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[Rapid Protocol]

Non-pharmacological measures implemented in the setting of long-term care facilities to prevent SARS-CoV-2 infections and their consequences: a rapid review

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ABSTRACT

Objectives

This is a protocol for a Cochrane Review (rapid). The objectives are as follows:

To assess the effectiveness of non-pharmacological measures implemented in the setting of long-term care facilities (LTCFs) in preventing or reducing transmission of SARS-CoV-2 infection among LTCF residents, staff, and those visiting LTCFs.

BACKGROUND

Description of the condition

The novel coronavirus disease strain, coronavirus disease 2019 (COVID-19), is caused by the highly transmittable severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Zhou 2020). It first emerged in Wuhan, China in 2019 and rapidly spread worldwide, being declared a global health emergency by the World Health Organisation (WHO) on 30 January 2020 (WHO 2020a). The consequences of an infection can range from no or mild symptoms of an upper respiratory tract infection to acute respiratory distress syndrome and death (Hu 2021).

The global pandemic has affected different population groups very unevenly. Early in the pandemic, studies reported on the determinant effect of age on COVID-19-related morbidity and mortality. Senior citizens, and in particular (but not limited to) those with pre-existing conditions, such as Alzheimer's disease and other dementias, face the highest risk (Manca 2020, Mok 2020). While there is a low risk of death of < 0.01% in infected individuals aged younger than 50 years, this risk sharply increases in older age groups, with an estimated infection fatality rate (IFR) of 12 to 16% in infected men and 5 to 6% in infected women 80 years and older, respectively (Bonanad 2020; Pastor-Barriuso 2020; Williamson 2020). Another group with a higher risk of severe outcomes from COVID-19 is people living with intellectual and developmental disabilities (IDD), such as people living with Down's Syndrome (Clift 2021; Turk 2020). An important factor in the transmission dynamics of SARS-CoV-2 is the so called 'superspreading event', where one infected individual causes a very large number of secondary cases, often in a specific setting. Outbreaks linked to superspreading events have been found to be associated with enclosed, poorly-ventilated indoor environments, where adherence to protective measures such as social distancing is difficult or impossible, hence leading to high human contact rates with elevated risk of transmission over prolonged periods of time (Althouse 2020; Koh 2020; Wong 2020). Long-term care facilities (LTCF) display all these features and have therefore been found to be at high risk for outbreaks and superspreading events (Comas-Herrera 2020; ECDC 2020; Koh 2020; Salcher-Konrad 2020). For example, in the first three weeks of January 2021, the Robert Koch Institute (German National Public Health Institute) classified 50,839 COVID-19 cases as being attributed to outbreaks in high-risk settings. Of those, 22,568 (44%) were attributed to LTCFs, a setting where less than 1% of the German population resides (RKI 2021).

The combination of a setting characterised by features that increase the risk for SARS-CoV-2 transmission and inhabitants at high risk of suffering a severe course of COVID-19, due to their age and health status, has made LTCFs a focal point for the morbidity and mortality burden of the SARS-CoV-2 pandemic. According to the European Centre for Disease Prevention and Control (ECDC), between 26% (England and Wales) and 66% (Spain) of all deaths during the first wave of the COVID-19 pandemic in 11 European countries were among residents of LTCFs (ECDC 2020). With less than 1% of the USA's population living in LTCFs, this fraction of the country's population accounted for 36% of the USA's COVID-19 deaths (The COVID Tracking Project 2021). The International Long-Term Care Policy Network, which tracks the COVID-19-related mortality burden in LTCFs, found that, on average, 46% of deaths in 21 high- and middle-income countries were attributable to LTCFs (Comas-Herrera 2020). According to their report, 4% of care home residents in Belgium, Ireland, Spain, the UK, and the USA had died as a result of COVID-19 by October 2020.

Description of the interventions

To protect residents and staff in LTCFs from COVID-19, various protective measures have been recommended in several national and international guideline documents (Rios 2020; WHO 2020b; WHO 2020b; WHO WPRO 2020). These have been implemented to a varying extent (Fischer 2020; Frazer 2020a; Gmehlin 2020; WHO 2020b). Based on a preliminary scoping of the literature, we developed an a priori process-based logic model to display the relation between intervention domains and outcomes (Figure 1) and a system-based logic model to describe and classify relevant interventions in relation to broader contextual factors (Figure 2). These models represent the authors' evidence-informed understanding of the system in which the measures to protect residents of LTCFs were implemented during the present SARS-CoV-2 pandemic. Based on this, we have distinguished four domains of measures that focus on (i) entry regulations, (ii) regulating contacts and transmission, (iii) surveillance, and (iv) outbreak control measures.

Figure 1. Figure 1: Process-based logic model on the relation between intervention domains and outcomes (LTCF: Long Term Care Facility)

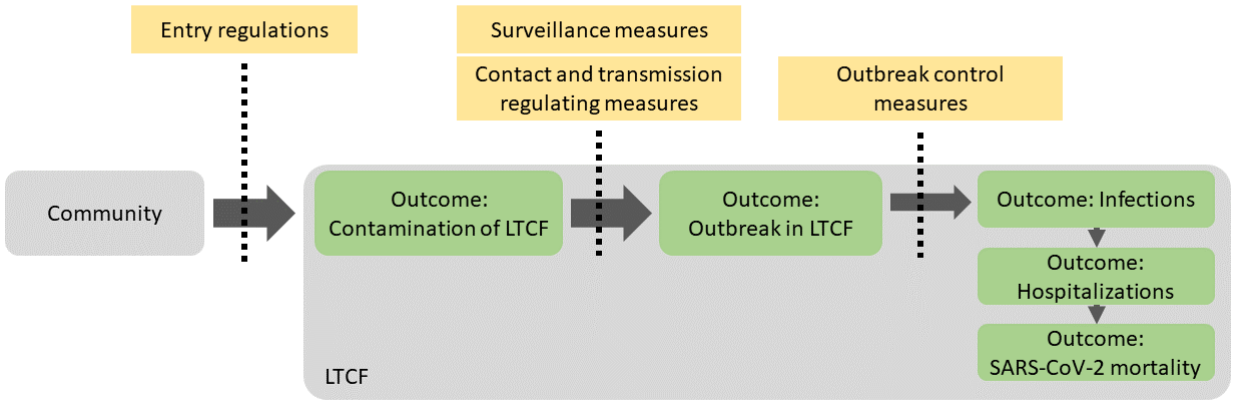
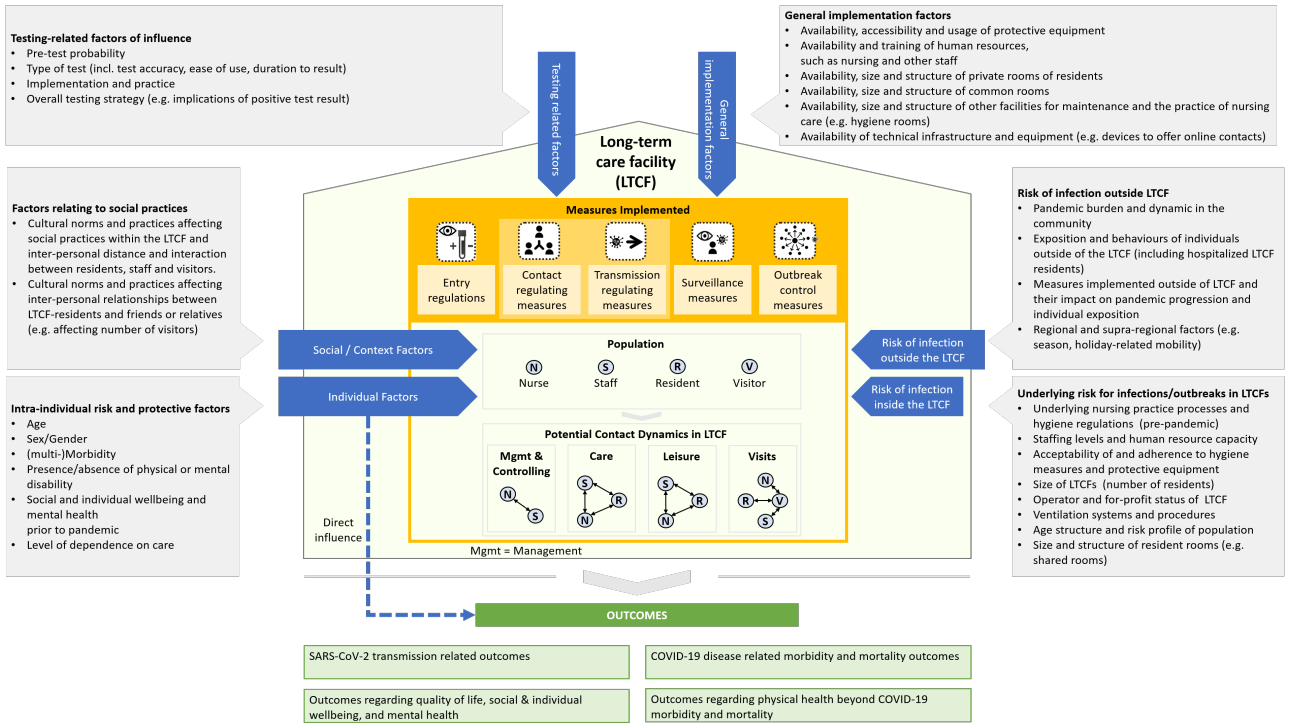


Figure 2. Figure 2: System-based logic model of the interventions and contextual factors as potential moderators (LTCF: Long Term Care Facility)



Entry regulations

Measures that focus on entry regulationscan (potentially) prevent infected individuals from entering LTCFs, which results in reducing the risk of infection for residents and staff. This can be achieved, for example, through rapid antigen testing of visitors and staff prior to entry, recommendations or regulations on abstaining from visiting or working in the presence of symptoms of a respiratory tract infection, or policies temporarily suspending visits from friends and relatives (Frazer 2020a; Gmehlin 2020; Rios 2020).

Contact regulating measures

Some interventions focus on daily routine and practice within the LTCF and aim to reduce the risk of infection, primarily through reducing the number of contacts with potential for transmission or the risk of transmission upon contact occurring. Contact regulating measuresto reduce the number of contacts with potential for transmission include: physical distancing; moving residents from shared rooms into single rooms; limiting the number of persons present in common rooms at any point in time, such as through staggered dining times; suspending non-essential services (e.g. hairdressing services for residents); suspending group activities (such as gathering in large groups for religious services); or cohorting wards (Frazer 2020a; Gmehlin 2020; Rios 2020).

Transmission regulating measures

Transmission regulating measures can be implemented to reduce the risk of transmission (from droplets or airborne particles) upon contact occurring. These include: guidelines on respiratory hygiene and cough etiquette; physical barriers, such as mobile acrylic glass walls; or regulations on mask wearing (e.g. staff wearing masks when interacting with residents). Measures may also include suspending activities that are judged to be at high risk of producing aerosols, such as singing (Rios 2020). Other measures aim to reduce the risk of infection stemming from the physical environment. These include measures to reduce fomite transmissions, for example, by way of limiting the use of shared equipment, adapting surface cleaning measures, or usage of protective equipment such as gloves (Frazer 2020a; Gmehlin 2020; Rios 2020). Other transmission regulating measures aim to reduce the number of infectious particles in the air, through active or passive ventilation or air filtration technologies (Kohanski 2020).

Surveillance measures

Surveillance measures, such as surveillance testing (e.g. weekly antigen testing) or symptom-based screening (e.g. daily temperature measurement) conducted in a sample of residents on a regular basis, where there is no known case in the facility or among staff members, can be a measure to ensure early detection. Such strategies may prevent secondary infections or outbreaks within LTCFs if the appropriate measures are then taken. This is of particular importance due to the risk of SARS-CoV-2 transmission by asymptomatic or pre-symptomatic individuals (Salcher-Konrad 2020).

