BMJ Open

A rapid systematic review of measures to protect older people in long term care facilities from COVID-19

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-047012
Article Type:	Original research
Date Submitted by the Author:	17-Nov-2020
Complete List of Authors:	Frazer, Kathleen; University College Dublin Mitchell, Lachlan; University College Dublin, Stokes, Diarmuid; University College Dublin Lacey, Ella; University College Dublin Crowley, Eibhlin; University College Dublin Kelleher, Cecily; University College Dublin,
Keywords:	COVID-19, Public health < INFECTIOUS DISEASES, GERIATRIC MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

A rapid systematic review of measures to protect older people in long term care facilities from COVID-19

Kate Frazer[1*], Lachlan Mitchell[2,3*], Diarmuid Stokes[4], Ella Lacey[5], Eibhlin Crowley[6], Cecily Kelleher[2,3].

1. School of Nursing, Midwifery and Health Systems, University College Dublin, Belfield, Dublin 4, Ireland
2. National Nutrition Surveillance Centre, University College Dublin, Belfield, Dublin 4, Ireland
3. School of Public Health, Physiotherapy and Sport Science, University College Dublin, Belfield, Dublin 4, Ireland
4. Health Sciences Library, University College Dublin, Belfield, Dublin 4, Ireland
5. School of Medicine, University College Dublin, Belfield, Dublin 4, Ireland
6. Office for Health Affairs, College of Health and Agricultural Science, University College Dublin, Belfield, Dublin 4, Ireland

*Equal contribution

Corresponding author: Lachlan Mitchell

Lachlan.mitchell@ucd.ie

National Nutrition Surveillance Centre, University College Dublin, Belfield, Dublin 4, Ireland

Running title: Measures to protect older people from COVID-19

Word count: 2451

Abstract word count: 261

Keywords: Coronavirus, COVID-19, nursing homes, transmission

Abstract

Objectives: The global COVID-19 pandemic produced large-scale health and economic complications. Older people and those with comorbidities are particularly vulnerable to this virus, with nursing homes and long term care facilities experiencing significant morbidity and mortality associated with COVID-19 outbreaks. The aim of this rapid systematic review was to investigate measures implemented in long term care facilities to reduce transmission of COVID-19 and their effect on morbidity and mortality of residents, staff, and visitors.

Setting: Long term care facilities.

Participants: Residents, staff and visitors of facilities.

Primary and secondary outcome measures: Databases (including MedRXiv pre-published repository) were systematically searched to identify studies reporting assessment of interventions to reduce transmission of COVID-19 in nursing homes among residents, staff, or visitors. Outcome measures include facility characteristics, morbidity data, case fatalities, and transmission rates. Due to study quality and heterogeneity, no meta-analysis was conducted.

Results: The search yielded 1414 articles, with 38 studies included. Reported interventions include mass testing, use of personal protective equipment, symptom screening, visitor restrictions, hand hygiene and droplet/contact precautions, and resident cohorting. Prevalence rates ranged from 1.2-85.4% in residents and 0.6-62.6% in staff. Mortality rates ranged from 5.3-55.3% in residents.

Conclusions: Novel evidence in this review details the impact of facility size, availability of staff and practices of operating between multiple facilities, and for-profit status of facilities as factors contributing to the size and number of COVID-19 outbreaks. No causative relationships can be determined; however, this review provides evidence of interventions that reduce transmission of COVID-19 in long term care facilities.

Trial registration: The protocol is registered on PROSPERO (CRD42020191569).

Strengths and Limitations of the Study

- Evidence from 38 studies identifies the measures taken to reduce transmission of COVID-19 in long term care facilities.
- No limitations were placed on study type, and all languages were eligible for inclusion.
- Study quality was formally examined using the MMAT tool.
- Due to heterogeneity of included studies, meta-analysis was not able to be performed.

Introduction

Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) is a novel virus, first identified in China in 2019, resulting in the current global pandemic in 2020.[1] The ensuing disease associated with infection from SARS-CoV-2, termed COVID-19, has produced large-scale public health and worldwide economic effects.[2]

The virus spreads between people through close contact and droplet transmission (coughs and sneezes). While most infected people will experience mild flu-like symptoms, others may become seriously ill and die.[3] At-risk groups include older people and those with underlying medical conditions, while men appear to have more susceptibility than women. Symptom severity varies; several individuals remain asymptomatic, others experience fever, cough, sore throat, general weakness, and fatigue, while more severe respiratory illnesses and infections may result, which can be fatal.[4,5] Deterioration in clinical presentations can occur rapidly, leading to poorer health outcomes. Anosmia and ageusia are reported in evidence from South Korea, China, and Italy in patients with confirmed SARS-CoV-2 infection, in some cases in the absence of other symptoms.[6]

The World Health Organization (WHO) declared the COVID-19 outbreak constituted a Public Health Emergency of International Concern (PHEIC) on January 30, 2020.[5] Two primary goals of action were 1) to accelerate innovative research to help contain the spread and facilitate care for all affected, and 2) to support research priorities globally the learning from the pandemic response for preparedness. Globally, up to October 5, 2020, there are 35 247 104 cases of COVID-19 (following the applied case definitions and testing strategies in the affected countries) including 1 038 069 deaths.[7] Within Europe, over 5 431 510 cases are reported, with 226 869 deaths[7]

Presently there is no vaccine; therefore, preventing and limiting transmission is advocated. International and national evidence mandates physical distancing, regular hand hygiene and cough etiquette, and limiting touching eyes, nose or mouth; in addition to regular cleaning of surfaces.[8]

As noted older people are an at-risk group for COVID-19, and throughout the pandemic, the impact on this population has resulted in increased mortality, specifically those living in long term care

facilities (LTCF) where a high proportion of outbreaks with increased rates of morbidity and case fatality in residents are recorded.[9] In several EU/EEA countries, LTCF deaths among residents, associated with COVID-19, account for 37% to 66% of all COVID-19-related fatalities.[9] The specific rationale for their increased susceptibility is less clear. The United Nations (UN) (2020) acknowledge that COVID-19 exposes the inequalities in society and the failures expressed in the 2030 Agenda for Sustainable Development. The UN report the disproportionate fatality rates in those aged over 80 years as five times the global average[10] and suggest a need for a more *inclusive, equitable and age-friendly society, anchored in human rights* (p.16).[11]

The aim of this rapid review of the literature was to assess the extent to which measures implemented in LTCF reduced transmission of COVID-19 (SARS-CoV-2) among residents, staff, and visitors, and the effect of these measures on morbidity and mortality outcomes.

