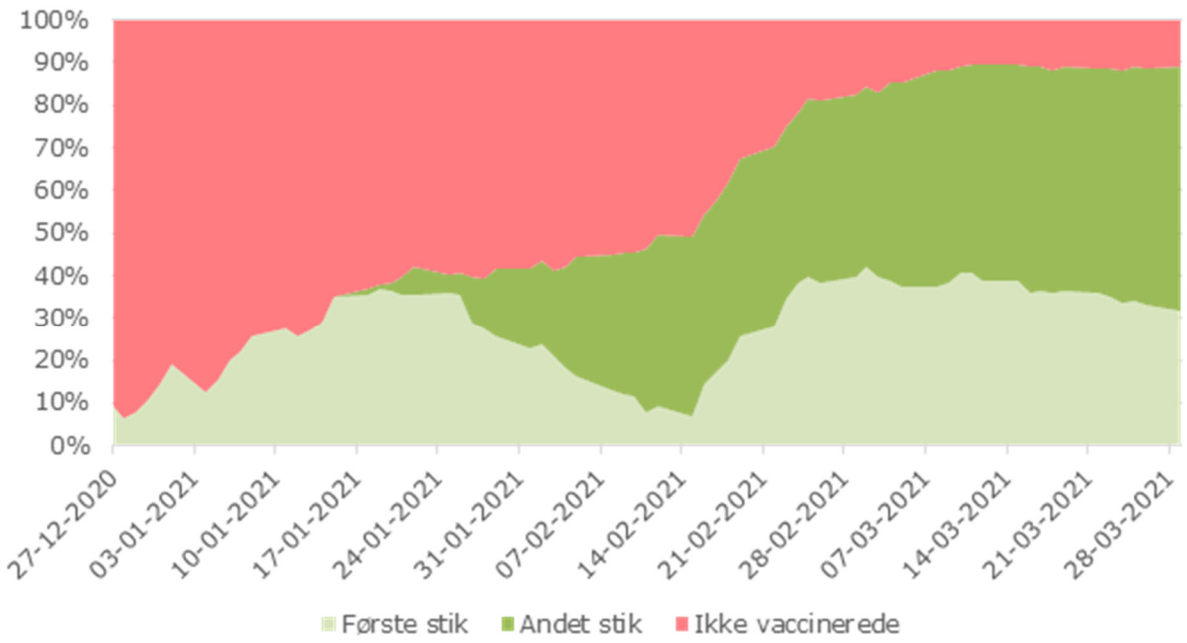
Kære deltager i COVID-19 forskningsprojektet

Vi går heldigvis mod lysere tider, både når det drejer sig om årstiden og COVID-19. Som du kan se i dette nyhedsbrev, så stiger andelen af vaccinerede medarbejdere, mens der er et fald i antallet af nærkontakter med COVID-19 smittede og medarbejdere, der testes positiv for COVID-19.

Vi er imponerede over den fortsatte velvillighed til at deltage, og vi håber, I alle vil fortsætte med at svare frem til undersøgelsen slutter d. 30. april. Vi er meget interesserede i at følge udviklingen henover påske, da vi jo senest så øget smitte henover jul og nytår.

Vaccinationsstatus i projektet

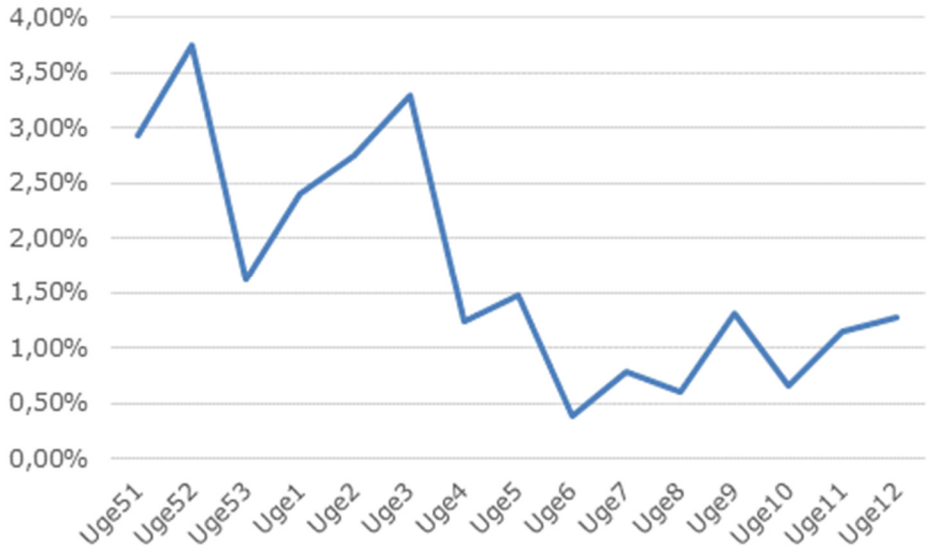
Vores data viser at ca. 90% af dem, der udfører arbejdsopgaver, som kan indebære en smitterisiko, rapporterer at de nu er vaccinerede. 30% har fået første stik, mens 60% har fået begge. Andelen har været stagnerende i de seneste uger svarende til den periode, hvor AstraZeneca har været på pause.



