The effect of working at home versus at the office on risk of transmission of SARS-CoV-2 and other respiratory agents. A randomized controlled trial (study protocol).

Petter Elstrøm (project manager)[1,4], Ingeborg Hess Elgersma[1], Stein Knardahl[3], Atle Fretheim[1,2], Arnfinn Helleve[1,5], Oliver Kacelnik[1,4], Didrik Vestrheim[1,4], Tone Bruun[1,4]

[1]Centre for Epidemic Interventions Research (CEIR), Norwegian Institute of Public Health
[2]Faculty of Health Sciences, Oslo Metropolitan University
[3] National Institute of Occupational Health, Oslo, Norway
[4]Division of Infection Control, Norwegian Institute of Public Health
[5]Centre for Evaluation of Public Health Measures, Norwegian Institute of Public Health

Contact: petter.elstrom@fhi.no

Abstract

Background: Working from home has in many countries been a strongly advised infection prevention during the COVID-19 pandemic. However, we have not found evidence that this intervention influences the transmission of SARS-CoV-2 or other respiratory agents. Randomized trials are needed to assess if working from home reduce the risk of respiratory infections or outbreaks among employees.

Methods: Randomized two-arm multi-period crossover superiority trial. We will recruit 3-5 large firms with over 2000 eligible participants, located in Oslo and neighbouring municipalities. All consenting employees in the selected organizations are eligible to participate in the trial. The organizations can define in advance certain key personnel that cannot take part in the trial. The participants will be randomized (1:1) to either i) mainly work from home in 4 weeks, and then at the office in 4 weeks, or ii) first work in the office in 4 weeks and then at home. Our primary outcome will be the proportion of participants who report having symptoms of respiratory disease during the trial period (self-reported). Given a dropout rate of 50%, we assume we need to enrol > 5500 participants to be able to detect a 50% reduction in the risk of COVID-19.

Discussion: We expect there to be some bias in the self-reporting of symptoms of respiratory disease, since participants allocated to the going to the office group, will need to consider every day if they feel healthy, while participants staying at home will not have to consider this. Thus, we plan to look only at symptoms above a certain threshold

Trial registration

ClinicalTrial.gov: NCT05298488

Cristin.no: CristinID2535463

Keywords

COVID-19; non-pharmaceutical intervention; prevention; home office; pragmatic trial; randomized trial

Introduction

Background and rationale

Radical social distancing interventions are highly likely to reduce the risk of viral transmission, based on both theory on the transmission of viral pathogens and the experiences from the COVID-19 pandemic. Most countries implemented a range of policies to reduce social contact between people, and these combinations of policy measures have been associated with reductions in SARS-CoV-2 transmission. Still, controversy remains around the relative importance of different measures, e.g. school closures, banning serving of alcohol, and limiting the number of social contacts, as well as other infection control measures that have usually been implemented alongside social distancing interventions, including hand washing and face masks. It has proved hard to deduce the relative importance of different measures partly because little or no rigorous research has been conducted to elucidate the effect of single interventions, and partly because the most common sources of infection are often unknown. For example, the relative importance of school closures is uncertain, both because no trial of school closures has been conducted, and because it is unclear to what extent transmission happens in schools.

Working in the office entails to various extent contact with colleagues, and for some it includes close contact to others when using public transport to and from work. This likely increases the risk of transmission and many workplaces along with health authorities have strongly advised employees to work from home as much as possible during the COVID-19 pandemic. On the other hand, most people are infected from other family members, and working from home increases exposure to other family members.

We have not identified any other trials on the effects of teleworking / home office on the risk of transmission of SARS-CoV-2 and other respiratory agents. Studies that have looked at associations between teleworking and COVID-19 have found a negative correlation (Fisher et al 2020; Chen 2021).

A systematic review from the National Institute of Occupational Health (STAMI) showed that workers working from home experienced higher work satisfaction and productivity, while also reporting negative effects on work-life balance, professional isolation and working outside core hours. Effects on health outcomes were mixed. The quality of the studies was generally judged as low.