Methods

The protocol is registered on PROSPERO (CRD42020191569)[12] and reporting follows PRISMA guidelines.[13] Ethical approval was not required for this systematic review.

Search strategy

Search strategies comprised search terms both for keywords and controlled-vocabulary search terms MESH and EMTREE (see Supplementary Table 1 for full search terms). EMBASE (via OVID), PubMed (via OVID), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Database and Repository, and MedRXiv pre-published databases were searched. No time limits were imposed, and databases were searched up to July 27, 2020. Reference lists of included evidence were checked for further articles.

Eligibility criteria

All study designs (experimental, observational, and qualitative) are included, and no exclusions placed on language. Included studies report an assessment of measures to reduce transmission of COVID-19 (including SARS or MERS) in residents, employees, or visitors of LTCF. To provide as comprehensive a review of the evidence we included any intervention implemented to reduce the

transmission of COVID-19 in long-term residential care facilities, including facility measures, social distancing, use of personal protective equipment, and hand hygiene.

Primary outcome measures

Primary outcome measures are morbidity data, case fatality rates, reductions in reported transmission rates, and facility characteristics associated with COVID-19 incidence.

Selection of studies and data extraction

Two authors developed search strings (DS & KF); all database searches were completed by one author (DS) (Supplementary Table 1). Following de-duplication, references were uploaded into Covidence management platform (LM), and two authors independently screened all titles and abstracts (LM & KF). Full texts of all potentially eligible studies were independently reviewed by two authors (LM & KF). Disagreements were resolved by discussion with a third author (CK). Data from included studies were independently extracted in duplicate (LM & KF). A data extraction form was developed and modified from documents used previously by authors (KF & CK). Extracted data included study characteristics (title, lead author, year of publication, country, study setting, study design), description of the intervention, number and characteristics of participants, outcomes, duration of follow-up, sources of funding, peer review status). Study design (required for review of quality) was independently assessed by two authors (LM & KF), with disagreements resolved by a third author (CK).

Assessment of Quality

Two review authors (LM & EL) independently assessed the quality of included studies using Mixed Methods Assessment Tool (MMAT),[14] with disagreements resolved by a third author (KF) and discussed with the lead author (CK) (Supplementary Table 2). The MMAT is used widely and considered a valid indicator of methodological quality using instruments for non-randomised and descriptive studies.

Data synthesis

Meta-analysis was not possible due to heterogeneity in study designs, participants, outcomes, and nature of the interventions and no attempt was made to transform statistical data. The SWiM criteria[15] guide a narrative summary, with data presented in tabular format and subgroup reporting of population groups.

Patient and public involvement

No patients were involved in this study.

Results

We identified 1414 articles, and 131 full-text articles were selected for review. After an evaluation against our inclusion criteria, 38 studies (40 papers) are included in this systematic review (Figure 1).

Study characteristics

Geographically we report evidence from eleven countries, the majority (20 studies) are from USA[16-35] and UK.[36-40] We report evidence from Canada,[41-43] France,[44,45] Hong Kong,[46,47] Belgium,[48] Germany,[49] Ireland,[50] Japan,[51] Korea,[52] and Spain[53] (Table 1).

Infection control measures

Twenty studies report the nature of LTCFs related with outbreaks and transmission of COVID-19 infection (Table 2; [16,23,28,29,31,33,35-39,41-43,45-47,50-52]). Thirty studies (Table 3a; [17-29,32-34,37-43,45-50,53]) report evidence of measures to reduce transmission of COVID-19 in long-term residential care facilities for residents, 25 studies (Table 3b; [17-22,24,26-30,32,34,38,39,42-48,50,53]) report evidence for employee outcomes, and two studies report evidence for visitors (Table 3c; [28,47]).

A variety of infection control measures are described (Tables 1 and 3a-c) including: mass testing/point-prevalence testing (22 studies; [17,19-22,25-30,32-34,38,39,44,45,48-50,53]), use of personal protective equipment (10 studies; [17,18,20,25,28,29,32,45,47,49]), screening of residents, staff, or visitors for symptoms (8 studies; [18-20,23,25,27,29,32]), restrictions on visitor entry (10 studies; [18-20,25,27,29,32,45,49,53]), hand hygiene and contact and droplet precautions (6 studies; [19,23,25,32,45,46]), and cohorting/isolation of residents (11

studies; [19,20,22,25,28,29,32,33,45,47,49]). Thirteen studies examined characteristics of LTCF and their association with COVID-19 infection and risk [16,24,31,35-37,39-43,51,52].

