

The first case of COVID-19 in the Netherlands was diagnosed on 27 February 2020, after which the incidence increased rapidly to a peak of 609 new COVID-19 hospitalizations (3.5 per 100.000 inhabitants) on 27 March. Nationwide lock-down measures were brought into force on 12 March, resulting in a rapid decline in the number of reported cases. The number of reported hospitalizations troughed in week 21 (17 May). Lock-down measures were gradually phased out as of 15 May; however, in July the incidence of COVID-19 confirmed cases started to increase again, with daily hospitalizations increasing to 1.2 per 100.000 inhabitants in week 42 (mid-October). Knowledge of the main factors contributing to community transmission is urgently needed to inform targeted lock-down policies so that transmission can be stopped whilst minimizing effects on society and the economy.

Since 1 June 2020, the Netherlands has made SARS-CoV-2 PCR testing available for all inhabitants experiencing COVID-19 compatible symptoms and for testing in the context of source and contact tracing. Inhabitants can schedule a test through a national call center or, since 12 August, an online portal. The 25 regional Public Health Services (PHS) facilitate sampling in public test locations. Demographic data, testing dates, and laboratory results are entered into a dedicated IT system, named CoronIT. Test results are exported from CoronIT into the HPzone software at the PHS, wherein source and contact tracing data are registered. The National Institute for Public Health and the Environment (RIVM) accesses the anonymized data in CoronIT for surveillance purposes.

When requesting a test, either online or through the call center, the patient is asked about their occupation. The question is posed as: *“have you worked in the past two weeks in the capacity of:”* with a list of employment categories focused on SARS-CoV-2 infection risk (see Table 1). Whenever a patient reports to have recently worked in healthcare or in a close-contact profession (i.e., a profession requiring contact with other persons within 1.5 meters), a follow-up question is triggered asking about the specific healthcare or close-contact profession.

Table 1. Occupational categories and subcategories registered in CoronIT. (1): Hospitality sector is here defined as hotels, restaurants and cafés/bars.

Occupation category	Occupation subcategory
<b>Healthcare worker or paramedic:</b>	Physician
- In a hospital	Audiologist
- In a long-term care facility	Dietician
- Elsewhere	Physiotherapist, occupational therapist, remedial therapist, podiatrist
	(Clinical) aesthetician
	Speech therapist
	Optometrist
	Dentist, dental hygienist
	Nurse
	Caregiver
<b>Close-contact professional</b>	Hairdresser
	Esthetician
	Manicure
	Pedicure
	Driving Instructor
	Sports trainer or instructor
	Retail employees
	Other
<b>Day care personnel (for children aged 0-3)</b>	
<b>Elementary school or after school care personnel (for children aged 4-12)</b>	
<b>Secondary school personnel (for children aged 12 and older)</b>	
<b>Higher education (for ages 16 and older)</b>	

<b>Hospitality worker (1) with client contact</b>
<b>Public transit worker with client contact</b>
<b>Informal caregiver</b>
<b>Police, military police, firefighter, corrections officer</b>
<b>Other occupation involving close contact with people within 1.5 meters</b>
<b>Other occupation not involving close contact with people within 1.5 meters</b>

Using the numbers of negative and positive tests, binomial proportions of positive tests and accompanying 95% confidence intervals were estimated by week of sampling for the test stratified by occupational category or age-group for persons up to and including 24 years of age in R 3.6.0 (prop.test, package 'stats') [1]. Patients aged 25 years and older reporting to have worked in a non-close-contact occupation were used as a reference group. Healthcare workers (HCW) were stratified by the setting in which they work (hospital, long-term care facility, elsewhere). Tests registered as performed in the context of source and contact tracing were excluded from all analyses. We define relevant differences as non-overlapping confidence intervals between the weekly test-positivity of the target group versus the reference group.

Figure 1. Weekly SARS-CoV-2 test-positive percentages with binomial confidence interval (left-hand y axis) and weekly number of tests (right-hand y axis) by population subgroup, the Netherlands, week 23-42. Please note the different scales of the right-hand y axes. The black reference line in each subplot is the test-positivity of adults reporting to have worked in the two weeks prior to testing in an "Other non-close-contact profession". Weekly numbers of tests for this reference group are shown in the last plot (gray bars). HCW: healthcare worker. \* : From week 39 onward, children up to and including 12 years old with complaints that match COVID-19 are no longer tested. Exceptions are severely ill children, children with symptoms who are a contact of a confirmed case, or children who are part of an outbreak investigation.

Figure 1 shows the weekly test-positivity of specific population sub-groups in violet, and of the reference group in black. Overall, an increase in test positivity was seen in weeks 32-33, after which it dropped in week 34-35, and then steadily increased until the last week included in this analysis, week 42. The following occupational groups had higher test-positivity than the reference group: people working in the hospitality sector and public transport, driving instructors, and hairdressers and estheticians. The use of non-medical face masks has been obliged since 1 June in public transportation and advised for contact professions; driving instructors were not advised to wear face masks until 19 October (week 43).