However, working at the office could mean increased exposure to transmission of SARS-CoV-2 and other respiratory agents. Thus, both interventions do pose potential benefits and harms for the participants.

Working from home is a broadly applied intervention nationally and internationally during the COVID-19 pandemic. Establishing what effect this intervention has on actual spread of SARS-CoV-2 and other respiratory agents could hence provide valuable insight to national and local authorities and decision-makers.

Objectives

We propose to conduct a trial to assess whether working at home impacts on employees' risk of respiratory infection and reduce the risk of work-related outbreaks. The aim is to reject the null

hypothesis that working at home does not reduce the risk of respiratory infections or outbreaks among employees.

Trial design

We plan to conduct the trial as a two-arm multi-period crossover superiority trial where the employees are allocated into two equally sized groups.

Figure 1 illustrates the trial timeline and the cross-over structure.

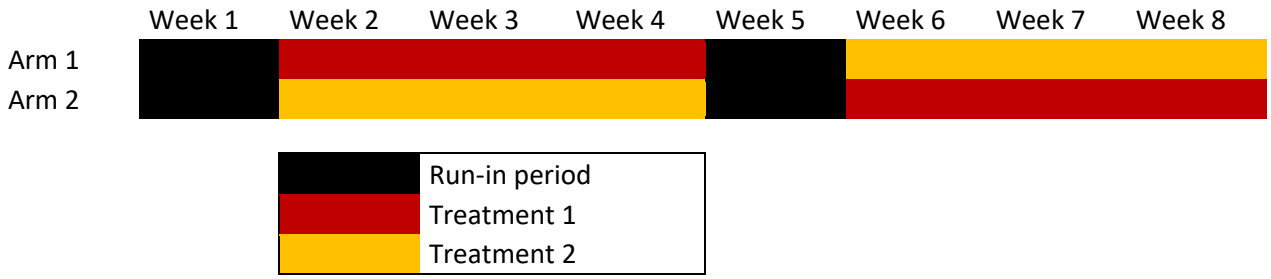


Figure 1: Trial design

The first and second arm will cross-over (change treatment) after four weeks. Week 1 and week 5 will be considered run-in periods for these arms, and the data collected these run-in weeks will not be used as outcome data in the statistical analysis.

Methods: Participants, interventions, and outcomes

Study setting

We propose to recruit 3-5 large firms with over 2000 eligible participants. In appendix 1, we have attached an information form that we plan to forward to the firms. We will include firms located in Oslo and neighbouring municipalities which currently are seeing the highest incidence rates of SARS-CoV-2 in the ongoing covid-19 pandemic in Norway.

Eligibility criteria

All consenting employees in the selected organizations are eligible to participate in the trial. The organizations can define in advance certain key personnel that cannot take part in the trial (see information sheet, appendix 1).

Employees at the Norwegian Institute of Public Health (NIPH) who are directly working with this study are excluded, if NIPH chooses to participate.

Interventions

We will test two different interventions, described in the table below:

	Description
1	Participants will strive to be working from home every day. Participants can go to the office in order to complete tasks that cannot be completed from home.
2	Participants will be working from the office most days, but at least three days a week.

The nature of the two treatments will be further shaped in collaboration with the participating organizations, in accordance with current teleworking policies.

The intervention for treatment 1 and 2 will last for four weeks, the first week considered the run-in period.

Persons who test positive for COVID-19 during the first step will be censored in the second step. Trial participants that during the trial for any reason cannot follow the allocated intervention will also be excluded from the analysis.

Outcomes

Our primary outcome will be the proportion of participants who report having symptoms of respiratory disease during the trial period (self-reported).

Secondary outcomes:

- Proportion of participants who test positive for SARS-CoV-2 (based on both self-reported and registry data)
- Number of days of absence from work.
- Number of secondary cases (transmission from participants in the study) or outbreaks (2 or more cases)
- Self-reported work-satisfaction, perceived work-life balance.