Outbreak control measures

Interventions can also focus on preventing secondary infections or outbreaks within LTCFs in the event that a SARS-CoV-2 infection is detected within the LTCF or a high risk of infection is suspected among residents, staff, or visitors. This can include outbreak control measures, such as isolation of infected individuals or quarantine following a potential exposure (e.g. after contact with a visitor who tested positive for SARS-CoV-2 or upon returning from medical treatment outside the LTCF). Furthermore, it can entail mass testing strategies, stricter measures that aim to reduce transmission, or stricter measures to reduce contacts among residents and staff — in comparison to the transmission and contact regulating measures implemented before the infection was detected (Hatfield 2020; Shrader 2020).

How the interventions might work

As displayed in Figure 1, entry regulations aim to prevent the introduction of infectious agents from the community into the LTCF (via staff, residents, or visitors) and thereby prevent the outcome of contamination, defined as at least one individual infected with SARS-CoV-2 in the facility. Contact and transmission regulating measures aim to prevent the transmission from unknown or not yet identified cases, such as staff members working in the pre-symptomatic stage within the community, to individuals within the LTCF who are not yet infected. Surveillance measures aim to detect infections at an early stage and prevent further transmission through targeted measures, such as isolation. Both intervention domains can stop or prevent progression of a (known or unknown) contamination in a LTCF into an outbreak, defined as secondary infection in the LTCF. Furthermore, these measures, as well as other outbreak control measures, can contribute to limiting the number of infections, and — as a result — the number of hospitalisations and SARS-CoV-2 related deaths. The effectiveness of these measures is likely to vary, depending on implementation factors that can influence fidelity to the various elements of an intervention's key functions, as well as consistency of delivery and maintenance over time (Hawe 2004). For example, a national directive on the wearing of FFP2-masks by nursing staff in their interaction with residents may not be consistently implemented due to a lack of protective equipment (Nyashanu 2020). Similarly, the screening of visitors to the nursing home using a rapid antigen test may miss a higher proportion of cases due to inappropriate approaches in taking swab samples (Lippi 2020), or shortages in staff (Nyashanu 2020). Adherence to measures (e.g. enforcing and maintaining social distancing) may be influenced by their general understandability and acceptability of the measures, as well as by the approach taken to enforcing them. The level of adherence has profound implications, and likely to also impact on the effectiveness of such measures (Nyashanu 2020).

Furthermore, the effectiveness of these measures regarding SARS-CoV-2 transmission may be moderated by contextual factors within and outside the LTCF. Characteristics of LTCFs that have been linked to infections or outbreaks within LTCFs include the for-profit status of the facility (Shallcross 2020), lower staff-to-resident ratios (Shallcross 2020), larger facility size in terms of beds or staff (Temkin-Greener 2020), quality ratings of the facility (Bui 2020), presence of healthcare unions (Dean 2020), reliance on agency staff (Shallcross 2020), higher occupancy rates (Shen 2020), and the sharing of rooms by residents (Frazer 2020a). While these factors could be causally linked to an increased risk of infection (e.g. sharing a room leads to a higher probability of transmission), others could merely be associated with other causally linked risk factors (e.g. if a care facility with lower quality ratings has a higher rate of shared rooms).

Moderating factors outside the care facilities could include broader sociocultural norms and practices, for example, the frequency of visits of the relatives and how they interact with the residents. Furthermore, risk factors for infection outside the facilities could be of relevance; for example, a high disease burden within a community could lead to a higher probability of staff and visitors being infected with SARS-CoV-2 and carrying the infection into the LTCF. Factors such as staff living in high prevalence communities or high levels of transmission in the community where the LTCF is located have been found to be associated with increased SARS-CoV-2 infections and COVID-19 related mortality in the LTCFs (Bui 2020; Gorges 2020; Lipsitz 2020; Shen 2020; Shi 2020; Sugg 2021; Temkin-Greener 2020). Other factors at the country level that were found to be associated with infections or outbreaks include per capita income, unemployment rate, level of urbanisation, and higher population density (Sugg 2021). It is possible that these factors influence local levels of community transmission or are associated with characteristics of care facilities, which could increase the risk of outbreaks. Contextual factors such as these could explain the difference in effectiveness of the same measure across different LTCFs, so would need to be accounted for in the research.

The intended effect of these measures is to prevent or reduce the transmission of SARS-CoV-2 and the related morbidity and mortality. However, some of these measures are highly intrusive and restrictive, for example, when restricting interactions of residents with other residents or with their family and friends. Numerous researchers and advocacy groups have pointed out the adverse effects of such non-pharmacological measures on the mental and physical health of the residents of LCTFs (e.g. reduced physical activity, loneliness and social isolation, reduced well-being, and risk of depression and anxiety) (Abbasi 2020; Danilovich 2020; D'Cruz 2020; El Haj 2020b; Lekamwasam 2020; Van der Roest 2020), as well as staff (e.g. psychological distress or burn-out) (El Haj 2020a; Senczyszyn 2020). Furthermore, ethicists have criticised the outlined interventions in LTCFs for being potentially ageist, undermining individual autonomy, and infringing basic human rights (Blanco-Donoso 2021; D'Cruz 2020; Lekamwasam 2020). Adverse effects of the protective measures have been particularly reported and discussed regarding persons living with dementia (Manca 2020).

Intended and unintended effects of the measures are likely to depend on the intra-individual level of risk and protective factors, and do not solely depend on the measure implemented. These factors could affect the probability of adverse outcomes directly, for example as men over 80 years old are more likely to die from a SARS-CoV-2 infection (Pastor-Barriuso 2020). However, they could also affect the risk of infection through behaviours or interactions. For example, adhering to social distancing might be more challenging for people living with dementia (Nyashanu 2020). Such individual-level factors associated with elevated mortality rates following an outbreak in a LTCF have been found to be linked to older age, male sex, frailty, dependency on care, and dementia among LTCF residents (Dutey-Magni 2020; Heras 2020; Shi 2020; Temkin-Greener 2020). Furthermore, the particular challenges of individuals living with cognitive impairment regarding understanding of and adherence to infection control practices have been discussed as relevant factors in the effectiveness of infection control measures (Brown 2020,Manca 2020, Mok 2020).

Why it is important to do this review

A disproportionately large proportion of the morbidity and mortality burden of the ongoing pandemic is attributable to cases of illness and death among residents and staff in LTCFs (Comas-Herrera 2020). The implementation of effective measures to prevent or reduce the number of infections in LTCFs could therefore considerably reduce the overall burden due to COVID-19. High-quality reviews of the scientific literature can support decision makers in identifying and implementing appropriate measures to protect vulnerable populations in LTCFs during the SARS-CoV-2 pandemic, whilst avoiding or mitigating the potential for severe adverse effects associated with these interventions.

Several publications have provided literature reviews of moderate quality on measures implemented in LTCFs to protect residents from COVID-19 (Fischer 2020; Frazer 2020a; Gmehlin 2020; WHO 2020b), on the unintended effects of these measures (D'Cruz 2020; Lekamwasam 2020), and on recommendations and guidelines for nursing care during the SARS-CoV-2 pandemic (Bolt 2020; Rios 2020). Two reviews aiming to assess the effectiveness of non-pharmaceutical interventions (NPIs) implemented in LTCFs were published in August and July 2020, respectively: a scoping review by Fischer 2020, and a pilot of a systematic review conducted to inform a policy brief by the WHO (WHO 2020a). With the rapid progression of research on the topic in 2020, their searches are very likely outdated. Reviews by Salcher-Konrad 2020 and Gmehlin 2020 focused on SARS-CoV-2 transmission, COVID-19-related mortality, and clinical presentation of the disease in LTCFs, without assessing the effectiveness of protective measures. Frazer 2020b and NCCMT 2020 conducted systematic literature reviews on measures to protect older people in LTCFs from COVID-19, which included studies published up to 27 July 2020 and 30 November 2020, respectively. However, while these studies summarised the identified publications, the authors did not conduct a synthesis that allows estimates of the effectiveness of protective measures to be inferred, and neither study systematically included modelling studies in their analysis. The literature reviews by Lekamwasam 2020 and D'Cruz 2020 assessed the effects of the COVID-19 pandemic on the health and well-being of older people. However, they did not comprehensively assess the implications of NPIs implemented in LTCFs.

Despite the importance of the topic, no high-quality systematic literature review on this topic has yet been conducted, to the best of our knowledge.

OBJECTIVES

To assess the effectiveness of non-pharmacological measures implemented in the setting of long-term care facilities (LTCFs) in preventing or reducing transmission of SARS-CoV-2 infection among LTCF residents, staff, and those visiting LTCFs.

METHODS

We will conduct a rapid review of the available studies to meet our objectives. Rapid reviews can be useful in answering questions in relation to interventions and their outcomes where research is rapidly emerging and evolving (Tricco 2015). A rapid review is a “form of knowledge synthesis that accelerates the process of conducting a traditional systematic review through streamlining or omitting various methods to produce evidence for stakeholders in

a resource-efficient manner"(Garritty 2020; Garritty 2021). We will accelerate the process of this rapid review by limiting its scope (e.g. considering only a specific set of non-pharmacological measures as described below), omitting certain quality control procedures (e.g. limiting the exploration of heterogeneity of included studies), and simplifying the process of data extraction. Specifically, only one review author will conduct the data extraction of included studies; a second review author will check for correctness, and the two review authors will discuss any uncertainties with a third review author. To ensure that acceleration of the process does not compromise the methodological rigor of the rapid review and that all stages of the review are conducted consistently and correctly, we will pilot the procedures for each stage of the review process, conduct regular team meetings, and keep a rolling list of questions to address any uncertainties.

We used the logic model (see Figure 2) to develop criteria for considering studies for this review and plan the data extraction, and will adapt it inductively over the course of the review. We will present the revised logic model a posteriori to describe the identified evidence.

Criteria for considering studies

We will include studies that quantitatively assess the impact of measures implemented in the setting of LTCFs to prevent or reduce SARS-CoV-2 transmissions and COVID-19- related outcomes. The full list of eligibility criteria is provided in Appendix 1.

Types of studies

We intend to include two groups of studies, which we will analyse and present separately: (i) randomised trials (RCTs) and non-randomised observational studies of intervention effects, and (ii) mathematical modelling studies.

Experimental and observational studies of intervention effects

Due to the rapid progress of the pandemic and the challenges for evaluating complex public health interventions, it has not always been appropriate, feasible, or ethical to conduct RCTs. We therefore do not anticipate that there will be a great number of RCTs available at the time this review is conducted. Within the first group of studies, we will therefore include studies which fulfil two criteria:

1. the study is based on systematically collected, quantitative data on one of the outcomes of interest, with at least one measurement of the data collected after the intervention;
2. the study allows the effect of the intervention to be estimated, either:
   a. based on an estimated change over time (either through the same or different individuals at multiple different time points before and after the intervention); or
   b. based on differences between groups of individuals or clusters receiving either the intervention of interest or a comparator (this includes comparing the extent of change over time between groups).

This group of studies thereby contains a set of studies that use methods to control for confounding in design or analysis and allow, in principle, for any confounding (e.g. randomised trials) and those which, in principle, allow us to control in principle for time-invariant unobserved confounding (e.g. studies based on difference-in-difference analysis) (Reeves 2017). This will include: RCTs, quasi-randomised controlled trials (Q-RCT), controlled before-and-after (CBA) studies, interrupted-time-series (ITS) studies, and controlled interrupted-time-series (cITS) studies, as well as designs such as instrumental variable (IV) studies and regression discontinuity (RD) studies (Reeves 2017).

This group will furthermore contain a set of studies which — through design, analysis or both — only allow us to control for confounding by observed covariates, and are therefore more prone to be affected by bias. This will include cross-sectional studies, cohort studies (retrospective, non-concurrent, and prospective), and case-control studies (retrospective and prospective). As study design labels are used inconsistently, we will classify the studies based on their study design features, following the characterisation of these features by Reeves 2017.