Table 1. Characteristics of studies including infection control measures

Study ID	Country	Study Design	Setting	Population	Intervention/infection control strategy	Outcome groups	Outcome measures
Abrams et al. (2020)[16]	USA	Cross sectional	Nursing homes	Nursing homes across 30 USA States (n=9395 nursing homes). N=6446 facilities without COVID-19 cases; n=2949 facilities with COVID-19 cases.	Nursing homes characteristics associated with COVID-19 outbreaks	Facilities	Estimates on the relationship of nursing home characteristics and documented COVID-19 cases
Arons et al. (2020)[17]	USA, King County, Washington	Cross sectional cohort	Nursing home facility	Residents N=89 N=76 participated in point-prevalence testing.	PPE (eye protection, gown, gloves, face masks); mass testing.	Residents, staff	COVID-19 prevalence, testing, symptoms, hospitalization, mortality
Blackman et al. (2020)[18]	USA	Cross sectional	Skilled nursing facility	A 150-bedded skilled nursing facility. Single story building with four units.	Employee and visitor screening on entry; visitor restrictions; review of PPE and infection control in the building; use of heat maps in a facility to track staff and residents' symptoms	Residents, staff	COVID-19 prevalence, testing, mortality
Borras-Bermejo et al. (2020)[53]	Spain	Cross sectional cohort	Nursing homes	N=69 nursing homes in Barcelona. N=3214 residents and N=2655 staff	Surveillance testing program for COVID- 19 in nursing homes; introduction of restrictions for visitors	Residents, staff	COVID-19 prevalence, testing, symptoms

Brainard et al. (2020)[36]	England, Norfolk	Retrospective cohort	Care homes	N=248 care homes	Statistical modelling assessing detection of COVID-19 infection relative to PPE availability and impact of staffing by non-care workers	Facilities	Descriptive data and statistical modelling for COVID-19, staffing levels, access to PPE
Brown et al. (2020)[41]	Canada, Ontario	Retrospective cohort	Nursing homes	N=623 nursing homes. N=78,607 residents	Impact of home crowding on COVID-19 infection and mortality using nursing home crowding index score	Residents, facilities	COVID-19 incidence, modelling mortality and overcrowding adjusting for facility characteristics
Burton et al. (2020)[39]	Scotland	Cross sectional cohort	Nursing homes	N=189 nursing homes included and data for 109 homes (57.7%) for older people reported, representing 5227 beds (89.5% of total beds in 189 care homes)	Surveillance data to understand the evolution of COVID-19 following outbreaks and care home characteristics in one health board	Facilities, residents	COVID-19 outbreaks, mortality, and facility characteristics
Dora et al. (2020)[19]	USA, California	Cross sectional	Veterans Affairs Greater Los Angeles Healthcare System	N=3 skilled nursing facilities (n=150 long term beds) N=99 residents (95% male, age range 50 to 100 years) N=136 staff Visitors	Three point-prevalence surveys; visitor restrictions (initially all visitors screened, then no visitors permitted into buildings); staff screening; hand hygiene, droplet, and contact precautions; cohorting	Residents, staff	COVID-19 prevalence, symptoms, mortality
Dutey-Magni et al. (2020)[38]	UK (England, Scotland, and Northern Ireland)	Cohort	Long term care facilities	N=8713 resident's health records Daily counts of infection in 9339 residents and for 11604 staff across 179 LTCF.	The home testing program introduced for all staff and residents in Four Seasons Healthcare Group (representing 9% of all	Residents, staff, and facilities	Cumulative incidence of COVID-19, Kaplan-Meier estimates mortality and symptoms.

					long-term care beds). All tested at least once.		
Eckardt et al (2020)[20]	USA, Florida	Cross sectional cohort	Long term care	120-bedded long-term care facility.	PPE; staff and visitor screening; visitor restrictions; distancing of residents; cohorting exposed residents; point-prevalence testing.	Residents, staff	COVID-19 prevalence
Feaster & Goh (2020)[21]	USA, Pasadena	Cross sectional cohort	Long term care homes	Residents and staff (n=1093) of LTCF (n=9) N=608 residents (age 78 ± 13.3 years; n=332 female) N=485 staff (age 41.8 ± 13.3 years; n=249 female)	Mass surveillance testing	Residents, staff	COVID-19 prevalence, symptoms
Fisman et al. (2020)[42]	Canada, Ontario	Cohort	Long term care facilities	N=269 total individuals who died of COVID-19 in Ontario to April 11, 2020, and n=83 individuals who died of COVID-19 in Ontario LTCF to April 7, 2020. Denominators not available for long-term care residents approximated as the total number of long-term care facility beds in Ontario (79 498), assuming complete occupancy. Median beds 120 [9 to 543]	Surveillance data analysed to evaluate the risk of death and identification of risk factors for prevention strategies	Residents, staff, facilities	COVID-19–specific mortality incidence rate ratios (IRRs) of long term care residents were calculated with community-living Ontarians older than 69 years as the comparator group.

Graham et al. (2020)[22]	England	Cross sectional cohort	Four nursing homes in London, England	N=4 nursing homes. N=394 residents (37.6% male, median age 83 years [IQR 15], 75.4% white) N=596 staff.	Mass surveillance testing; isolation of infected residents	Residents, staff	COVID-19 prevalence, symptoms, mortality. Multivariable logistic regression of presenting symptoms in those who had an available test
Guery et al (2020)[44]	France, Nantes	Cross sectional cohort	Nursing home	N=136 staff (age 39 years [IQR 27-48.5], n=112 female)	Surveillance testing of staff following confirmed index case	Staff	COVID-19 prevalence, symptoms
Hand et al. (2018)[23]	USA, Louisiana	Cross sectional cohort	Long term care facility	Long term care facility provides services for up to 130 residents: report on 20 resident cases	Outbreak surveillance after 20 cases reported. Adherence to standard droplet precautions for symptomatic residents	Residents, facilities	Prevalence of Coronavirus NL63 symptoms, hospitalizations, mortality
Harris et al. (2020)[24]	USA, Virginia	Cross sectional cohort	Long term care facility	N=41 of 48 residents (median age 75 years [44-104], 52.1% female (25/48). 60.4% White (29/48)) N=7 staff	Following an outbreak, response developed for the management of residents and the use of telemedicine. Early identification of residents for escalation of care; monitoring and treating patients safe to remain in a facility; care coordination - bidirectional; daily needs assessment related to technology, infection control and staff wellbeing	Residents, staff	COVID-19 prevalence, mortalities, comorbidities, telemedicine consultations