Table 1: Table of outcomes

Outcome	**Source**	**Analysis metric**	**Method of aggregation**	**Time point**
Primary outcome				
Symptoms of respiratory disease (over a certain threshold)	Self-reported	Final value	Number of person-days with respiratory symptoms	Measured from week 2 to week 4 during each step
Secondary outcome				
Sars-CoV-2	Self-report of rapid test result	Final value /time until event?	Share of participants who tests positive during each step	Measured by the end of each step
Positive tests of notifiable respiratory infections	Registry data (MSIS)	Final value	Number of cases per 1000 person-days, distributed by disease/identified microbe	Measured per day and by the end of each step
Absence from work	Self-report of absence caused by infectious disease, quarantine, or other/unknown causes	Final value	Count	Weekly
Secondary cases at the office and in the household	Based on reported date and place of infections among employees at the office, and self-reported number of secondary cases in the household	Final value	Count	Weekly

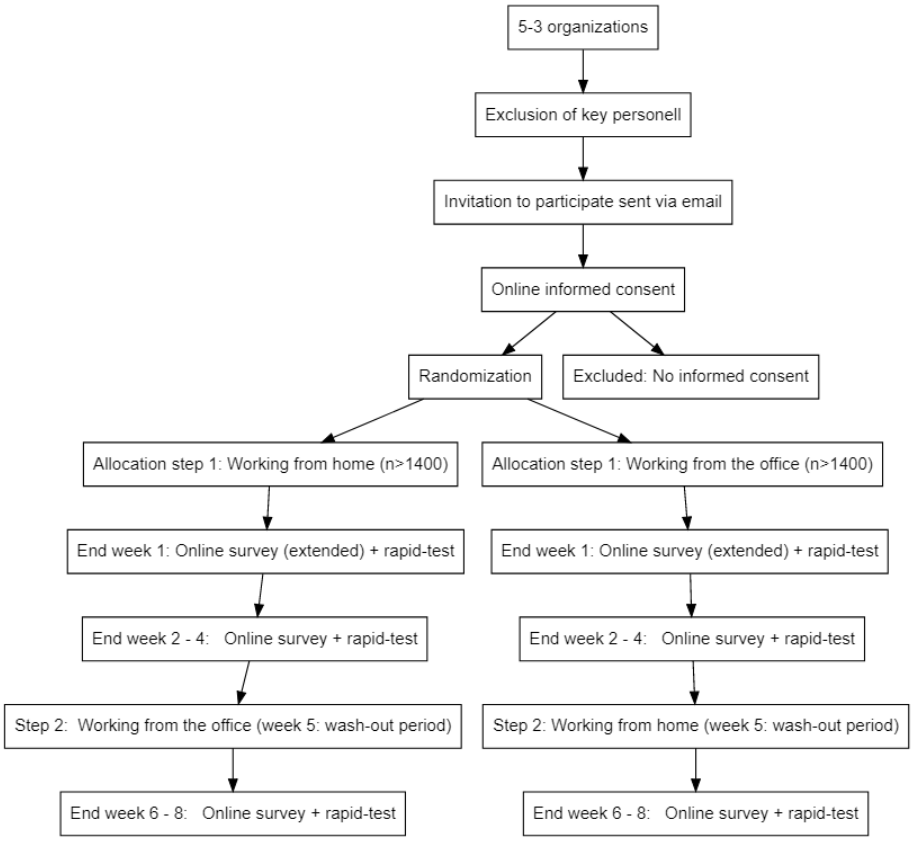
Place of infection	Self-reported exposure to persons with communicable disease at home, in the office or in other settings	Final value	Categorical variable	Weekly
Work-life-balance	Self-reported – Likert scale	Final value	Averaged over each period	Weekly
Work satisfaction	Self-reported each week – Likert scale	Final value	Averaged over each period	Weekly

We expect there to be some bias in the self-reporting of symptoms of respiratory disease, since participants allocated to the going to the office group, will need to consider every day if they feel healthy, while participants staying at home will not have to consider this. Thus, we plan to look only at symptoms above a certain threshold (see appended questionnaire, appendix 3).