Modelling studies

Within the second group, we will include mathematical modelling studies which we define as a "mathematical framework representing variables and their interrelationships to describe observed phenomena or predict future events" (Eykhoff 1974). This could include mechanistic models (models of systems representing causal mechanisms), empirical models (models predicting outcomes from input data), and hybrid models (models combining mechanistic with empirical approaches). Among others, this will include probabilistic and deterministic compartmental models (e.g. traditional SEIR-models (Susceptible-Exposed-Infected-Recovered), agent-based epidemiologic models or Bayesian hierarchical models (i.e. models comprising several sub-models to integrate observed data and uncertainty).

In line with the GRADE guidance on approaches to assessing the certainty of modelled evidence, we will not include statistical models used to estimate the associations between measured variables (e.g. proportional hazards models or models used for meta-analysis) (Brozek 2021).

We will consider studies published in scientific journals, as well as those published on preprint servers (e.g. medRxiv) and in the grey literature. We will report studies that have been registered but not yet published (in a peer-reviewed journal or on a preprint server) as 'ongoing studies'.

We will exclude the following types of studies and publications.

- Studies that do not provide a quantitative measure of impact (e.g. qualitative studies)
- Diagnostic test accuracy studies (e.g. studies assessing the sensitivity and specificity of different screening tests)
- Studies that do not provide primary empirical data on the outcomes of interest (e.g. commentaries, editorials, literature reviews not reporting primary empirical data)
- Systematic and literature reviews (although we will use these for backward and forward citation tracking)
- Conference abstracts and summary reports, since these do not report sufficient data on population, intervention, comparison, outcomes, and settings to allow an assessment of their eligibility.

If we find studies that report quantitative data without a control group or a counterfactual, we will exclude them from the synthesis but will report their references.

Types of settings

For this review, we will focus on interventions implemented in the setting of LTCFs. In the context of this work, we will define LTCFs as residential institutions that take care of people who require support because they experience difficulties living independently in the community. These difficulties arise from the interaction between barriers in their environment and physical, mental, intellectual, or sensory impairments, possibly related to old age or chronic medical conditions. We will use the term LTCF to encompass long-term care facilities, skilled nursing facilities, nursing homes, retirement homes, assisted-living facilities, residential care homes or other similar facilities or institutions (ECDC 2020).

Within this review, we define the setting of LTCFs broadly to encompass both the physical space of the LTCF itself and the spaces and activities beyond it which have direct implications for the practice of (long-term) care in the LTCFs. Measures may be implemented, therefore, either (i) within the building and its premises (e.g. hygiene measures within the rooms of the building) and (ii) outside of LTCFs, if they target structures, institutions standing in direct relation to the residents, the LTCFs staff, and visitors. This would include regulations that prohibit residents from leaving the premises or taking part in activities such as public religious services outside of the LTCF, as well as those affecting staffing levels in LTCFs or visitors.

We will not include home care and related settings, where an individual receives nursing care or other medical and social support through family members, home care nursing or social services, but does not reside within a LTCF.

We will exclude studies that report on measures implemented in institutions primarily or exclusively providing acute care (e.g. hospitals), rehabilitative care (e.g. rehabilitation centres), or specialised palliative care facilities (e.g. hospices). We will also exclude any LTCFs which are primarily or exclusively focused on paediatric populations, i.e. if more than 75% of the population is under 18 years old.

We will include modelling studies which operationalise a virtual setting simulated after, or with a high degree of similarity with, measures implemented in real world LTCF settings. All modelling studies providing an assessment of the impact of measures implemented in LTCFs make some assumptions to simulate the real-world. These assumptions relate to aspects such as the intervention itself, the operationalisation of the facility, the population living or working in the facility, and their interaction with the general population. Studies in which most of these aspects use simplistic or conceptual assumptions, however, tend to provide abstract findings that cannot readily be interpreted or applied. We feel that mainly theoretical studies are not sufficiently informative for decision-makers. We will therefore only include modelling studies that are based on structural and parameter assumptions which we judge to be sufficiently informative for practice in LTCFs. Where this judgement is not clear, the review author team will discuss the case and make a decision about eligibility.

Types of populations

Particular populations of interest are:

- adult residents in LTCFs;
- staff working in the setting of LTCFs.

This includes both nursing staff and non-nursing staff working in the setting of LTCFs on a regular basis (e.g. kitchen staff, physiotherapists), as well as individuals or groups who visit the setting of LTCFs on a less regular basis for work-related purposes (e.g. primary care physicians, LTCF inspectors, social workers).

While we will exclude the setting of specialised institutions primarily intended to provide palliative care, we will include populations receiving palliative care in an LTCF. We will not look at paediatric populations living in nursing homes, and will exclude studies that are primarily or exclusively focused on paediatric populations.

We will exclude studies which assess the impact of measures implemented in the setting of LTCFs for the wider community (e.g. modelling studies assessing the implications of closing LTCFs for national transmission dynamics) if they do not provide specific data for at least one of the two population groups of interest.

Types of interventions

We will include studies that assess the impact of non-pharmacological measures aiming to protect populations living in LTCFs from SARS-CoV-2 infections or the consequences of COVID-19 disease, or both. The measures need to be implemented in the setting of LTCFs (as defined above).

In line with the logic model, the review will include measures aiming to reduce SARS-CoV-2 infections and prevent or mitigate the consequences of COVID-19 disease in the four domains (i) entry regulations, (ii) contact regulating and transmission reducing measures, (iii) surveillance measures, and (iv) outbreak control measures; and the respective categories within them:

1. **Entry regulations (E):** measures to prevent infectious individuals such as staff, visitors, and residents from (re-)entering the setting of LTCFs.
   a. **Full or partial closure of the LTCF to the outside (E1)**: organisational, regulatory, and educational measures, which reduce or restrict access to all or some individuals. These can be based on individual characteristics (e.g. individuals showing symptoms of respiratory tract infection without active screening) or based on roles and functions within the LTCF (e.g. not allowing any non-work-related visits, restricting access to individuals providing non-essential services in the LTCF, such as hairdressing).
   b. **Measures intended to reduce influx through LTCF staff (E2)**: organisational, regulatory, and educational measures intended to reduce the probability of viral influx through focusing on LTCF staff at elevated risk of carrying an infection (e.g. staff members with symptoms typical for COVID-19, staff members working in multiple LTCFs); preventing these staff members from entering the LTCF or allowing them to abstain from entering the LTCF (e.g. provision of staff sick leave)
   c. **Measures intended to reduce influx through residents (E3)**: organisational, regulatory, and educational measures intended to reduce the probability of viral influx through focusing on residents at elevated risk of being infected (e.g. residents returning after being hospitalised). This is likely to include a combination of testing and quarantine (e.g. 14-day single room quarantine with polymerase chain reaction (PCR) testing on day 1 and day 14).

d. **Pre-entry screening and testing (E4)**: active screening and testing measures intended to detect individuals who are infected with SARS-CoV-2 or who are at an elevated risk of being infected with SARS-CoV-2, including measures in place to prevent individuals who were tested or screened positive from entering the LTCF (e.g. providing antigen based rapid tests to all visitors prior to entering the LTCF and prohibiting access to those who tested positive).

2. **Contact regulating and transmission reducing measures (C):** measures intended to prevent or reduce the risk of infections among residents, nursing staff, non-nursing staff and visitors through (i) reducing the number of contacts with potential for transmission or (ii) the risk of transmission upon contact occurring. This includes the following:
   a. **Organisational measures limiting contact and transmission within LTCFs (C1):** organisational, regulatory, or educational measures to prevent transmission through limiting the number of contacts and reducing the probability of transmission within the LTCF. This will include measures focused on preventing transmission between staff members in activities and spaces not directly related to providing care to residents, such as care planning, handover between shifts, preparation and documentation activities, breaks (e.g. introducing staggered break and working hours or shift hand-overs through video calls, etc.). This furthermore includes measures to prevent transmission among residents and between residents, staff members and visitors in (leisure) activities and spaces not directly related to providing care or services to residents, such as in the common or dining rooms, during social activities (e.g. by implementing social distancing measures in the dining room or providing single rooms).
   b. **Cohorting within LTCF (C2)**: organisational, regulatory, or educational measures intend to limit the spread of SARS-CoV-2 within the LTCF through an unknown source of infection. This is done through creating groups of staff and residents and limiting contact and exposure between these groups (e.g. limiting nursing staff to individual cohorts of residents).
   c. **Usage of protective equipment to limit contact and transmission within LCTFs (C3):** this includes organisational, regulatory, or educational measures intended to reduce the risk of transmission through provision and correct usage of protective equipment and clothing, and personal hygiene (e.g. guidelines or regulations on the wearing of masks by nursing staff when interacting with residents; regulations on hand washing; and training on the correct wearing of masks).
   d. **Technical devices and changing the physical environment to limit contact and transmission within LCTFs (C4):** refers to measures which intend to reduce the risk of transmission through the air and from surfaces by changing the physical environment (e.g. the use of air filters; usage of antiseptic equipment and furniture; introduction of physical barriers to limit direct contact between residents and visitors).
3. **Surveillance measures (S)**: measures to detect infections among residents and staff to limit secondary infections and reduce the outbreak size.
   a. **Surveillance testing and screening of LTCF staff and residents using PCR-based tests (S1) or point of care tests (S2):** active screening and testing measures intended to detect individuals who are infected with SARS-CoV-2 or who are at elevated risk of being infected with SARS-CoV-2, including the measures in place to prevent secondary infections (e.g. quarantine for those who were found to have elevated body temperature). Screening and testing is not related to entry into the LTCF and is intended to identify infections early where there is no known case in the facility at the time point of the surveillance testing (e.g. weekly testing of all residents with antigen-tests).
4. **Outbreak control measures (O)**: measures to interrupt or prevent further spread or an outbreak after a case of COVID-19 is detected within the LTCF.
   a. **Symptom-based targeted testing approaches of LTCF staff and residents (O1):** testing strategy in the case of an outbreak intended to interrupt or prevent further spread after an infected individual is detected within the LTCF, through focusing on symptom-based testing of individuals.
   b. **Generalised testing approaches of LTCF staff and residents (O2):** testing strategies in the case of an outbreak intended to interrupt or prevent further spread after an infected individual is detected within the LTCF through employing a testing strategy other than symptom-based testing (e.g. testing all individuals on the same ward as the index case multiple times for two weeks).
   c. **Contact-tracing and testing approaches of LTCF staff and residents (O3):** organisational, regulatory, or educational measures intended to isolate individuals with known infections (including isolating staff members, such as through sick leave), as well as placing individuals at an elevated risk of infection under quarantine. This includes conducting contact-tracing in combination with focused quarantine of contact persons of infected individuals.

This is not an exhaustive list of measures but rather a broad overview of the category types we assume that measures will fall into. We also anticipate that many of these interventions will be implemented in combination with each other. We will include studies that only report on a combination of these measures, as well as those based on individual measures.

We will exclude studies if:

- they do not assess or allow us to determine the impact of non-pharmacological interventions or their components (e.g. a study assessing a pharmacological intervention, such as chemoprophylaxis of LTCF residents); or
- they only describe interventions not directly intended to reduce the transmission of SARS-CoV-2 (e.g. video calls to relatives introduced as a measure to reduce loneliness among residents); or
- they describe the interventions detailed above, but do not implement them in the setting of LTCFs. This includes a range of containment and mitigation measures (e.g. community-based quarantine, bans on mass gatherings, or regulation on personal protective measures, hygiene behaviours, and other social-distancing measures aimed at the general population).

We will exclude studies which aim to assess measures aiming to reduce the adverse effects of protective measures (i.e. smartphone apps or video calls to reduce isolation), but will provide the references of such studies identified in the literature review. We will exclude studies which do not assess an intervention but explore

institutional level risk factors for transmission-related outcomes in LTCFs (e.g. cross-sectional studies assessing the relationship between staff levels and mortality risks). We define risk factors as those characteristics of LTCFs or practices within them that were in place before the pandemic, not specifically implemented with the intention to reduce SARS-CoV-2 infection and COVID-19 disease, and which were assumed or evaluated for explaining differences in SARS-CoV-2 infections and COVID-19 morbidity between LTCFs. We will, however, provide a list of any such studies that we identify during literature screening.