Heung et al (2006)[46]	Hong Kong	Cross sectional cohort	Residential care home	N=90 residents N=32 staff N=67/90 residents participated; n=7 (10%) aged 65 -75 years, n=32 (48%) 76-85 years, n=28 (42%) >85 years; n=53 (79%) females. Staff 26/32 participated; n=18 (69%) aged 31-50 years, n=8 (31%) >50 years; 85% females; 54% nursing care role, 46% assistance in daily activities.	Surveillance screening in a residential care home with the introduction of infection control precautions: droplet and contact precautions	Resident, staff, facilities	Seroprevalence of SARS-CoV antibodies. Symptoms, transmission, and mortality
Ho et al. (2004)[47]	Hong Kong	Cross sectional cohort	Nursing home	N=7 residents, staff, visitors in one nursing home (n=4 females aged in their 60s to 90s; n=3 males aged in their 20s to 80s)	Proposed intervention for future management. Community-based outreach teams led by geriatricians, nurses to closely monitor nursing home residents discharged from hospital	Residents, staff, visitors, facilities	Descriptive data on seven cases, the onset of illness, transmission and outcome including mortality
Hoxha et al. (2020)[48]	Belgium	Cross sectional cohort	Long Term Care Facilities	Reporting for 2074 of 2500 invited facilities; 280,427 COVID-19 tests. 51% residents (N=142,100) and 49% staff (N=138,327)	Mass testing	Residents and staff	COVID-19 prevalence, symptoms, characteristics associated with positive test outcome
Iritani et al. (2020)[51]	Japan	Cross sectional cohort	Across long term care hospitals/facilities, general medical/welfare facilities, and non-	381 clusters with 3786 infected cases accounting for 23.9% of 15,852 cases	Following government recommendation suspension or restricting temporary use of LTCF in areas where infection prevalent	Facilities	Descriptive data on clusters reported, mortality data

			medical/welfare facilities				
Kennelly et al. (2020)[50]	Ireland	Cross sectional cohort	Nursing homes	Nursing home residents in three community health organizations in Ireland (N=28 nursing homes). Represents 2043 residents & 2303 beds	Mass surveillance testing; post testing program	Staff, residents, facilities	COVID-19 prevalence, symptoms, clinical outcomes, including mortality. Characteristics of facilities associated with transmission.
Kim (2020)[52]	Korea (South)	Cross sectional cohort	Nursing home	N=142 nursing home residents N=85 health care workers and caregivers working in one facility	Procedures identified to reduce transmission of COVID-19 following confirmed case in a staff member	Facilities	Data on the preparedness of the facility to reduce transmission.
Kimball et al. (2020)[25]	USA, King County, Washington	Cross sectional cohort	Long-Term Care Skilled Nursing Facility	Nursing home. N=82 residents; 76/82 (92.7%) underwent symptom assessment and testing; three (3.7%) refused testing	Surveillance testing; PPE; hand hygiene; visitor restrictions; staff screening; daily resident symptom assessments; isolation of positive residents	Residents	COVID-19 prevalence and symptoms
Klein et al (2020)[51]	Germany, Hamburg	Cross sectional	Residential care facility	N=60 resident and report from eight deceased residents.	Mass testing; PPE; resident cohorting; visitor restrictions	Residents	COVID-19 prevalence and symptoms, management

Lennon et al. (2020)[26]	USA, Massachusetts	Cross sectional cohort	Skilled facilities, nursing homes and assisted living facilities	N=366 skilled nursing facilities N=32,480 residents and staff tested once, and 6.7% tested subsequently. N=16,966 residents (mean age 82 ± 13; 65% female). N=15,514 staff (mean age 45 ± 15; 76% female).	Mass testing and recording of symptoms, comparison of viral levels	Residents, staff	COVID-19 prevalence, symptoms
Louie et al. (2020)[27]	USA, San Francisco	Cohort	Three skilled nursing facilities and one assisted living facility	N=431 residents and staff tested as part of initial surveillance. Follow up testing of n=303 asymptomatic cases.	Mass surveillance testing; restrictions on visitors & non-essential staff; increased monitoring/screening of people entering/residing in a facility	Residents, staff	COVID-19 prevalence, hospitalizations, fatalities, management
McMichael et al. (2020) a[28]	USA, King County, Washington	Cross sectional cohort	Skilled Nursing Facility	N=167 N=101 residents (median aged 83 (51-100), n=32 (31.7%) male, n=69 (68.3%) female). N=50 health care personnel (median age 43.5 (21-79), n=12 (24%) males, n=38 (76%) female). N=16 visitors (median age 72.5 (52-88), n=11 (68.7%) male, n=5 (31.2%) females).	Mass surveillance testing; contact tracing; quarantine of exposed persons; isolation of confirmed and suspected cases; on-site enhancement of PPE/infection prevention and control.	Residents, staff, visitors, facilities	COVID-19 prevalence, symptoms, mortality, hospitalizations, management