Figur 1: Vaccinestatus for deltagere i projektet, der udfører arbejdsopgaver, som indebærer en smitterisiko.

Kviktest for COVID-19

Deltagerne får foretaget ca. 300-400 hurtigtest/quicktest om ugen. Vi kan se, at andelen af positive tests er faldet siden uge 3, og i de seneste 5-6 uger har den ligget omkring 1%, svarende til 2-4 personer, der testes positiv om ugen ved en hurtigtest/quicktest.



Figur 2: Andel positive kviktests blandt deltagerne opgjort per uge.

Kontakt med COVID-19 smittede på arbejdspladsen

Antallet af patienter med COVID-19 har været faldende siden starten af januar, og i vores data kan vi se, at antallet af medarbejdere, der har haft nærkontakt med smittede på arbejdspladsen har været faldende.

Figur 2: Antal medarbejdere, der dagligt rapporterer, at de har haft nærkontakt med mindst en COVID-smittet på arbejdspladsen.

Husk

Du kan fortsat ringe på tlf. 2943 5466 mellem 9-15 eller sende en mail til COBRA@rm.dk med spørgsmål til projektet.

Tusind tak for din værdifulde hjælp og god påske!

Venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

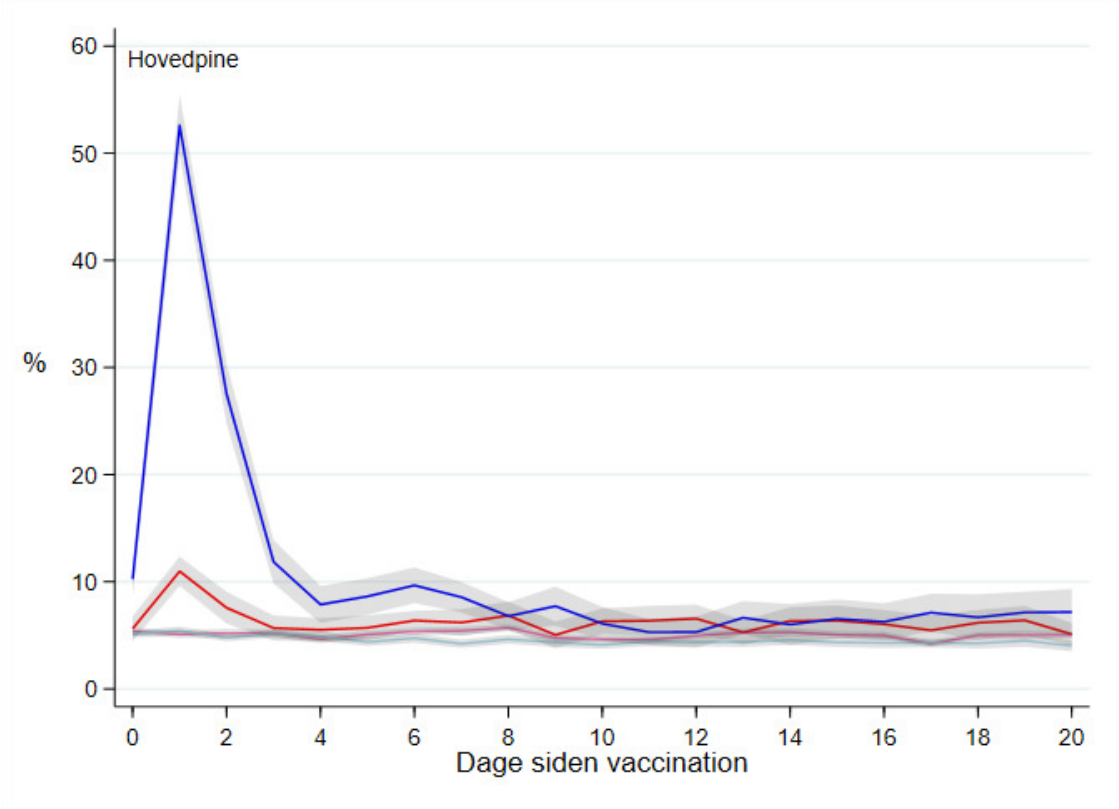
27/4-2021

Emne: Vil du hjælpe med at undersøge akutte bivirkninger ved COVID-19 vaccination?

Kære deltager i COVID-19 forskningsprojektet

De daglige besvarelser på symptomer i undersøgelsen af COVID-19 blandt regionsansatte har bekræftet, hvad mange har erfaret: AstraZeneca-vaccinen medfører flere akutte symptomer end PfizerBioNTech-vaccinen.

Figuren nedenfor viser et eksempel. 50% af deltagerne fik hovedpine dagen efter 1. stik af AztreaZeneca (blå kurve). Dette var kun tilfældet for 10% af dem, som fik PfizerBioNTech (rød kurve) og 5% af de ikke-vaccinerede (grå kurve).