We will also look at positive or negative effects of the intervention for the household. We will ask Regional Ethics Committee to consider whether we need to ask household members for consent if we ask participants in the questionnaire to report on the number of household members with symptoms of communicable diseases.

Participant timeline

The following flowchart presents the participant timeline. Follow-up time will be in total eight weeks, after the trial commences.



Sample size

The prevalence of symptoms of respiratory disease varies over time. Numbers from Symptometer, show that the proportion of the population who have displayed symptoms of respiratory diseases in a given week has varied between just below 2 % to 8 % the last year (week 45 2020 – week 48 2021) (FHI Symptometer 8.12.2021).

Given that 10 % experience symptoms within a period of three weeks in the control group, and working from home reduces this share with 30 %, and the share that experience symptoms at least once in the intervention group is 7 %, we estimate a need for 1346 participants to demonstrate a statistically significant difference ($p<0.05$), and 80% power, given a two-arm trial.

The sample size is calculated based on the expected effect on the primary outcome; however, the primary outcome will require a smaller sample size to receive enough power that some of the secondary outcomes, e.g. the risk of COVID-19. We will also need to plan for a high dropout rate.

Thus, we have also conducted a sample size calculation on the basis of COVID-19. Assuming that 1 % in the working-at-home group will test positive for COVID-19 in the follow-up period and 2 % in the working at the office group, we estimate a need for 2254 participants to demonstrate a statistically significant difference ($p<0.05$), and 80% power, given a two-arm trial.

Given a dropout rate of 50%, we assume we need to enrol > 5500 participants to be able to detect a 50% reduction in the risk of COVID-19.

We will thus customize the trial and the number of secondary outcomes in accordance with the number of participants we are able to recruit. If the number is too low to detect a possible difference

in COVID-19, we will consider not handing out rapid-tests, nor will the questionnaire contain questions on COVID-19.

Recruitment

Recruitment will take place in two steps. First, organizations will be recruited. Appendix 1 contains an information sheet that we plan to distribute to potential participating organizations. For those organizations that decide to join, we also plan to provide a standardized package of information that they could use during the trial, reflecting current recommendations in place regionally or nationally.

After we have recruited enough organizations, information on the trial and how to participate, will be distributed by email and/or on the intranet. Appendix 2 contains an information sheet and consent form to be sent to participants. Different organizations may have different routines on how to inform employees, so we need a close dialogue with the organizations in order to recruit enough participants.

Participants will be enrolled by filling out a form that will be sent to them by email or posted on the intranet. The trial will commence 4 weeks after this information was made available, if enough participants have accepted to participate in the trial. Participants will then be contacted later in order to be informed of which arm of the trial they are assigned to.

Methods: Assignment of interventions

Allocation

Allocation will be random. Randomization will be stratified by organization. Randomization software in R will produce the random sequence.

Allocation concealment mechanism and implementation:

The assignment of the intervention will be conducted as follows:

- One team member will create a random sequence of A and Bs using randomization software
- Another team member will extract a list of participants
- The third team member will put these two lists together.

Blinding (masking)

To the extent practically possible, we will see to that the dataset is prepared in a way which blinds the person conducting the analyses from the group allocation of each study participant.

Methods: Data collection, management, and analysis

Data collection methods

Data will be collected mainly by weekly questionnaires.

The first questionnaire will also contain some questions on background data: number of household members, how many days of week the participants usually work, commute to work.

We also plan to collect data from the following national registries: The National Population Register (Folkeregisteret), Norwegian Surveillance System for Communicable Diseases (MSIS), Norwegian Immunisation Registry (SYSVAK).

Participants will be sent reminders if they fail to reply to the survey.

Data management

Statistical methods

We will provide details of the statistical analysis in the final protocol and statistical analysis plan before the analyses are conducted.

Methods: Monitoring

Data monitoring and harms

As this is not a clinical study, a data monitoring committee is not needed.