Types of comparators

We will consider different comparators for the measures listed above. Specifically, we will include studies that provide data on the following comparisons.

- Measure versus no measure (e.g. a scenario of daily pre-entry testing of staff is compared to a scenario without testing).
- More stringent versus less stringent implementation of a measure (e.g. a scenario of daily PCR-testing of staff is compared to a scenario where only weekly testing is conducted).
- Measure versus an alternative measure (e.g. a scenario of daily pre-entry testing of staff using RT-PCR-based tests is compared to restricting the access to the LTCF for visitors).
- Earlier versus later implementation of a measure (e.g. conducting a general testing approach earlier or later after an index case has been identified in an LTCF).

Types of outcomes

Primary Outcomes

In line with the WHO-INTEGRATE COVID-19 (WICID) framework (Stratil 2020), which aims to support evidence-informed decision-making on non-pharmacological interventions targeting COVID-19, we will consider studies assessing any of the following COVID-19 related outcomes or any health-related adverse or unintended effects.

- **SARS-CoV-2 infections avoided due to the measure** (e.g. number, proportion, rate of SARS-CoV-2 infections observed or predicted in an LTCF with and without the intervention).
- **Contaminations of LTCFs avoided due to the measure**. In this context, contamination of LTCFs refers to LTFCs with at least one infection in the observation period (outcomes of interest include for example: number, proportion, rate of LTCFs with less than one SARS-CoV-2 infection observed or predicted among LTCFs with and without the intervention).
- **Outbreaks in LTCFs avoided due to the measure**. This refers to LTFCs with more than one SARS-CoV-2 infection from the same source; i.e. an index case in an LTCF has caused at least one additional infection (e.g. number, proportion, rate of LTCFs with an outbreak (> 1 SARS-CoV-2 infection from the same source) observed or predicted among LTCFs with and without the intervention).
- **COVID-19-related hospitalisations avoided due to the measure** (e.g. number, proportion, rate of hospitalisations due to severe COVID-19 infections observed or predicted in an LTCF with and without the intervention).
- **COVID-19-related deaths avoided due to the measure** (e.g. number, proportion, rate of deaths of people infected with SARS-CoV-2 observed or predicted in an LTCF with and without the intervention).
- **Adverse and other unintended mental or physical health outcomes** (e.g. rate of residents experiencing loneliness; incidence or severity of depression; rate of psychogeriatric hospitalisations, health-related quality of life, changes in health-related behaviour or metabolic risk factors, such as weight change or smoking behaviour).

Secondary outcomes

We will not assess any secondary outcomes in this review.

Other outcome-related considerations

We will exclude publications that report on (intended and unintended) societal or ecological outcomes (e.g. changes in waste production or energy consumption), economic or financial outcomes (e.g. studies estimating cost or resource use of an intervention) or other implementation-related outcomes (e.g. reported acceptability or adherence to the measure, reported barriers for implementation) without reporting on any of the primary outcome categories.

The findings on the adverse and other unintended effects of some interventions will not be comprehensive, as adverse effects may take a long time to emerge, may not be measurable within the frameworks of these intervention studies, or may go beyond the scope of effects related to physical and mental health. We acknowledge this as a limitation within this rapid review.

Search methods for identification of relevant studies

Our search strategy will be structured around two main search components focused on 1) SARS-CoV-2/COVID-19 and 2) terms describing the LTCF setting and related populations. For COVID-19 topic databases, we will only include terms describing the LTCF setting and related populations in the search. We developed the search strategy in Embase with a search specialist (IM), and will adapt this to related databases. A second search specialist peer reviewed the search strategy.

An experienced Information Specialist (IM) will adapt and run systematic searches in the following COVID-19-specific databases and general electronic databases. We will limit the results to the years 2020 and 2021, the time period during which publications about LTCFs and the COVID-19 have been published.

- The Cochrane COVID-19 Register (covid-19.cochrane.org/) is a specialised register built within the Cochrane Register of Studies (CRS) and maintained by Cochrane Information Specialists. The register contains study reports from several sources:
  - daily searches of PubMed;
  - daily searches of ClinicalTrials.gov;
  - weekly searches of Embase.com;
  - weekly searches of medRxiv;
  - weekly searches of the WHO International Clinical Trials Registry Platform (ICTRP);
  - monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL).
- The WHO COVID-19 Global literature on coronavirus disease is a specialised register maintained by WHO information specialists, which aims to provide a comprehensive multilingual

source of current literature on the topic. The database is updated daily (Monday to Friday) from searches of bibliographic databases, handsearching, and the addition of other expert-referred scientific articles (search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/). The register contains study reports from several sources:

* daily searches of CINAHL EBSCO (Cumulative Index to Nursing and Allied Health Literature);
* daily searches of Embase (Ovid);
* daily searches of Scopus;
* daily searches of Science direct;
* daily searches of Web of Science;
* daily searches of Wiley Online;
* daily searches of Academic Search Complete (EBSCO);
* daily searches of Africa Wide Information (EBSCO);
* daily searches of bioRxiv;
* daily searches of CAB Abstracts (Ovid);
* daily searches of chemRxiv;
* daily searches of China CDC MMWR (Center for Disease Control, Morbidity and Mortality Weekly Reports)
* daily searches of CDC Reports;
* daily searches of Global Health (Ovid);
* daily searches of Global Index Medicus;
* daily searches of medRxiv;
* daily searches of ProQuest Central (Proquest);
* daily searches of PsychInfo (Ovid);
* daily searches of SSRN (Social Science Research Network);
* weekly handsearches of Eurosurveillance;
* weekly searches of American Chemical Society;
* weekly searches of Scielo (Web of Science);
* biweekly searches of BioMed Central;
* biweekly searches of Jstage;
* biweekly searches of Mary Ann Liebert;
* biweekly searches of MDPI (Multidisciplinary Digital Publishing Institute);
* biweekly searches of Oxford Academic Group;
* biweekly searches of Sage Publications;
* biweekly searches of Taylor and Francis;
* monthly searches of Airiti library;
* monthly searches of JMIR (Journal of Medical Internet Research);
* monthly searches of Korean Science Index (Web of Science);
* monthly searches of Russian Science Index (Web of Science).

- Web of Science (Science Citation Index) Clarivate
- CINAHL EBSCO

See Appendix 2 for the search strategies.

Finally, we will conduct forward and backward citation searches of all relevant systematic and literature reviews and guidelines identified through the searches (see Appendix 3 for a preliminary list), as well as all included studies. We will conduct these searches in Scopus (published studies) and Microsoft Academic (preprints). To retrieve grey literature of unpublished reports or studies not published through traditional publication platforms, we will search Google Scholar. In this search, we will screen the first 10 pages of relevancy-ranked results (i.e. the first 100 web pages). If a significant number of potentially relevant results are retrieved, we will screen an additional 10 pages (200 web pages total).

Data collection and analysis

Study selection

We will deduplicate the publications identified through the database searches using EndNote and further by hand. Next, two review authors will independently screen all titles and abstracts in duplicate, excluding only those studies which are clearly irrelevant. We will move publications that are marked as unclear forward to the next stage of full-text screening. We will use standardised screening guidance based on the eligibility criteria and conduct a calibration exercise with all review authors involved in title and abstract screening. The two screening review authors will discuss any discrepancies, classify as 'unclear' those cases which cannot be resolved, and forwarded these to the next stage.

Two review authors will independently conduct the full-text screening. They will resolve any discrepancies through discussion in the presence of at least one other review author. At this stage, the review authors will make a final decision regarding inclusion/exclusion. Prior to starting the screening process, all review authors involved with full text screening will screen a set of 10 studies (Garritty 2020; Garritty 2021). The team will discuss any open questions or issues and adapt the screening guidance accordingly, in order to harmonise screening across all review authors.

We will use EndNote to manage collection of records. For title and abstract screening, we will use the web-based application Rayyan (Mourad 2016), which was designed for citation screening for systematic reviews. We will use a form in Microsoft Excel to document and report reasons for the exclusion of full texts.

Inclusion of non-English language studies

We will consider studies published in Armenian, English, French, German, Italian, Russian and Spanish, based on language skills within the review team. We will exclude studies in languages other than those listed.

Data extraction and management

One review author will extract study characteristics and data from all included studies using a pre-developed and validated data extraction form in Microsoft Excel. A second review author will check all extracted data. All review authors involved in the data extraction will independently extract a sample of three purposively selected heterogeneous studies that meet the inclusion criteria; they will discuss their extractions as part of a calibration exercise.

We will include the following main categories in the extraction form, including relevant subcategories (see data extraction form in Appendix 4).

- Study information
- Study design
- Population and setting
- Intervention
- Outcomes and results
- Context and Implementation

Assessment of risk of bias in and quality of included studies

Two review authors will rate the risk of bias (RoB) or quality of each included study independently, using multiple tools depending on the type of study. They will discuss any conflicts, questions, or uncertainties between themselves and, where necessary, with the review team. The authors will carry out the assessment using templates created in Microsoft Excel.

Assessment of risk of bias in randomised controlled trials

For the assessment of the risk of bias in RCTs, we will apply the Cochrane RoB 2 tool; we will use the most current version available from riskofbias.info/ (Higgins 2019). For cluster-RCTs, we will use the version of the tool adapted specifically for this type of study (Eldridge 2020). For RCTs and cluster-RCTs, we consider the assignment to intervention as the effect of interest. We will conduct an RoB 2 assessment for the primary outcomes in line with the specifications in the section on the measures of intervention effects. The RoB 2 tool includes the following domains: bias arising from the randomisation process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, and bias in selection of the reported results. The judgement options within the bias domains to be used include: low risk, some concerns, and high risk. We will use the Excel tool provided on riskofbias.info/ for the assessment.

We will designate an overall risk of bias for an outcome within a study (across domains) using the following criteria.

- High risk of bias: the trial is judged to be at high risk of bias in at least one domain for this result, or the trial is judged to have some concerns for multiple domains in a way that substantially lowers confidence in the result.
- Some concerns: the trial is judged to raise some concerns in at least one domain for this result, but not to be at high risk of bias for any domain.
- Low risk of bias: the trial is judged to be at low risk of bias for all domains for this result.

Risk of bias will also be summarised for an outcome across studies as part of the GRADE rating. We will judge an outcome as follows.

- Low risk of bias: most information for the outcome is generated from studies at low risk of bias.
- Moderate risk of bias: most information is from studies at low risk of bias or studies with some concerns.
- High risk of bias: the proportion of information from studies at high risk of bias is sufficient to affect the interpretation of results.

Assessment of risk of bias in non-randomised studies of the effects of interventions

For the assessment of the risk of bias of non-randomised studies of the effects of interventions (NRSIs), with the exception of cross-sectional studies, we will use the most recent version of the ROBINS-I tool (Risk Of Bias In Non-randomised Studies - of Interventions) (Sterne 2016a; Sterne 2020). This tool is concerned with evaluating the risk of bias of NRSIs; these include quantitative studies estimating the effectiveness (harm or benefit) of interventions that did not use randomisation to allocate units to comparison groups to compare the health effects of two or more conditions (Sterne 2016b). The terminology around such studies is often used inconsistently, and sometimes incorrectly; relevant terms sometimes used include quasi-randomised studies, quasi-experimental studies, natural experiment studies, and observational studies, among others. The base version of the tool is primarily concerned with studies where participants are followed up from the start of an intervention up to a later time for ascertainment of outcomes of interest, so called follow-up studies (or cohort-like designs) (Sterne 2016b). The developers of the tool note that, while much of the material is also relevant to designs such as case-control studies, cross-sectional studies, ITS studies and CBA studies, modifications to the signalling questions are required for these other types of studies (Sterne 2016b).
Therefore, we will follow the guidance laid out in chapter 25 in the *Cochrane Handbook for Systematic Reviews of Interventions* on how to address additional or different issues relating to risk of bias assessment including ITS studies, CBA and cITS studies (Sterne 2020).