I løbet af de næste par måneder vil mange blive vaccineret. Vi vil gerne følge symptomerne hos både færdigvaccinerede og ikke-vaccinerede for at få mere viden om bivirkningerne.

Derfor inviterer vi alle til at fortsætte i undersøgelsen frem til d. 30. juni. Der vil kun blive spurgt til symptomer i de sidste 24 timer. Det tager meget kort tid at besvare.

Hvis du vil deltage, kan du give samtykke i bunden af det daglige spørgeskema.
Hvis ikke du giver samtykke senest på fredag, vil du stoppe i undersøgelsen d. 31. april som planlagt.

Hvis du har spørgsmål, er du som altid meget velkommen til at kontakte os på cobra@rm.dk eller ringe til os alle hverdage fra 9-15 på 2943-5466.

Tak for din hjælp!

Venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Hospitalsenheden Vest

22/9-2022

Resultater fra COBRA: Risiko for COVID-19-smitte blandt ansatte i Region Midtjylland kortlagt

Kære tidligere deltager i undersøgelsen af COVID-19 blandt regionsansatte (COBRA)

Du har tidligere deltaget i COBRA-projektet, hvor du dagligt svarede på et spørgeskema om symptomer og arbejdsopgaver under COVID-19 pandemien. Derfor vil vi gerne orientere dig om, at der i dag offentliggøres nye resultater fra undersøgelsen, som viser højere risiko for smitte med COVID-19 på hjemmefronten end i arbejdet med COVID-19-smittede patienter.

Under COVID-19 pandemiens anden bølge havde medarbejdere på Region Midtjyllands hospitaler, som var i nær kontakt med COVID-19-patienter, tre gange så stor risiko for selv at blive smittet med COVID-19 i forhold til medarbejdere, uden kendt nær kontakt med COVID-19-patienter. Resultaterne viser også, at medarbejdere, der uden for arbejdet, havde nær kontakt med COVID-19-smittede – for eksempel derhjemme – havde 18 gange så stor risiko for selv at blive smittet sammenlignet med medarbejdere uden kendt nær kontakt til smittede i privatlivet. Endelig havde medarbejdere, der på jobbet havde nære kontakter til smittede kolleger, cirka 2,5 gange så stor risiko for selv at blive smittet.

- Selvom smitterisikoen var højest uden for arbejdet, så viser resultaterne også at medarbejderne kan beskyttes bedre når de er på arbejdet, siger professor Henrik Kolstad, Arbejdsmedicin på Aarhus Universitetshospital.

- Forskningsprojektet understreger nødvendigheden af, at medarbejderne anvender de rigtige værnemidler korrekt og i det hele taget overholder de infektionshygiejniske forholdsregler - både i kontakten med patienter og kolleger. Og derfor må arbejdet tilrettelægges, så det er muligt at overholde forholdsreglerne – også i en travl hverdag.

Resultaterne er baseret på 5.985 regionale medarbejderes besvarelser under anden bølge af COVID-19 pandemien i perioden 25. november 2020 – 30. april 2021 kombineret med deres 36.000 PCR-testresultater. I alt 159 af disse medarbejdere blev smittet med COVID-19.

Du kan læse mere om undersøgelsens resultater i det kommende nummer af MidtNyt og i den publicerede artikel: https://www.sjweh.fi/article/4049

Med venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Karin Biering, seniorforsker, Arbejdsmedicin, Regionshospitalet Gødstrup

22/9-2022

COBRA: Defekt FFP3 maske øgede smitterisikoen omkring jul og nytår 20/21

Kære tidligere deltagere

I januar 2021 deltog du i en undersøgelse af hvorfor der var en stigning i COVID-19-smitte blandt personalet på flere afdelinger i Region Midtjylland omkring jul og nytår 20/21. Mistanken rettede sig mod en bestemt type FFP3-maske (Meixin FFP3 foldemaske), som medarbejderne oplevede ind imellem gik op i sømmene under brug. Maskerne var i brug fra den 24. december 2020 – 8. januar 2021, hvorefter de blev trukket tilbage.

Vi kombinerede dine spørgeskemasvar med resultater af dine PCR-test. Vi fandt, at blandt medarbejdere med nærkontakt til COVID-19 patienter, havde de som brugte Meixin FFP3-masken 2-3 gange forøget risiko for at blive smittet med COVID-19 sammenlignet med dem der benyttede andre typer af FFP2- eller FFP3-masker.

Der deltog 631 medarbejdere i analysen og 15 blev smittet med COVID-19.

Hændelserne med Meixin-maskerne, der gik op i sømmene under brug, førte i øvrigt til at alle lignende foldemasker fra andre leverandører blev testet en ekstra gang for at sikre, at de ikke gik op i sømmen under brug.

Du kan læse mere om undersøgelsens resultater i det kommende nummer af MidtNyt og i den publicerede artikel: https://academic.oup.com/annweh/advance-article/doi/10.1093/annweh/wxac031/6576216

Venlig hilsen

Henrik Kolstad, professor, Arbejdsmedicin, Aarhus Universitetshospital
Kent Nielsen, seniorforsker, Arbejdsmedicin, Regionshospitalet Gødstrup