Harms

Participants' work satisfaction will be monitored through the trial. If work satisfaction is considered low, the trial will be terminated. What should be considered too low work satisfaction will be agreed upon with the safety representatives in the organisations prior to the trial.

Participants will be informed that they can drop out of the trial whenever they want to, and that they will not need to provide a reason for not participating or dropping out of the trial.

Ethics and dissemination

Research ethics approval

The trial will start when the plan is approved by the Regional Committees for Medical and Health Research Ethics South East Norway.

Protocol amendments

Important protocol amendments will be communicated to REK and to the organizations.

Consent or assent

Since participants will actively need to enrol in the trial, consent will be obtained when participants are enrolled in the trial. A consent form is attached.

Confidentiality

After the questionnaires are received each week, the data will be transferred, stored and analysed in the Norwegian Institute of Public Health's High Security IT environment. We will not report any information that directly or indirectly can identify individuals.

Declaration of interests

We declare no conflicting interests.

Access to data

Petter Elstrøm and Ingeborg Hess Elgersma will have access to the final trial dataset.

Dissemination policy

Results will be communicated to trial participants in company channels, for example on the intranet.

Furthermore, the results will be published in an academic journal. We will strive to make the results accessible to non-academic readers.

The protocol will be attached as supplementary material to any journal article.

Statistical code will be made available upon request. A participant-level dataset cannot be made available.

Sources

Chan A-W, Tetzlaff JM, Altman DG, Laupacis A, Gøtzsche PC, Krleža-Jerić K, Hróbjartsson A, Mann H, Dickersin K, Berlin J, Doré C, Parulekar W, Summerskill W, Groves T, Schulz K, Sox H, Rockhold FW, Rennie D, Moher D. SPIRIT 2013 Statement: Defining standard protocol items for clinical trials. Ann Intern Med 2013;158:200-207.

Chan A-W, Tetzlaff JM, Gøtzsche PC, Altman DG, Mann H, Berlin J, Dickersin K, Hróbjartsson A, Schulz KF, Parulekar WR, Krleža-Jerić K, Laupacis A, Moher D. SPIRIT 2013 Explanation and Elaboration: Guidance for protocols of clinical trials. BMJ 2013;346:e7586.

Chen Y-H, Glymour M, Riley A, Balmes J, Duchowny K, Harrison R, Matthay E, Bibbins-Domingo K. Excess mortality associated with the COVID-19 pandemic among Californians 18–65 years of age, by occupational sector and occupation: March through November 2020. PLOS ONE. 2021 Jun 4;16(6):e0252454.

Fisher KA, Olson SM, Tenforde MW, Feldstein LR, Lindsell CJ, Shapiro NI, Files DC, Gibbs KW, Erickson HL, Prekker ME, Steingrub JS, Exline MC, Henning DJ, Wilson JG, Brown SM, Peltan ID, Rice TW, Hager DN, Ginde AA, Talbot HK, Casey JD, Grijalva CG, Flannery B, Patel MM, Self WH; IVY Network Investigators; CDC COVID-19 Response Team. Telework Before Illness Onset Among Symptomatic Adults Aged ≥18 Years With and Without COVID-19 in 11 Outpatient Health Care Facilities - United States, July 2020. MMWR Morb Mortal Wkly Rep. 2020 Nov 6;69(44):1648-1653. doi: 10.15585/mmwr.mm6944a4. PMID: 33151918; PMCID: PMC7643895.

Fløvik L., Lunde, L-K, Vleeshouwers J, Johannessen H, Finne LB, Mohr B, Jørgensen IL, Christensen JO. Arbeid hjemmefra, helse og arbeidsmiljø - En systematisk kunnskapsoppsummering. *STAMI-rapport*. 2021 22(3). ISSN 1502-0932

Folkehelseinstituttet. Symptometer. Ukerapport – uke 48 onsdag 8. desember 2021. Available at https://www.fhi.no/hn/statistikk/symptometer/resultater-fra-symptometer/