As there is no guidance on how to adapt the ROBINS-I tool for cross-sectional studies and case-control studies, we will use the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies and the JBI Critical Appraisal Checklist for Case-Control Studies, respectively (Moola 2017).

In applying the ROBINS-I and JBI tools, it is important to define a priori the important confounding factors that each study would ideally be controlled for. We defined the relevant domains for confounding factors in the logic model, including the following:

1. intra-individual risk and protective factors;
2. underlying risk factors for infections/outbreaks in LTCFs;
3. risk of infection outside LTCF;
4. factors relating to social practices;
5. testing-related factors of influence; and
6. general implementation factors.

Relevant co-interventions that could lead to bias should also be considered when assessing the risk of bias in such studies. In principle, any number of co-interventions applied in LTCFs or in the wider community, if applied differently between comparator arms, could lead to bias. However, there is no accepted standard care in LTCFs, and practices are likely very context-dependent; thus, we will not define these concretely a priori. We will thus list important co-interventions for each included study before conducting the risk of bias assessment, based on the intervention domains/categories defined in this protocol (Sterne 2020).

When using ROBINS-I, the effect of interest can either be the effect of assignment to the interventions at baseline or the effect of adhering to the interventions (Sterne 2016a; Sterne 2016b). As we are interested in the overall effect of implementing measures in LTCFs, not only in the effect of compliance of individuals or LTCFs, we will assess the effect of the assignment of the intervention at baseline.

JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies

The JBI checklist for cross-sectional studies includes domains referring to:

1. inclusion criteria;
2. description of the study population;

3. validity and reliability of the measurement of the exposure (i.e. the intervention in the case of this study);
4. objective measurement of the condition of interest;
5. identification of confounding factors;
6. approach to handling confounders;
7. reliability and validity of outcome measurements; and
8. appropriateness of the statistical analysis (Moola 2017)

JBI Critical Appraisal Checklist for Case-Control Studies

The JBI checklist for case-control studies includes domains referring to:

1. comparability of cases and controls;
2. appropriateness of the process for matching cases and controls;
3. differences in the approaches for identifying cases and controls;
4. standardisation, validity and reliability of the measurement of the exposure (i.e. the intervention in the case of this study);
5. differences in the measurement of exposure between cases and controls;
6. identification of confounding factors;
7. approach to handling confounders;
8. standardisation, reliability and validity of outcome measurements;
9. sufficient length of the observation period; and
10. appropriateness of the statistical analysis (Moola 2017).

For both the JBI checklists, the respective indicator questions are to be answered with 'yes', 'no', 'unclear', and 'not applicable'. To align the rating with the ratings used within ROBINS-I, we will in addition provide a rating of 'low risk of bias', 'moderate risk of bias', 'serious risk of bias', and 'critical risk of bias' to each of the eight categories. In reaching an overall risk of bias judgement for a specific outcome in an individual study assessed with these JBI checklists, we will apply the following criteria.

- Low risk of bias: the study is judged to be at low risk of bias for all domains.
- Moderate risk of bias: the study is judged to be at low or moderate risk of bias for all domains.
- Serious risk of bias: the study is judged to be at serious risk of bias in at least one domain, but not at critical risk of bias in any domain.
- Critical risk of bias: the study is judged to be at critical risk of bias in at least one domain.

ROBINS-I tool

The ROBINS-I tool includes domains relating to bias:

1. due to confounding;
2. in selection of participants into the study;
3. in classification of interventions;
4. due to deviations from intended interventions;
5. due to missing data;
6. in measurement of the outcome; and
7. in selection of the reported result.

Based on answers to the signalling questions, judgements for each bias domain can be 'low', 'moderate', 'serious', or 'critical' risk of bias.

In reaching an overall risk of bias judgement for a specific outcome in an individual study, we will apply the following criteria:

- Low risk of bias: the study is judged to be at low risk of bias for all domains for this result.
- Moderate risk of bias: the study is judged to be at low or moderate risk of bias for all domains.
- Serious risk of bias: the study is judged to be at serious risk of bias in at least one domain, but not at critical risk of bias in any domain, or has moderate risk of bias in multiple domains and is therefore considered to be at serious risk of bias.
- Critical risk of bias: the study is judged to be at critical risk of bias in at least one domain.

We will also summarise the risk of bias for an outcome across studies as part of the GRADE rating. We will judge an outcome as follows:

- Low risk of bias: most information for the outcome is generated from studies at low risk of bias
- Moderate risk of bias: most information is from studies at low or moderate risk of bias
- High risk of bias: the proportion of information from studies at serious or critical risk of bias is sufficient to affect the interpretation of results.

Assessment of the quality of modelling studies

There is currently no standardised method for appraising the quality of modelling studies within the systematic review community. In their rapid review of travel-related control measures, Burns 2021 describe the challenge of critically appraising modelling studies by referring to a rapid review of the methodological literature that sought to identify and summarise studies describing criteria for assessing the quality of mathematical studies (Egger 2017). This review suggested that an assessment of the quality of a modelling study should capture the aspects of:

1. model structure;
2. input data;
3. different dimensions of uncertainty;
4. transparency;
5. external validation; and
6. internal validation.

This tool does not combine multiple criteria into a summary score (Appendix 5) (Burns 2021; Egger 2017). Based on these findings, Burns 2021 developed a bespoke tool for the assessment of modelling studies. This tool has been applied in the update of the Burns 2021 review, and the review by Krishnaratne 2020. We will also apply this tool in our Cochrane Review (Appendix 5). It covers the following aspects:

1. model structure;
2. input data;
3. external validation;
4. internal validation;

5. uncertainty; and
6. transparency.

We will rate each of these aspects as 'no/minor concerns', 'moderate concerns', or 'major concerns'. For modelling studies, review authors with modelling expertise will undertake and check the assessment, and we will consult researchers with advanced modelling expertise to assist with the quality assessment of modelling studies as needed.

In reaching an overall rating for the quality of an individual study, we will apply the following criteria.

- No/minor concerns: the study is judged to have no/minor concerns in: model structure, input data, validation (external), and uncertainty; and either no/minor concerns or moderate concerns regarding internal validation and transparency.
- Moderate concerns: the study is judged to have moderate concerns for at least one of the following domains: model structure, input data, or uncertainty, and not be judged to have major concerns in any of these three domains.
- Major concerns: the study is judged to have moderate concerns for multiple domains in a way that substantially lowers confidence in the result, or the study is judged to have major concerns in the domain of uncertainty. In both cases, neither model structure nor input data may be judged to have major concerns.
- Critical concerns: the study is judged to have major concerns regarding model structure or input data, or both.

As for the rating of 'critical risk of bias' in the ROBINS-I tool, a study that has an overall rating of 'critical concerns' is regarded as too problematic to provide any useful evidence on the effects of the intervention, and we will not include such a study in the synthesis.

We will also summarise the quality of the body of evidence comprised of modelling studies for each outcome as part of the GRADE rating. We will judge a body of evidence for an outcome as follows.

- No/minor concerns: the majority of studies contributing evidence to the outcome are judged to have no/minor concerns, with no studies judged to have major concerns.
- Moderate concerns: the majority of studies contributing evidence to the outcome are judged to have moderate concerns.
- Major concerns: the proportion of information from studies judged to have major concerns is sufficient to affect the interpretation of results.

Definition of minimal thresholds for public-health relevancy

The thresholds for the public-health relevance of reported effect sizes (corresponding to the minimal patient-relevant differences) are defined in this study as any difference from the null. Given the high disease burden of SARS-CoV-2 in LTCFs, any intervention which allows for a reduction of infection risk could potentially be relevant. Outweighing the costs and adverse effects of the interventions is beyond the scope of this study.

Accordingly, the narrative synthesis, graphical display thereof, and our assessment of the certainty of evidence focus on the existence and direction of effects, rather than the effect size. Information on the effect sizes will be provided, in order for decision makers to judge the practical relevance of the intervention effect in light of other decision-making criteria.

Measures of intervention effect

Across outcomes, we expect the intervention effects to be reported in a range of estimates or descriptive measures. Therefore, we will decide what measure is most appropriate after we have extracted data from included studies, but before we begin the evidence synthesis.

For continuous outcome measures, such as the number of SARS-CoV-2 infection per 100 residents, the preferred measure of intervention effect will be the standardised mean difference (SMD). For dichotomous outcomes, such as presence or absence of an outbreak in LTCFs during the observation period, we will use the risk ratio (RR). When provided in the publication, we will include 95% confidence intervals (CIs) for all reported intervention effects.

If a study reports both unadjusted and adjusted intervention effects, we will use the adjusted effects in conjunction with data on the covariates that the models adjust for. If a study reports multiple adjusted estimates of an intervention effect, we will use the one that we judge to minimise the risk of bias due to confounding (Reeves 2019). Some studies, such as modelling studies or quasi-experimental studies, may present multiple 'main effects' that may be plausible and similar regarding risk of bias. In such cases, we will extract multiple estimates. For studies providing multiple estimates with comparable risk of bias, we will use the median of the estimates in a meta-analysis and use the direction of effect of the median estimate for vote counting (see below). If there is an even number of estimates, we will select the most conservative estimate closest to the median estimate. For studies reporting measurements with multiple time points for the same primary outcome, we will select the outcome measure with the longest follow-up period from the intervention.

If the study provides different measures for the same outcome, we will select or calculate (if data allows) the outcome measure, which is used or can be calculated in all or most other studies reporting on the same intervention domain and category within the same population group. If there are multiple measures of the same outcome meeting this condition, we will choose the one with the lowest risk of bias.

Some studies will likely allow multiple comparisons. For example, modelling studies may assess pre-entry testing of staff, providing data for a scenario without testing, with different weekly rates of testing, or with different forms of tests. In these cases, we will include all comparisons that meet the eligibility criteria and will select the comparisons of no measure versus the most stringent implementation of the measure for the summary of findings tables (e.g. no pre-entry testing versus daily pre-entry testing). For studies assessing different levels of stringency of implementation of the measure, we will select the comparison of the most stringent versus the least stringent implementation (e.g. daily pre-entry testing versus biweekly testing).
For studies comparing multiple measures with different levels of stringency of implementation, we will select the comparison of the most stringent form of the different measures (e.g. daily pre-entry testing with RT-PCR-based tests versus daily testing with antigen tests).

Unit of analysis issues

We do not anticipate identifying cluster-RCTs for this review, however we may identify other studies in which the allocation of the intervention occurred at the cluster-level.

Where identified cluster-level studies do not take clustering into account in their analyses, we will attempt to reanalyse these studies. We will do this by incorporating an intra-class correlation coefficient (ICC) to account for the design effect. If the ICC is not reported for a study, we will try to obtain estimates from the study authors. Alternatively, we will use external estimates obtained from comparable included studies, or we will apply an ICC value that has been reported elsewhere in similar research and conduct sensitivity analyses on higher and lower ICC values.

Assessment of reporting biases

If we identify at least 10 studies within the same intervention domain and category which assess comparable outcomes in the same population group, we will use funnel plots to assess the risk of reporting bias and perform tests for funnel plot asymmetry (e.g. Egger's tests) (Page 2021).

Data synthesis

We will attempt to pool all studies within a given intervention domain and category as specified above that assess the same outcome and effect measure (e.g. number of infected people per 100 residents within an outbreak) in the same population group (e.g. residents, staff) and using a comparable comparator (e.g. no intervention, similar alternative intervention). We will conduct the meta-analysis using RevMan 5 (Review Manager 2020). Due to the expected large heterogeneity in intervention delivery, setting and study population, we will use the random-effects model.

It is likely that studies will report on bundles of interventions across multiple domains and categories, without allowing us to trace the effect measure back to a single intervention. In such cases, we will pool multicomponent interventions based on the intervention domains the particular measures fall under (e.g. pooling studies that assessed multicomponent interventions which include contact and transmission regulating measures, as well as surveillance measures).