Office for National Statistics (2020)[39]	England	Cross sectional cohort	Care homes providing care for older residents and those with dementia only.	N=9081 care homes for people aged 65 years and older - representing 292,301 residents (95% CI 293,168 to 293,434) and 441,498 staff. N=5126 homes participated (56%)	Prevalence of COVID-19 in residents and staff. Factors associated with higher levels of infection.	Residents, staff, facilities	COVID-19 prevalence in residents aged 65 years and older and employees.
Patel et al. (2020)[29]	USA, Illinois	Cross sectional cohort	Nursing home (150 bedded unit)	N=127 residents. 9% (n=11) single occupancy rooms, 91% (n=116) double occupancy rooms.	Mass surveillance testing; screening of staff and visitors; visitor restrictions; cohorting of residents; PPE	Residents, staff, facilities	COVID-19 prevalence, symptoms, hospitalizations and survival rates, management
Quicke et al. (2020)[30]	USA, Colorado	Longitudinal cohort	Five skilled nursing facilities	N=454 staff	Weekly surveillance nasopharyngeal swabs tests were collected.	Staff	COVID-19 prevalence and incidence, symptoms and information on genomic epidemiology
Quigley et al (2020)[31]	USA, 29 States	Cross sectional cohort	Nursing homes	N=56 nursing homes from 29 States: Midwest (30%), West (25%), Northeast (23%), South (22%).	Reported on preparedness for COVID-19, testing, supplies and staffing levels	Facilities	Preparedness of nursing home facilities during COVID-19

Roxby et al. (2020)[32]	USA, Seattle, Washington	Cross sectional cohort	Assisted living community older adults	Older aged residents and staff in an assisted living community. N=80 residents (mean age 86 years (range, 69-102); n=62 (77%) female). N=62 staff (mean age 40.0 ± 15; n=42 (68%) female). N=83 private apartments, n=45 independent, n=38 assisted living	Mass testing; resident cohorting/isolation; PPE; staff screening; visitor screening; additional hand hygiene stations.	Residents, staff	COVID-19 prevalence and symptoms
Sacco et al (2020)[45]	France, Maine-et-Loire	Cross sectional cohort	Nursing home	N=87 residents (age 87.9 ± 7.2; 71% female) N=92 staff (age 38.3 ± 11.7; 89% female)	Mass testing; PPE; visitor restrictions; hand hygiene; resident isolation	Residents, staff, facilities	COVID-19 prevalence and case-fatality rates. Resident's clinical signs and symptoms obtained from retrospective chart audit.
Sanchez et al (2020)[33]	USA, Detroit	Time series cohort	Skilled Nursing Facilities	N=26 skilled nursing facilities N=2773 residents' tests reported at baseline (median age 72 years [IQR 64-82 years]); n=2218 1st follow up; n=637 2nd follow up	Two point-prevalence surveys; follow up in 12 facilities following PPE guidelines; resident cohorting	Residents, facilities	COVID-19 prevalence, hospitalizations, and deaths pre and post introduction of testing

Stall (2020)[43]	Canada, Ontario	Retrospective cohort	Nursing homes	N=623 nursing homes (n=75,676 residents); 360/623 (57.7%) for-profit homes, 162/623 (26.0%) non-profit, 101/623 (16.2%) municipal homes. Mean number residents: n=113.2 (for profit); n=119.6 (non-profit); n=101 (municipal).	Impact of profit status at the level of a home rather than a resident. Using data from the Ontario Ministries of Health and Long-Term Care as part of the province's emergency "modelling table."	Facilities, residents, and staff	Descriptive data on outbreaks, facility characteristics and mortality rates. Nursing home profit status (for-profit, non-profit or municipal), nursing home COVID-19 outbreaks (at least one resident case), COVID-19 outbreak sizes (total number of confirmed resident cases amongst homes with outbreaks), and the total number of COVID-19 resident deaths (amongst homes with outbreaks). Outbreaks in staff reported. Death rates for residents
Stow (2020)[40]	England	Longitudinal ecological study	Care home units from 46 local authority areas in England.	N=460 care home units N=6,464 residents	Use of National Early Warning Score (NEWS) for identification of at-risk/surveillance to reduce mortality	Residents	Descriptive data NEWS surveillance on reducing mortality. Time-series comparison with Office for National Statistics weekly reported registered deaths of care home residents and COVID-19 was the underlying cause of death, and all other deaths (excluding COVID-19) up to 10/05/2020.

Telford et al. (2020)[34]	USA State of Georgia (Fulton County and City of Atlanta)	Cross sectional cohort	Nursing homes	N=28 nursing homes. N=5671 participants; n=2868 (50.6%) residents, n=2803 (49.4%) staff.	Mass surveillance testing of staff and residents	Residents, staff	COVID-19 prevalence, hospitalizations, and deaths.
Unruh et al. (2020)[35]	USA States New Jersey, New York, Connecticut	Case study	Nursing homes with ≥100 beds	N=1162 nursing home facilities	Nursing home characteristics associated with mortality rates	Facilities	Mortality data. Predicted probabilities with Logistic Regression, Independent variables compared on characteristics of facilities

Study setting is presented as defined in original study. PPE, personal protective equipment; LTCF, long term care facilities; IQR, inter quartile range; NEWS, national early warning score.

Table 2. COVID-19 outcomes related to the nature of long term care facilities.

Study	Facilities	Outcomes
Abrams et al. (2020)[16]	Facilities	Average number of cases was 19.8 (range 1 to 256). New Jersey (88.6%, OR 7.16) and Massachusetts (78.0%, OR 4.36) had a higher number of affected facilities. Probability of having a COVID-19 case: Facility size (relative to small): Large OR=6.52; Medium OR=2.63 Location (relative to rural): Urban OR=3.22 % African American residents (relative to low %): Greater % OR=2.05 Nursing home chain status (relative to non-chain status): Chain status OR=0.89 State were significantly related to the probability of having COVID case