Figure 1 further shows that during the second increase in test-positivity starting at week 36, education personnel and HCW showed lower test-positive proportions than the reference group. These results may indicate good compliance to precautionary measures among these workers, and proper personal protective equipment use among HCW where indicated. They also may – at least in part – be due to a higher testing rate among both these professional categories who in general cannot work from home and for which there are staff shortages meaning it is generally not easy to find a stand-in.

Up to week 39, children below 12 years of age have consistently lower test-positivity than adults. Young children are more likely to develop mild or no symptoms after SARS-CoV-2 infection [2]. Our data shows that among young children with (mild) symptoms, the SARS-CoV-2 test-positivity is also lower. As of week 39, children below the age of 13 years who have mild symptoms and who have not had known contact with a laboratory confirmed COVID-19 patient are no longer advised to undergo SARS-CoV-2 testing due to limited test capacity. The resulting reduction in testing among children in the age groups 0-3 and 4-11 is visible in Figure 2. This change in testing policy likely resulted in an increase in test-positivity. The lower test-positivity among educators is in line with the lower test-positivity among primary school students (up to week 39), suggesting that transmission of SARS-CoV-2 in primary schools is modest, as has been described before [3]. Prevention measures have been taken in schools such as physical distancing between teachers and students and, since week 42, mask use by secondary school students in between classes (Table 2).



Table 2. Brief description of relevant COVID-19 prevention measures and testing policies in the Netherlands, 1 June – 17 October 2020. The following prevention advice has been in place since 12 March and throughout the study period: frequent hand washing, sneeze and cough hygiene, physical distancing of at least 1.5 meters, self-isolate when experiencing COVID-19-like symptoms or when a household member has a fever and/or shortness of breath, and avoid crowded places.

Calendar week 2020	Prevention in short	Testing policies
<b>Week 23</b>	Maintain physical distance of 1.5 meters, above age 12. Non-medical face masks obligatory in public transport. Cinemas, restaurants and cafes, and cultural institutions (such as concert halls and theaters) are allowed to open, with precautionary measures. Schools are open, measures are taken to prevent contact between students and teachers within 1.5 meters.	All inhabitants can schedule a SARS-CoV-2 PCR test if they have complaints that are consistent with COVID-19, such as: running nose, sneezing, sore throat, cough, fever, or sudden loss of smell or taste.
<b>Week 27</b>	The communal sanitation facilities at campsites and holiday parks are re-opened. The maximum number of visitors is expanded to 100 people for cinemas, restaurants and cafes, cultural institutions. Fitness clubs, saunas and wellness centers, club canteens, casinos are re-opened.	
<b>Week 32</b>	Higher education remains online as much as possible. The hospitality sector is open for reservations (in advance or at the door), with a health check and the allocation of a fixed seat (placement) at a table or at the bar. All visitors are asked to register to enable contact tracing.	
<b>Week 34</b>	Gatherings in private homes are limited to 6 people (residents and guests; age 13+) Continue to work from home as much as possible. Home quarantine is reduced from 14 to 10 days.	
<b>Week 39</b>	Bars and restaurants close at 1 a.m. Maximum group size is 50.	Due to shortages in test capacity, children up to and including 12 years old with complaints that match COVID-19 are no longer tested. Exceptions are critically ill children, children with symptoms who are a contact of a confirmed case, or children who are part of an outbreak investigation. Essential healthcare and education personnel can get tested with priority.
<b>Week 40</b>	Work from home wherever possible. Gatherings in private homes are limited to 3 guests, excluding children up to and including 12 years old. Maximum group size elsewhere 4 (>12). The number of people indoors is limited to 30 (>12), outdoors 40.	

	<p>Food and beverage outlets close by 9 p.m., stores close by 10 p.m.</p> <p>Canteens at sporting facilities are closed, no fans allowed at sporting events.</p> <p>People with a close-contact profession ask their customers to register.</p> <p>Limit the number of travel movements as much as possible.</p> <p>All people 13 years of age and older are urgently advised to wear a (non-medical) face mask in publicly accessible indoor areas.</p>
<b>Week 42 'partial lockdown'</b>	<p>Gatherings in private homes are limited to 3 guests per day, excluding children up to and including 12 years old.</p> <p>In secondary education and higher education, everyone must wear a mask outside of class.</p> <p>All restaurants and bars are closed (take-out is allowed).</p> <p>Public transportation only for essential travel.</p> <p>Retail stores close by 8:00 p.m..</p> <p>No alcohol is sold between 8:00 p.m. - 7:00 a.m..</p> <p>Events are cancelled.</p> <p>For everyone 18 years of age and older, sports are only allowed at a distance of 1.5 meters, maximum team size is 4</p> <p>In addition to the canteens at sporting facilities, showers and changing rooms are also closed.</p> <p>Travel abroad as little as possible.</p>