A meta-analysis may be inappropriate, for example, because of limited evidence for a prespecified comparison, the intervention effects being incompletely reported, or the studies reporting different effect measures (and where recalculation and transformation does not allow for an estimation of the same effect measure) (McKenzie 2021). In this case, we will synthesise the results narratively through vote counting based on the direction of effect (Campbell 2020). To do so, we will first create tables structured according to on specific comparisons (i.e. corresponding intervention domain/category and comparator) and outcome categories; we will populate the tables with the summaries of the effects from each individual study contributing evidence to the specific outcome within the comparison, as well as describe the potential moderators that the individual studies assessed.

For experimental, quasi-experimental, and observational studies, we will report the following characteristics.

- Study ID
- Time point in the pandemic (year and month in which the study was conducted)
- Country of conduct
- Study design
- Key details of intervention
- Key details of comparator or counterfactual
- Key details of underlying protective measures in place in the LTCF
- Key details about level of community transmission
- Facility type
- Study population and sample size (including age structure)
- Outcome domain and specific outcome measure
- Available data on the effect measure (the data directly reported or calculated from the reported statistics, in terms of e.g. effect estimate, direction of effect, confidence interval, precise P value, or statement regarding statistical significance (either statistically significant, or not)).

For mathematical modelling studies, we will report the following characteristics.

- Study ID
- Country of conduct
- Type of mathematical modelling study
- Key details of the mathematical model
- Key details about how LTCFs and population of LTCFs were represented in the model
- Key details of how the intervention was operationalised in the model
- Outcome domain and specific outcome measure
- Available data on the effect measure (as described above).

Next, we will classify the direction of effect for each study in the tables. These will be categorised as showing beneficial or harmful effect, based on the observed direction of effect alone, thereby creating a standardised binary metric. In accordance with our definition of the minimal threshold for the public-health relevance of reported effect sizes being any difference from the null, we will consider any effects that are different from the null to be beneficial or harmful.

We will then create summary of findings tables for each comparison. These will summarise the directions of effect of the bodies of evidence for each outcome (e.g. proportion of studies showing beneficial effect per each outcome). In line with the Synthesis Without Meta-Analysis (SWiM) guidelines, these summaries will also report the ranges of the effect sizes per outcome (Campbell 2020).

We will visualise the vote counting results by way of effect direction plots or harvest plots (tools developed to visually display non-standardised effects across multiple outcome domains) (McKenzie 2020; Ogilvie 2008; Thomson 2013).

One of the lead authors will prepare the summary and data synthesis, and a second review author will check this before the research team members involved in the risk of bias assessment and data extraction review it.

Dealing with missing data

In cases where missing data on study characteristics or outcome measures limits the use of a study at further stages of the review, we will contact the corresponding author.

Assessment of heterogeneity

Describing heterogeneity

We will assess methodological and clinical heterogeneity in a tabular form, documenting the following characteristics of the included studies.

- Time point in the pandemic (year and month in which the study was conducted)
- Country of conduct
- Study design
- Details of intervention and its implementation
- Details of comparator or counterfactual
- Details of underlying protective measures in place in the LTCFs
- Details about level of community transmission (e.g. 7-day SARS-CoV-2 incidence at time of conduct)
- Characteristics of the study population (e.g. sex or gender, age groups, ethnicity)
- Outcome domain and specific outcome measure
- Available data on the effect measure (the data directly reported or calculated from the reported statistics, in terms of e.g. effect estimate; direction of effect; confidence interval; precise P value; or statement regarding statistical significance, i.e. either statistically significant or not).
- Outcome on the standardised binary metric of whether the study reported and beneficial effect or an adverse effect.

Assessing heterogeneity

For those studies where we consider it feasible and appropriate to pool the studies and conduct a meta-analysis, we will examine heterogeneity for each outcome through (i) inspecting the forest plots visually (i.e. we will look at overlaps of confidence intervals across the included studies) and (ii) assessing statistical heterogeneity among the intervention effects across all included studies in each meta-analysis. We will assess statistical heterogeneity by using the Chi^2 test for heterogeneity, the I^2 statistic to quantify heterogeneity, and Tau^2 to measure the extent of heterogeneity. We will calculate these values using Review Manager 2020.

In our meta-analyses, we will consider substantial heterogeneity to be present if we find an I^2 value of greater than 50% and either a Chi^2 of less than 0.1 or Tau^2 greater than 0. In meta-analyses where we find substantial heterogeneity, we will perform prespecified subgroup analyses if the studies report the data necessary to conduct these. Where we identify unexplained substantial heterogeneity, we will not pool results into an overall effect estimate and will only report these results through a vote counting synthesis with visual display in the form of harvest or effect direction plots.

Where it is not feasible or appropriate to pool studies or conduct a meta-analysis, we will examine heterogeneity per outcome through visual inspection of the harvest or effect direction plots (i.e. we will look at heterogeneity in the direction of effects). If the effect of one or more studies out of three points in a different direction to the others, we will conduct a hypothesis-generating, subgroup analysis through creating separate harvest or effect direction plots for each of the prespecified subgroups. We will, however, clearly communicate that these should be interpreted as being exploratory and not confirmatory.

Subgroup analyses and investigation of heterogeneity

We will only conduct subgroup analyses for outcomes when the set of contributing studies contains three or more studies. We will consider performing separate meta-analyses or creating separate harvest or effect direction plots for outcome data disaggregated by the following factors.

- Whether LTCFs in the study primarily serve senior citizens (> 80% of LTCF residents ≥ 60 years; < 80% of LTCF residents ≥ 60 years). Interventions in an LTCF may not be implemented in the same way or be equally applicable in LTCFs for senior citizens compared with LTCFs for people with need for care where age does not play a major role (e.g. LTCFs for people living with intellectual disabilities, who are more mobile than senior citizens).
- Underlying protective measures in place in the LTCF beyond the intervention of interest (e.g. no protective measures; increased hygiene concept and PPE-regulation for staff only; hygiene concept, PPE and restrictions for visitors). The rationale is that the underlying set of interventions may affect the secondary attack rate and therefore lead to the same intervention leading to different effects across otherwise comparable LTCFs. We expect there to be a range of different combinations of underlying interventions. We will, therefore, decide what form is most appropriate after we have extracted data from included studies, but before we begin the subgroup analysis.
- The underlying burden of COVID-19 disease where the LTCF is located (e.g. SARS-CoV-2 7-day incidence < 35 per 100,000, 35 to 50 per 100,000, 50 to 100 per 100,000, and > 100 per 100,000). The rationale is that the disease burden in the community is likely to affect the risk of outbreaks in an LTCF. We expect there to be a range of different ways in which the local disease burden is expressed. If the data provided do not allow for a transformation into 7-day incidence rates, we will decide what form is most appropriate after we have extracted data from included studies, but before we begin the subgroup analysis.
- The income group of the country the study is conducted in or modelled after (study conducted in high-income countries, middle-income countries, low-income-countries). The rationale for this analysis is that, due to relevant social or economic factors affecting the LTCFs and their practice, the same intervention may not lead to the same results.
- The regional grouping of the country the study is conducted in or modelled after (East Asia and the Pacific; Europe and Central Asia; Latin America and the Caribbean; Middle East and North Africa; North America; South Asia; Sub-Saharan Africa). The rationale for this analysis is that, due to relevant social, cultural, and geographic factors affecting the LTCFs and their practice, the same intervention may not lead to the same results.

Sensitivity analyses

We will examine how the following characteristics affect the results:

- study design (experimental and quasi-experimental, other observational studies, mathematical modelling studies);
- overall risk of bias of the study (high, moderate, low)

This will be done by creating separate meta-analyses, harvest plots or effect direction plots, from which we will remove studies with particular characteristics (e.g. separate meta-analysis for all studies, for those with low or moderate risk of bias assessment only, and for those with low risk of bias assessment rating only).

Assessment of certainty of evidence

We will use the GRADE approach to assess the certainty of primary outcomes (Hultcrantz 2017). One review author will collate the evidence for each primary outcome category and develop a preliminary assessment of the certainty of evidence. The evidence and preliminary assessments will be shared with other review authors, and the review team will make a joint decision regarding the certainty of evidence ratings.

The certainty of evidence is defined in GRADE as the extent to which one can be confident that the true effect of an intervention lies on one side of a specified threshold, or within a chosen range (Hultcrantz 2017). In this rapid review, we will consider 'difference from the null' as an important threshold assuming that even small effect sizes may be relevant for measures implemented in LTCFs. The certainty of evidence rating in GRADE yields four possible levels of evidence: high certainty (i.e. the estimated effect lies close to the true effect), moderate certainty (i.e. the estimated effect is probably close to the true effect), low certainty (i.e. the estimated effect might substantially differ from the true effect), and very low certainty (i.e. the estimated effect is probably substantially different from the true effect) (Hultcrantz 2017).

We will rate bodies of evidence from the two groups of studies we specified above – namely, (i) experimental and quasi-experimental studies (i.e., CBAs and ITS), and other observational studies of intervention effect and (ii) mathematical modelling studies, separately. In GRADE, evidence from RCTs enters the rating as high certainty, as does evidence from observational studies whose risk of bias has been assessed using ROBINS-I (Schünemann 2019). Further to this, five domains are used to further downgrade evidence, including study limitations, inconsistency, indirectness, imprecision, and publication bias; three domains are used to upgrade evidence, including plausible confounding, large estimates of effect, and dose-response relationship. These domains apply to assessment of evidence from all types of studies, including modelling studies (Hultcrantz 2017).

To rate certainty of evidence from modelling studies, we will use the recent guidance developed by the GRADE Working Group (Brozek 2018Brozek 2021). Evidence from modelling studies also enters the assessment as high certainty, and all the GRADE domains described above are then used to assess certainty of model outputs.

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APPENDICES

Appendix 1. Eligibility criteria

	Inclusion	Exclusion
Intervention	• Study assesses a measure implemented with the intention to protect residents of LTCFs from SARS-CoV-2 transmission and infection and COVID-19 disease morbidity and mortality outcomes.	
	• The measure is a non-pharmacological Intervention.	• The measure is a pharmacological intervention (e.g. prophylactic drug treatment of patients in LTCFs).