		Outbreak size associations: Facility size (relative to small facility size): Large= -15.88; medium= -10.8 (percentage point change) For-profit status (relative to non-profit status) =1.88 State. Medicaid dependency, ownership, five-star rating, and prior infection violation were not significantly related to COVID-19 cases.
Brainard et al. (2020)[36]	Facilities	Risk of infection: Facility employee numbers (relative to <10 workers): 11-20 non-care workers HR = 6.502 (95%CI 2.614 -16.17); 21-30 non-care workers HR = 9.870 (95% CI 3.224 -30.22); >30 non-care workers HR = 18.927 (95% CI 2.358 -151.90). Predictors of spread and increase in cases per unit after 5th April risk increased 1.0347 (95% CI 1.02-1.05) p < 0.001, reduced availability of PPE for eye protection increased risk 1.6571 (95% CI 1.29-2.13) p < 0.001, PPE for facemasks 1.2602 (95% CI 1.09-1.46) p = 0.002, count of care workers employed 1.0379 (95% CI 1.02-1.05) p < 0.001 count of nurses employed (in bands of 0-10,11-20, 21-30 and 31+) 1.1814 (95% CI 1.13-1.24) p < 0.001.
Brown et al. (2020)[41]	Facilities	Incidence in high crowding index homes was 9.7% versus 4.5% in low crowding index homes (p<0.001), while COVID-19 mortality was 2.7% versus 1.3%. Likelihood of COVID-19 introduction did not differ (31.3% vs 30.2%, p=0.79). After adjustment for a regional nursing home, and resident covariates, the crowding index remained associated with increased risk of infection (RR=1.72, 95% CI: 1.11-2.65) and mortality (RR=1.72, 95% CI: 1.03-2.86). Simulations suggested that converting all 4-bed rooms to 2-bed rooms would have averted 988 (18.9%) infections of COVID-19 and 271 (18.7%) deaths.
Burton et al. (2020)[37]	Facilities	Significant associations between the presence of an outbreak and number of beds (OR per 20-bed increase 3.50), a history of multiple previous outbreaks (OR 3.76), and regulatory risk assessment score (OR high-risk vs low 2.19). However, in the adjusted analysis, only number of beds (OR per 20-bed increase 3.50, 95%CI 2.06 to 5.94 per 20-bed increase).
Dutey-Magni et al. (2020)[38]	Facilities	COVID-19 outbreak recorded in 121 of 179 facilities (67.6%). Large LTCF had greater rates of infection (aHR=1.8 [95% CI: 1.4-2.4] for LTCF with ≥70 beds versus <35 beds. The adjusted hazard ratio for confirmed infection was 2.5 times [95% CI: 1.9-3.3] greater in LTCF with 0·85-1 resident per room versus LTCF with 0.7-0.85 resident per room. A ten-percentage point increase in the bed to staff ratio was associated with a 23% increase in infection (aHR=1·23 [95% CI: 1.17-1.31]).
Fisman et al. (2020)[42]	Facilities	Covid-19 cases higher in for-profit operators 165/361 (45.7%) compared to charitable 18/57 (31.6%).
Hand et al. (2018)[23]	Facilities	Residents noted to share rooms, walk throughout the facility and spent time in shared areas (e.g., gym, dining rooms, and recreational rooms). Because all case-patients had visited the gym at the facility for recreation or physical therapy before becoming ill, environmental cleaning of this area was performed.

Heung et al. (2006)[46]	Facilities	67 of 90 residents participated. 26 of 32 staff participated. 2 residents and one staff member were positive during the outbreak. None of the remaining participants was positive for SARS-CoV antibodies. Residents were aged 65+ years, 79% were female, 93% were ambulant, 90% did activities with others, 79% went out. Review of residents who died: Resident A transferred from the hospital and was chair bound and dependent with care needs. Resident B was chair bound and had not left home or had visitors. She was brought to a shared sitting room during mealtimes. This was only time residents A and B were located near each other. One resident shared a room with patient B and tested positive. Staff C was a domestic worker, and contact was via clinical waste in resident A room. Low seroprevalence attributed to precautionary measures taken in the facility to reduce droplet and prevent contact transmission. Risks noted of SARS via fomites possible.
Ho et al. (2004)[47]	Facilities	3 residents positive for SARS. 1 employee positive for SARS. 3 visitors positive for SARS. The index case was a single resident who was infected during a hospital stay, returned to the LTCF, and the virus spread to another 6 people. Transmission of the virus occurred due to lack of isolation rooms in nursing homes, lack of restricted movement of other patients and relatives, lack of infection control precautions, lack of knowledge among staff.
Iritani et al. (2020)[51]	Facilities	Larger cluster sizes in long term care hospitals/facilities were significantly positively associated with higher morbidity ($\rho = 0.336$, $P = 0.006$) and higher mortality ($\rho = 0.317$, $P = 0.009$). Multivariate logistic regression showed larger cluster size (OR = 1.077, 95% CI: 1.017-1.145) and larger cluster number (OR = 2.019, 95% CI: 1.197-3.404) associated with mortality.
Kennelly et al. (2020)[50]	Facilities	Outbreak recorded in 75.0% (21/28) of facilities – four public and seventeen private. During the study period, 40.1% of residents in 21 nursing homes with outbreaks had a laboratory diagnosis of COVID-19. Correlation between the proportion of symptomatic staff and number of residents with confirmed/suspected COVID-19 (ρ=0.81). No significant correlation between the proportion of asymptomatic staff and number of residents with confirmed/suspected COVID-19 (ρ=0.18 p=0.61).
Kim (2020)[52]	Facilities	After the management of the outbreak, there were no more infected persons. All patients and employees tested negative 14 days from the start of quarantine.
McMichael et al. (2020) a[28]	Facilities	February 28, 2020, four cases COVID-19 identified in County. One person identified as index case from Facility A. Staff roles for confirmed cases reported: therapists, nurses, nurse assistants, health information manager, physician, and case manager. Paper reports that 30 facilities in County had confirmed cases and provides detail on first 9 (Facilities A to I). Facility A shared staff with another facility and two resident transfers from facility A. Surveillance reported inadequate PPE, training, infection control practices, lack of documentation signs and symptoms, working in unfamiliar facilities or sharing staff. On March 10, 2020, the governor of Washington implemented mandatory screening of health care workers and visitor restrictions for all licensed nursing homes and assisted living facilities including screening, testing, policies around visiting, excluding symptomatic staff, close monitoring of residents, testing, training and PPE. Monitoring of staff absences.
Office for National Statistics (2020)[39]	Facilities	For each additional member of infected staff working at the care home, the odds of resident infection increase by 11%, i.e. OR = 1.11 (95% CI: 1.1-1.11). Care homes using bank or agency nurses or carers most or every day more likely to have cases in residents (OR= 1.58, 95% CI: 1.5 - 1.65) compared to those who never use bank or agency staff. Residents in care homes outside of London had a lower chance of infection, except West Midlands (OR = 1.09, 95% CI: 1.0 - 1.17). Homes where staff receive sick pay are less likely to have resident cases (OR= 0.82 to 0.93, 95% CI: 7-18%), compared to homes where no sick leave. For each additional infected resident at a home, the odds of staff infection increase by 4% OR=1.04 (95% CI: 4 - 4%). Care homes using bank or agency staff most or every day OR=1.88 (95% CI: 1.77-2.0) compared to homes not using. Homes where staff regularly work elsewhere