The data presented in this rapid communication have some limitations. Registration of a profession is rather incomplete. In total, 47% of tests fall in the 'unknown' category. Also, certain high-risk professions, such as food processing [4], cannot be identified in our dataset given the limited number of occupational categories in the questionnaire. The completeness of the information improved over time: in week 23, 74% of tests were in category 'unknown', versus 39% in week 42. The category 'unknown' includes patients who did not work in the two weeks preceding their test (e.g. due to (fulltime) education, unemployment, illness, vacation, or retirement), and is therefore not solely 'missing data'.

Test-positivity might not translate to COVID-19 incidences equally for all subgroups. Important unknowns are the incidence of testing per group, the test behaviour, and the incidence of COVID-19-like symptoms per group. The number of tests per 100,000 inhabitants per age group can be determined using demographic data. Denominators for the different specific occupational groups are much more uncertain. Furthermore, since in CoronIT patients are categorized in an occupational group only when having worked in the past two weeks and this question is not always filled in, the numbers should not simply be divided by denominators of known occupational group sizes. Test behaviour is likely to differ between occupational groups, e.g. due to differences in risk perception and the extent to which it is possible to work from home. For example, for small business owners in the hospitality sector, the threshold for testing may be relatively high. In recent weeks of test scarcity, people may have been discouraged from testing due to long delays (90 hours on average in week 41) between applying for a test and receiving its result, during which time the patient is requested to self-isolate. Since 21 September (week 39), essential HCW and teachers receive priority testing to facilitate a swift return to work. The number of tested individuals among HCW and educational staff (especially working in secondary education) increased since week 39, and the curves for HCW (hospital and elsewhere) and education (secondary and higher) diverge more from the reference as of this week. The incidence of symptoms is even



more uncertain. A novel population-based syndromic surveillance system (modeled on *influenzanet* [5]) will hopefully provide more insight into the incidence of COVID-19-like symptoms in the coming months. It may be hypothesized that occupational groups such as HCW and childcare professionals might be at an increased risk of exposure to other respiratory pathogens with symptoms similar to COVID-19, such as rhinovirus, rendering these patients more likely to test and to test negative for SARS-CoV-2.

Published data on COVID-19 associated deaths [6,7] and hospitalizations [8] by occupation have highlighted healthcare workers as being at increased risk for severe COVID-19, which is in contrast with our finding of lower test-positivity. It is possible that there is selection bias in our data on HCW. HCW employed by a hospital and long-term care facilities with direct links with a hospital can be tested via their own employer (the hospital laboratory) rather than the PHS test locations. These tests outside of the PHS are not registered in the CoronIT database and are therefore not included in our analysis. However, some hospital laboratories also report directly to RIVM the numbers of negative and positive tests separately for patients and employees. In these data, the percentages positive among hospital employees are slightly lower than in the tested persons registered in CoronIT as 'HCW in hospital' [9]. The risks of SARS-CoV-2 infection and severity for HCW do not appear to be higher than average, from notifications received since June. Compared to other notified cases aged 17-69, we have seen relatively low percentages of hospitalized (0.3% vs 0.7% of non-HCW notified cases) and deceased (0.01% vs 0.05%) HCW since 1 June. For the 'first wave' of COVID-19 in the Netherlands, such comparisons are less informative due to testing policy prioritizing HCW.

Despite its limitations, CoronIT provides the unique possibility of detailed nationwide surveillance of SARS-CoV-2 by population subgroup in the Netherlands. Evidence on occupational risk of testing positive for COVID-19 is thus far scarce. The finding of increased test-positivity among workers in hospitality sector, public transport, driving instructors, and hairdressers and estheticians has not only implications for these professionals, but also for the wider public making use of these services. The registration of occupation of tested patients is very relevant for policy makers. The CoronIT data are useful to evaluate COVID-19 mitigation policies and identify sectors eligible for re-opening or requiring further restrictions. Changes to testing practices in the near future, such as rapid antigen testing, should be embedded in this surveillance system, so that subgroup-specific surveillance of test-positivity remains possible.

In the current 'partial lockdown' of COVID-19 in the Netherlands, the government has ordered restaurants and bars to be closed whilst schools were allowed to remain open. The surveillance data in CoronIT will allow evaluation of the further development of the COVID-19 epidemic in specific subpopulations targeted by prevention measures. We believe these population-level subgroup-specific surveillance data can also be informative for European countries without data on specific target groups that might aid choices in national policies to slow the spread of COVID-19.

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