(Continued)

	• The measure is a deviation from the regular praxis conducted outside of the context of a pandemic or epidemic (e.g. basic food hygiene).	
Setting	• The measure is implemented in the setting of LTCFs (as defined in the protocol).	• The measure is implemented in institutions primarily or exclusively providing (i) acute (medical) care, (ii) rehabilitative care, (iii) palliative care. • The measure is implemented in the setting of home care and home care services. • LTCFs which are primarily or exclusively focused on paediatric populations (> 75% of the population is < 18 years old) will be excluded.
		• The measure is implemented outside of the setting of LTCFs; independent of the effect on transmission within LTCFs (e.g. school closures affecting the transmission in LTCFs through the overall pandemic progression).
Population	• Study focuses on adult residents living in LTCFs or nursing staff or non-nursing staff or individuals visiting LTCFs on a regular or irregular basis (for work and non-work-related purposes) or other individuals directly affected by measures implemented in LTCFs.	• Study focuses on the general population. • Study focuses on the general population primarily of individuals not living and/or working in the LTCF. • Study focuses primarily or exclusively on paediatric populations (> 75% of the study population is < 18 years old).
Outcomes	Study reports on at least one of the following primary outcome categories. •SARS-CoV-2 infections avoided due to the measure • Contaminations of LTCFs avoided due to the measure •Outbreaks in LTCFs avoided due to the measure •COVID-19-related hospitalisations avoided due to the measure •COVID-19-related deaths avoided due to the measure •Adverse and other unintended mental or physical health outcomes (e.g. rate of residence experiencing loneliness; incidence or severity of depression; rate of psychogeriatric hospitalisations, health-related quality of life, changes in health-related behavior or metabolic risk factors, such as weight change or smoking behavior).	• Publications assessed/reports on (i) societal or ecological outcomes (e.g. changes in waste production or energy consumption), (ii) on economic or financial outcomes (e.g. studies estimating cost or resource use of an intervention) or (iii) on (other) implementation-related outcomes (e.g. reported acceptability or adherence to the measure, reported barriers for implementation) without reporting on any of the primary or secondary outcome categories.
Study types	• Study provides quantitative data on the outcomes of interest • Study is a RCT, cRCT, NRCT, CBA, or ITS	• Study provides only qualitative data on the outcomes of interest • Study is an opinion paper, editorial, commentary

(Continued)

	• Study is mechanistic, empirical, or hybrid mathematical modelling study	• Study is a non-comparative study (e.g. case series)
Language	Studies published in Armenian, English, French, German, Italian, Russian and Spanish.	Studies in languages other than those listed

LTCFs = Long-term care facilities; RCT = Randomised controlled trial; cRCT = Cluster-randomised controlled trial; NRCT = Non-randomised controlled trials; CBA = Controlled before after study; ITS = Interrupted time series

Appendix 2. Search Strategies

Cochrane COVID-19 Study Register

"nursing home" OR "nursing homes" OR "care home" OR "care homes" OR "nursing residence" OR "nursing residences" OR "nursing residency" OR "nursing residencies" OR "nursing care facility" OR "nursing care facilities" OR "nursing care home" OR "nursing care homes" OR "nursing care residence" OR "nursing care residences" OR "nursing residency" OR "nursing residencies" OR "senior citizen home" OR "senior citizens home" OR "senior citizen homes" OR "senior citizens homes" OR "senior citizen facility" OR "senior citizen facilities" OR "senior citizens facility" OR "senior citizens facilities" OR "senior citizen residence" OR "senior citizen residences" OR "senior citizen residency" OR "senior citizen residencies" OR "senior citizens residence" OR "senior citizens residences" OR "senior citizens residency" OR "senior citizens residencies" OR "assisted living facility" OR "assisted living facilities" OR "assisted living home" OR "assisted living homes" OR "assisted living residence" OR "assisted living residences" OR "assisted living residency" OR "assisted living residencies" OR "assisted living community" OR "assisted living communities" OR "skilled nursing facility" OR "skilled nursing facilities" OR "skilled nursing residence" OR "skilled nursing residences" OR "skilled nursing residency" OR "skilled nursing residencies" OR "longterm care home" OR "longterm care homes" OR "longterm care facility" OR "longterm care facilities" OR "longterm care residence" OR "longterm care residences" OR "longterm care residency" OR "longterm care residencies" OR "longterm care resident" OR "longterm care residents" OR "long-term care resident" OR "long-term care residents" OR "long-term care home" OR "long-term care homes" OR "long-term care facility" OR "long-term care facilities" OR "long-term care residence" OR "long-term care residences" OR "long-term care residency" OR "long-term care residencies" OR "longterm care residence" OR "longterm care residences" OR "longterm care residency" OR "longterm care residencies" OR "convalescent home" OR "convalescent homes" OR "convalescent hospital" OR "convalescent hospitals" OR "convalescent facility" OR "convalescent facilities" OR "convalescent residence" OR "convalescent residences" OR "convalescent residency" OR "convalescent residencies" OR "retirement facility" OR "retirement facilities" OR "retirement home" OR "retirement homes" OR "retirement residence" OR "retirement residences" OR "retirement residency" OR "retirement residencies" OR "rest home" OR "rest homes" OR "residential care home" OR "residential care homes" OR "residential care facility" OR "residential care facilities" OR "home of the aged" OR "homes of the aged" OR "extended care facility" OR "extended care facilities" OR "extended care home" OR "extended care homes" OR "old age home" OR "old age homes" OR "old age residence" OR "old age residences" OR "old age residency" OR "old age residencies" OR "old peoples home" OR "old people home" OR "old people's home" OR "old people homes" OR "old peoples homes" OR "old people's homes" OR "old people residence" OR "old people residences" OR "old people residency" OR "old people residencies" OR "old peoples residence" OR "old peoples residences" OR "old peoples residency" OR "old peoples residencies" OR "old people's residence" OR "old people's residences" OR "old people's residency" OR "old people's residencies" OR "charitable home" OR "charitable homes" OR "charitable facility" OR "charitable facilities"

World Health Organization COVID-19 Global literature on coronavirus disease (excluding MEDLINE/PubMed)

"nursing home" OR "nursing homes" OR "nursing residence" OR "nursing residences" OR "nursing care" OR "senior citizen home" OR "senior citizens home" OR "senior citizen homes" OR "senior citizens homes" OR "assisted living" OR "longterm care" OR "long-term care" OR "retirement facility" OR "retirement facilities" OR "retirement home" OR "retirement homes" OR "retirement residence" OR "retirement residences" OR "rest home" OR "care home" OR "care homes" OR "residential care" OR "extended care facility" OR "extended care facilities" OR "old age home" OR "old age homes" OR "charitable home" OR "charitable homes"

Web of Science (Science Citation Index and Emerging Sources Citation Index) Clarivate

1 TI=((COVID OR COVID19) OR ("SARS-CoV-2" OR "SARS-CoV2" OR SARSCoV2 OR "SARSCoV-2" OR "SARS coronavirus 2") OR ("2019 nCoV" OR "2019nCoV" OR "2019-novel CoV" OR "nCov 2019" OR "nCov 19") OR ("severe acute respiratory syndrome coronavirus 2" OR "novel coronavirus disease" OR "novel corona virus disease" OR "corona virus disease 2019" OR "coronavirus disease 2019" OR "novel coronavirus pneumonia" OR "novel corona virus pneumonia") OR ("severe acute respiratory syndrome coronavirus 2"))

Indexes=SCI-EXPANDED, ESCI Timespan=All years

2 AB=((COVID OR COVID19) OR ("SARS-CoV-2" OR "SARS-CoV2" OR SARSCoV2 OR "SARSCoV-2" OR "SARS coronavirus 2") OR ("2019 nCoV" OR 2019nCoV OR "2019-novel CoV" OR "nCov 2019" OR "nCov 19") OR ("severe acute respiratory syndrome coronavirus 2"

OR "novel coronavirus disease" OR "novel corona virus disease" OR "corona virus disease 2019" OR "coronavirus disease 2019" OR "novel coronavirus pneumonia" OR "novel corona virus pneumonia") OR ("severe acute respiratory syndrome coronavirus 2"))

Indexes=SCI-EXPANDED, ESCI Timespan=All years

3 #2 OR #1

Indexes=SCI-EXPANDED, ESCI Timespan=All years

4 TI=(("nursing home*" OR "care home*" OR "nursing residenc*" OR "nursing care facilit*" OR "nursing care home*" OR "nursing care residenc*" OR "senior citizen* home*" OR "senior citizen* facilit*" OR "senior citizen* residenc*" OR "assisted living facilit*" OR "assisted living home*" OR "assisted living residenc*" OR "assisted living communit*" OR "skilled nursing facilit*" OR "skilled nursing home*" OR "skilled nursing residenc*" OR "longterm care home*" OR "longterm care facilit*" OR "longterm care residen*" OR "long-term care home*" OR "long-term care facilit*" OR "long-term care residen*" OR "convalescent home*" OR "convalescent hospital*" OR "convalescent facilit*" OR "convalescent residenc*" OR "retirement facilit*" OR "retirement home*" OR "retirement residenc*" OR "rest home*" OR "residential care home*" OR "residential care facilit*" OR "home of the aged" OR "homes of the aged" OR "extended care facilit*" OR "extended care home*" OR "old age home*" OR "old age residenc*" OR "old people* home*" OR "old people* residenc*" OR LTCF OR "charitable hom*" OR "charitable facilit*"))

Indexes=SCI-EXPANDED, ESCI Timespan=All years

5 AB=(("nursing home*" OR "care home*" OR "nursing residenc*" OR "nursing care facilit*" OR "nursing care home*" OR "nursing care residenc*" OR "senior citizen* home*" OR "senior citizen* facilit*" OR "senior citizen* residenc*" OR "assisted living facilit*" OR "assisted living home*" OR "assisted living residenc*" OR "assisted living communit*" OR "skilled nursing facilit*" OR "skilled nursing home*" OR "skilled nursing residenc*" OR "longterm care home*" OR "longterm care facilit*" OR "longterm care residen*" OR "long-term care home*" OR "long-term care facilit*" OR "long-term care residen*" OR "convalescent home*" OR "convalescent hospital*" OR "convalescent facilit*" OR "convalescent residenc*" OR "retirement facilit*" OR "retirement home*" OR "retirement residenc*" OR "rest home*" OR "residential care home*" OR "residential care facilit*" OR "home of the aged" OR "homes of the aged" OR "extended care facilit*" OR "extended care home*" OR "old age home*" OR "old age residenc*" OR "old people* home*" OR "old people* residenc*"" OR LTCF OR "charitable hom*" OR "charitable facilit*"))

Indexes=SCI-EXPANDED, ESCI Timespan=All years

6 AB=((elder* or senior* or aged or "old age" or "old people" or "old person*") NEAR/3 (nursing or "long-term care" or "LTC" or "long term care") NEAR/3 (home or homes or hous* or residenc* or facilit* or hospital*))

Indexes=SCI-EXPANDED, ESCI Timespan=All years

7 #6 OR #5 OR #4

Indexes=SCI-EXPANDED, ESCI Timespan=All years

8 #7 AND #3

Indexes=SCI-EXPANDED, ESCI Timespan=2020-2021

CINAHL EBSCO

Query

S10 S4 AND S9

Limiters - Published Date: 20200101-20210231

S9 S5 OR S6 OR S7 OR S8

S8 AB ((elder* or senior*or aged or "old age" or "old people" or "old person*") NEAR/3 (nursing or "long-term care" or "LTC" or "long term care") NEAR/3 (home or homes or hous* or residenc* or facilit* or hospital*))

S7 AB (nursing home* or care home* or nursing residen* or nursing care facilit* or nursing care home* or nursing care residen* or senior citizen* home* or senior citizen* faclit* or senior citizen* residen* or assisted living facilit* or assisted living home* or assisted living residen* or assisted living communit* or skilled nursing facilit* or skilled nursing home* or skilled nursing residen* or longterm care home* or longterm care facilit* or longterm care residen* or long-term care home* or long-term care facilit* or long-term care residen* or convalescent home* or convalescent hospital* or convalescent facilit* or convalescent residen* or retirement facilit* or retirement home* or retirement residen* or rest home* or Residential care home* or Residential care facilit* or home of the aged or homes of the aged or

extended care facilit* or extended care home* or old age home* or old age residen* or old people* home* or old people* residen* or LTCF or charitable hom* or charitable facilit*)

S6 TI (nursing home* or care home* or nursing residen* or nursing care facilit* or nursing care home* or nursing care residen* or senior citizen* home* or senior citizen* faclit* or senior citizen* residen* or assisted living facilit* or assisted living home* or assisted living residen* or assisted living communit* or skilled nursing facilit* or skilled nursing home* or skilled nursing residen* or longterm care home* or longterm care facilit* or longterm care residen* or long-term care home* or long-term care facilit* or long-term care residen* or convalescent home* or convalescent hospital* or convalescent facilit* or convalescent residen* or retirement facilit* or retirement home* or retirement residen* or rest home* or Residential care home* or Residential care facilit* or home of the aged or homes of the aged or extended care facilit* or extended care home* or old age home* or old age residen* or old people* home* or old people* residen* or LTCF or charitable hom* or charitable facilit*)

S5 (MH "Nursing Home Personnel") OR (MH "Nursing Home Patients") OR (MH "Nursing Homes")