		(most or every day) increase odds (OR=2.4, 95% CI: 1.92 - 3.0) compared to homes who never work elsewhere. Staff at homes outside London had higher odds of COVID-19 infection.
Patel et al. (2020)[29]	Facilities	First resident unwell March 9, female aged in her 60s with cough and fever. Hospitalized March 11 and tested positive COVID-19 March 13. 14 residents who were positive developed symptoms over 30 day follow up. 21% (n=7) confirmed cases lived in single occupancy rooms. 55% (n=18) were in a double room with another confirmed case, and 24% (n=8) were in a double room with a resident who was negative March 15. Screening visitors and staff for symptoms, restricting visiting hours from March 6. No visitor access from March 12. Universal masking of all staff and residents from March 14. 15th -19th March on-site team implemented assessment of symptoms, resident cohorting. Staff testing positive isolated and return 7 days or after 72 hours of symptoms resolving. Education and training to staff in facility A infection control, PPE, vital signs
Quigley et al. (2020)[31]	Facilities	For-profit = 67.86%, non-profit = 26.79% and government-owned = 5.36%. 37.5% were part of a chain. 54% have COVID-19 plans. All had staff training for COVID-19 and 100% processes to restrict/ limit visitors. 29% conducted COVID-19 simulation training. Communication with local Public Health - 96%, and 68% linked to local hospital referral. 66% reported access to COVID-19 tests - available for all residents and 53% of staff. 72% reported inadequate PPE supplies. 83% expected staff shortages. Solutions for staff included staff volunteer for more shifts (55%), non-clinical staff used (45%). 19% reported they would use agency staff.
Sacco et al. (2020)[45]	Facilities	Restrictions on residents from March 16 - social distancing, remain in single rooms, no communal dining or group activities. No visitors since March 10, individual walks outside only in the presence of one staff member. Mail and packages stored 24 hours before being delivered to residents. Enhanced hygiene and cleaning. Staff had permanent face masks and additional hand hygiene
Sanchez et al. (2020)[33]	Facilities	Of the 12 facilities in the final survey, eight had implemented cohorting in a dedicated COVID-19 unit before 1st follow up. 4 remaining initiating cohorting after receiving results. 4 facilities did not assign dedicated personnel to care for residents with COVID-19 due to staff shortages. Final survey census 80 residents (range 36 to 147). 373 of 1063 (35%) had received positive results 1st follow up.
Stall (2020)[43]	Facilities	Adjusted modelling odds of COVID-19 outbreak associated with for-profit status aOR 1.01 (95% CI: 0.64-1.57), Municipal aOR 0.83 (95% CI: 0.45-1.54). Model 2 + Health Region aOR 2.02 (95% CI: 1.20-3.38) population <10,000 rural aOR 0.27 (95% CI: 0.13-0.58); and model 3 + home characteristics. Number of residents (unit of 50) aOR 1.38 (95% CI: 1.18-1.61), older design aOR 1.55 (95% CI: 1.01-2.38), chain ownership vs single home aOR 1.47 (95% CI: 0.86 to 2.51) and staff (full time equivalent/ bed ratio aOR 1.98 (95% CI: 0.39-9.97). The extent of a COVID-19 outbreak with profit aRR 1.83 (95% CI: 1.18-2.84) vs municipal aRR 0.60 (95% CI: 0.28 -1.30) compared with non-profit. Health Region aRR 1.65 (95% CI: 1.02- 2.67), older design standards aRR (95% CI: 1.27 -2.79), chain ownership aRR 1.84 (95% CI: 1.08-3.15) and staff/ bed ratio a RR 0.73 (95% CI: 0.10-5.35). Deaths accounted for 6.5% of all residents in for-profit homes vs 5.5 % in non-profit vs 1.7% municipal LTCF. For-profit associated with total COVID-19 deaths aRR 1.78, (95% CI: 1.03 - 2.07). Adjusted model increased risk of death with for-profit aRR 0.82, (95% CI: 0.44- 1.54), older design facilities aRR 2.08 (95% CI: 1.28-3.36) and chain ownership aRR 1.89, (95% CI: 1.00- 3.59). Number of active residents was protective aRR 0.81, (95% CI: 0.70 -0.95) / 50 beds.
Unruh et al. (2020)[35]	Facilities	184 nursing homes (15.8%) had 6 or more COVID-19 deaths. Deaths associated with Medicaid patients (quintile 5: 8.6 PP greater probability vs quintile 1). Patients with higher ADL scores (2.6 (95% CI: 1.4-3.8) PP, p<0.001), more total beds (0.1 (95% CI: 0.0 to 0.1) PP, p<0.001), higher occupancy (0.3 (95% CI: 0.1-0.5) PP, p<0.009), for-profit status (4.8 (95% CI: 0.8-8.8) PP, p=0.019). Comparing States: Higher mortality in those with Medicaid (quintile 5: 6.1 (95% CI: 0.0-12.1) PP, p=0.048). Not significant for other States. More direct care hours per patient day associated with lower COVID-19 deaths All States (-4.8 95% CI: -9.4 - -0.03) PP, p<0.04).