S4 S1 OR S2 OR S3

S3 AB ("SARS-CoV-2" OR "SARS-CoV2" OR "SARSCoV-2" OR SARSCoV2 OR "SARS-CoV*" OR SARSCoV* OR "severe acute respiratory syndrome 2" OR "severe acute respiratory syndrome cov*" OR "Covid-19" OR Covid19* OR Covid OR nCoV* OR 2019nCoV* OR 19nCoV* OR "HCoV-19" OR coronavirus* OR "corona virus*") OR AB ("SARS-CoV-2" OR "SARS-CoV2" OR "SARSCoV-2" OR SARSCoV2 OR "SARS-CoV*" OR SARSCoV* OR "severe acute respiratory syndrome 2" OR "severe acute respiratory syndrome cov*" OR "Covid-19" OR Covid19* OR Covid OR nCoV* OR 2019nCoV* OR 19nCoV* OR "HCoV-19" OR coronavirus* OR "corona virus*")

S2 TI ("SARS-CoV-2" OR "SARS-CoV2" OR "SARSCoV-2" OR SARSCoV2 OR "SARS-CoV*" OR SARSCoV* OR "severe acute respiratory syndrome 2" OR "severe acute respiratory syndrome cov*" OR "Covid-19" OR Covid19* OR Covid OR nCoV* OR 2019nCoV* OR 19nCoV* OR "HCoV-19" OR coronavirus* OR "corona virus*") OR AB ("SARS-CoV-2" OR "SARS-CoV2" OR "SARSCoV-2" OR SARSCoV2 OR "SARS-CoV*" OR SARSCoV* OR "severe acute respiratory syndrome 2" OR "severe acute respiratory syndrome cov*" OR "Covid-19" OR Covid19* OR Covid OR nCoV* OR 2019nCoV* OR 19nCoV* OR "HCoV-19" OR coronavirus* OR "corona virus*")

S1 (MH "Coronavirus") OR (MH "Coronavirus Infections") OR (MH "COVID-19")

Appendix 3. Preliminary list of existing (systematic) reviews and guidelines for forward and backward searches

1.Bolt 2020: Bolt SR, van der Steen JT, Mujezinovic I, et al. Practical nursing recommendations for palliative care for people with dementia living in long-term care facilities during the COVID-19 pandemic: A rapid scoping review. Int J Nurs Stud 2020;113:103781.

2. D'Cruz 2020: D'Cruz M, Banerjee D. 'An invisible human rights crisis': The marginalization of older adults during the COVID-19 pandemic - An advocacy review. Psychiatry Res 2020;292:113369.

3. Fischer 2020: Fischer F, Raiber L, Boscher C, et al. COVID-19-Schutzmasnahmen in der stationaren Altenpflege. Pflege 2020;33(4):199-206.

4. Frazer 2020a: Frazer JS, Shard A, Herdman J. Involvement of the open-source community in combating the worldwide COVID-19 pandemic: a review. J Med Eng Technol 2020:1-8.

5. Gmehlin 2020: Gmehlin C, Munoz-Price L.S. Ao - Gmehlin C, Munoz-Price LS, et al. COVID-19 in Long Term Care Facilities: A Review of Epidemiology, Clinical Presentations, and Containment Interventions. Infect Control Hosp Epidemiol 2020:1-21.

6. Lekamwasam 2020: Lekamwasam R, Lekamwasam S. Ao - Lekamwasam S, et al. Effects of covid-19 pandemic on health and wellbeing of older people: A comprehensive review. Ann Geriat Med Res 2020;24(3):166-72.

7. Salcher-Konrad 2020: Salcher-Konrad M, Jhass A, Naci H, et al. COVID-19 related mortality and spread of disease in long-term care: a living systematic review of emerging evidence. 2020:2020.06.09.20125237. doi: 10.1101/2020.06.09.20125237 %J medRxiv

8. Rios 2020: Rios P, Radhakrishnan A, Williams C, et al. Preventing the transmission of COVID-19 and other coronaviruses in older adults aged 60 years and above living in long-term care: A rapid review. Syst Rev 2020;9(1):218.

9. WHO 2020a: World Health Organization. Preventing and managing COVID-19 across long-term care services. Policy brief. 24 July 2020. Geneva: World Health Organization (WHO/2019-nCoV/Policy_Brief/Long-term_Care/2020.1) 2020.

10. NCCMT 2020: National Collaborating Centre for Methods and Tools (2020). What risk factors are associated with COVID-19 outbreaks and mortality in long-term care facilities and what strategies mitigate risk? School of Nursing, McMaster University (Canada).

Appendix 4. Overview of items in data extraction form

Study information:

- Study ID

- Study title
- Publication year
- Study source (journal, report, pre-print publication)
- For pre-print publication only: date of publication
- Funding source
- Reported conflicts of interest

Study design:

- Study type (e.g. RCT, NRCT, CBA, ITS, mechanistic model, empirical model, hybrid model)
- Verbal summary of study type (e.g. “deterministic compartmental SEIR-model”)
- Comments

Population, setting and context:

- Overall number of participants
- Population targeted by intervention (residents, nursing staff, non-nursing staff, visitors)
- Population intended to be protected by intervention (residents, nursing staff, non-nursing staff, visitors)
- Profile of long-term care facility (LTCF) residents (e.g. age, sex, and morbidity-profile of residents, socio-economic status)
- Facility type
- Implementation level (e.g. on the level of LTCFs, individual wards within LTCFs)
- Context-related factors regarding community transmission and infection risk outside the LTCFs (e.g. 7-day-incidence rate at time of implementation of the measures)
- Context-related factors regarding institutional risk-factors for infection and outbreaks within LTCFs (e.g. number of residents, staff:resident ratio).
- Other/additional characteristics of the LTCF
- Co-Interventions implemented in the LTCFs intended to reduce or prevent SARS-CoV-2 infections (i.e. those that were reported in the study but not assessed)
- Co-Interventions implemented in the LTCFs intended to prevent or mitigate adverse effects of measures intended to reduce or prevent SARS-CoV-2 infections (e.g. regular video calls in intervention and control group)
- Geographical location (e.g. country where study is conducted)
- Comments

Intervention:

- Domain(s) intervention
- Category/categories of intervention
- Verbal summary of the measure(s) and implementation
- Verbal summary of comparator/counterfactual
- Level of intervention (i.e. individual, ward, nursing home, multiple, other)
- Rationale, theory, or goal of the elements essential to the intervention (as reported)
- Physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers
- Procedures, activities, and/or processes used in the intervention, including any enabling or support activities
- Provider of the intervention (including expertise, background and any specific training given)
- Modes of delivery of the intervention (such as face to face or by some other mechanism, such as internet or telephone, provided individually or in a group)
- Type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features
- When and how much: describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity or dose.
- Tailoring: in tailored interventions, not all participants receive an identical intervention. Was this intervention planned to be personalised, titrated or adapted?
- Modification: unforeseen modifications to the intervention can occur during the course of the study, particularly in early studies. Was this intervention modified during the course of the study?
- How well (planned): fidelity refers to the degree to which an intervention happened in the way the investigators intended it to ('how well' the intervention was received or delivered).

- How well (actual): for various reasons, an intervention, or parts of it, might not be delivered as intended, thus affecting the fidelity of the intervention. If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned.

Outcomes (repeated for each outcome) and results:

- Outcome category
  * SARS-CoV-2 transmission-related outcomes and COVID-19 disease-related morbidity and mortality outcomes
  * Outcomes regarding quality of life, social well-being, and mental health
  * Outcomes regarding physical health beyond COVID-19
- Verbal description of outcome
- Level on which outcome is assessed (i.e. individuals, aggregate on the level of wards or system level)
- Length of follow-up
- Estimate related to the impact of measure(s) implemented in the LTCF setting
- Summary of overall impact of measure(s) implemented in the LTCF setting
- Comments

Appendix 5. Tools for risk of bias assessment and quality appraisal

Tool for Criteria used for assessing the quality of individual modelling studies, developed from Burns 2021.

Domain	Source	Questions
Model structure	Philips 2006	1. Are the structural assumptions transparently stated together with their respective justifications? Guidance: Assess whether all structural model assumptions and model components are explicitly stated and whether the authors substantiate these assumptions either through theoretical reasoning or through prior knowledge from the literature. 2. Are the structural assumptions and justifications reasonable given the overall objective, perspective and scope of the model? Guidance: Assess the appropriateness of the model structure based on the provided justifications. Consider whether the structural assumptions reflect existing knowledge about the phenomenon of interest in the literature and whether these assumptions portray the specific situation correctly and comprehensively enough.
Input data	Caro 2014	3. Are the input parameters and data transparently stated? Guidance: Assess whether the values of all inputs are explicitly stated with their respective sources. Possible sources of inputs include but are not limited to the scientific literature or theoretical reasoning. If the source data cannot be employed directly, has the conversion to model input data been described appropriately? 4. Are the input parameters and data suitable to reliably populate the model? Guidance: Consider whether the values for the inputs used seem reasonable. Additionally, examine if the stated sources are trustworthy and indicate plausibility of the used parameters. Possible indicators are whether an assessment of accuracy is possible or whether the sources have been described allowing for an assessment of quality of the inputs. Consider whether the inputs used match the conditions under which they are used in the model. If input data is used to calibrate model parameters, is the calibration process sufficiently documented and do model predictions reasonably describe the data?
Validation (external)	Caro 2014	5. Have indications of external validity been reported?

(Continued)

		Guidance: Consider whether there has been a process of comparing model predictions against independent data sources or knowledge which were not used to build the model to establish external validity. If no validation on independent external data has been described, weaker forms of validations can help to discriminate between differently credible models. Are there indications that the model exhibits face validity to experts in the field? Such indications may comprise independent assessment of the model by other scientists, involvement of clinical experts in model building or a formal review process. Another indication of external validity is cross-validity to other studies by reflection upon results of modelling studies with a similar scope. 6. Has the model been externally validated to a reasonable extent? Guidance: Given the previously mentioned options of establishing external validity, assess to which extent the external validation procedure awards credibility to the model. Do the model predictions agree with external data? Does the model exhibit face validity in terms of plausibility and comprehensibility of generated results? Are study results comparable to those of other modelling studies? Has external validation been performed to a sufficient extent?
Validation (internal)	Caro 2014	7. Have indications of internal validity been reported? Guidance: Assess whether there has been a process of verifying the extent to which the mathematical calculations are consistent with the model's specifications, i.e. consider whether the modellers have shown that the model and its implementation work as intended. 8. Has the model been internally validated to a reasonable extent? Guidance: Assess the extent to which the consistency of mathematical calculations with the model's specifications is verified in the study. Possible examples of verifying internal consistency comprise analyses of whether the model behaves as expected in sensitivity analyses, verification that implemented code has been reviewed or analyses on simulated data which provide insight on whether a proposed model works as described. If a previously existing tool for the model was employed, this can also serve as some indication of internal validity.
Uncertainty	Caro 2014	9. Was there an adequate assessment of the effects of uncertainty? Guidance: Consider whether the robustness of results to alternative input parameter values or model assumptions was assessed sufficiently. Check whether stochastic uncertainty has been addressed appropriately if necessary, e.g. by a sufficient number of runs. Additionally, assess if the most urgent sources of uncertainty which are likely to have considerable impact on results were accounted for.
Transparency	Caro 2014	10. Is replication of model results possible with the materials provided by the authors? Guidance: Assess whether the description of the analyses (including model structure, input parameters, data sources and methods) is sufficiently detailed to allow for the replication of results. In particular, consider whether the code that was used to obtain the results is freely available and well documented.

HISTORY

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CONTRIBUTIONS OF AUTHORS

JMS developed the protocol with substantial input from RB and AM. LA, JB, KG, AK, JS, and KW reviewed the different versions of the protocol and provided input and feedback. IM developed the search strategy with input from JMS, which was reviewed by MIA (see acknowledgements). All authors approved the submitted version of the protocol.

DECLARATIONS OF INTEREST

Jan M Stratil: The Chair for Public Health and Health Services Research at the Institute for Medical Information Processing, Biometry and Epidemiology received funding from the German Federal Ministry of Education and Research (BMBF) as part of the COVID-19 evidence ecosystem (CEOsys) project. No other conflicts of interest are known.

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