OR, odds ratio; HR, hazard ratio; PPE, personal protective equipment; CI, confidence interval; LTCF, long-term care facility; aHR, adjusted hazard ratio; aRR, adjusted relative risk; ADL, activities of daily living; PP, percentage points.

Morbidity and mortality

Morbidity and mortality results from included studies are presented for residents (Table 3a), staff (Table 3b), and visitors (Table 3c). Prevalence of COVID-19 infection was reported in 29 studies, including prevalence in residents (27 studies; [17-29,32-34,38,39,41,43,45-50,53]) and staff (22 studies; [17,19-22,24,26-30,32,34,38,39,44-48,50,53]), with 2 studies reporting absolute case numbers in visitors.[28,47] Prevalence rates ranged from 3.8% in a sample of 2074 LTCF[48] and 1.2% in the third point-prevalence survey at a single facility[20] to 85.4% in a single facility that implemented a telemedicine service to limit transmission.[24] Staff prevalence ranged from 0.6% in a point-prevalence survey in a single facility[20] to 62.6% in a group of nine LTCF.[21] One study reported 16 COVID-19 positive visitor cases,[28] while a study which examined SARS infection following an outbreak in a Hong Kong facility reported 3 positive visitor cases.[47]

The symptom status (symptomatic/presymptomatic/asymptomatic, typical/atypical symptoms) of participants was reported in 16 studies, with resident and staff symptom status reported in 15 [17-19,21,22,25-27,29,32,33,45,48,50,53] and 13 studies,[19-22,26,27,29,32,44,45,48,50,53] respectively. No studies reported symptom status of visitors. The proportion of COVID-19 positive residents presenting with symptoms ranged from 26.3%[19,26] to 59.8% (a sample of both residents and healthcare workers).[27] Asymptomatic cases in residents were reported in 13 studies,[17,19,21,22,25-27,29,32,45,48,50,53] with proportions of COVID-19 positive residents presenting with no symptoms varying from 2.4%[45] to 75.3%.[48] Among COVID-19 positive staff, the proportion of symptomatic cases ranged from 6.4%[26] to 100%,[32] and asymptomatic cases ranged from 23.6%[50] to 100%.[20,22]

Mortality results were reported in 22 studies, including information on mortality of residents (22 studies; [17-19,22-24,27-29,33,34,37-43,45,47,49,50]), staff (4 studies; [28,34,45,47]), and visitors (2 studies; [28,47]). Mortality rates in COVID-19 positive residents ranged from 5.3%[19] to 55.3%.[38] One study reported a 66.7% death rate in residents who tested positive for the SARS virus.[47] A study examining the mortality risk in Ontario LTCF reported a death rate of 0.1% across all residents.[42] Across the three studies which presented mortality results in COVID-19 positive staff, mortality rates were 0%.[28,34,45] One study presenting mortality rates in a nursing home following a SARS outbreak reported one death of a

member of staff.[47] Mortality rates reported in visitors in two studies was 0%[47] and 6.2%,[28] respectively.

Characteristics of LTCFs on COVID-19 transmission

Numerous facility-specific characteristics were linked with risk of COVID-19 cases (Table 2). These include size of LTCF;[16,37,38,51] staffing levels and/or use of agency care staff;[28,31,36,38,39,43,50] part of larger chain of organisations and/or for profit status;[16,31,35,42,43,50] and related staffing, crowding, or availability of single rooms.[23,29,39,41,43,45-47]

Table 3a. Resident-specific outcomes of strategies implemented in nursing homes

Study	Interventions	Prevalence	Mortality	Other outcomes
Arons et al. (2020)[17]	Mass testing (two point-prevalence surveys) PPE	48/76 (63%) across two surveys, 17/48 typical symptoms, 4/48 atypical symptoms, 3/48 asymptomatic, 24/48 presymptomatic 57/89 through point-prevalence, clinical evaluation, post-mortem	15/57 (26%)	Common symptoms: fever (71%), cough (54%), malaise (42%) Estimated doubling time: 3.4 days (95% CI: 2.5-5.3)
Blackman et al. (2020)[18]	PPE Symptom screening Visitor restrictions	12 positive cases, 2 awaiting results, 47 symptomatic residents	3 COVID-19 related deaths	
Borras-Bermejo et al (2020)[53]	Mass testing Visitor restrictions	768/3214 (23.9%), 486 (69.5% of those with symptom information) were asymptomatic		2624 of all residents reported symptoms in the previous 14 days
Brown et al. (2020)[41]	Facility characteristics	5218/78607 (6.6%)	1452/5218 (27.8%)	
Burton et al. (2020)[37]	Facility characteristics		403 deaths recorded in care homes	472 excess deaths in care homes with an outbreak (399 COVID-19 related)
Dora et al. (2020)[19]	Mass testing (three point-prevalence surveys) Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	19/96 (19.8%) across three surveys, 5/19 symptomatic, 8/19 presymptomatic, 6/19 asymptomatic	1/19 (5.3%)	Symptoms: fever (58%), myalgia (58%), cough (47%), dyspnoea (32%), nausea (32%) Oxygen therapy required for 4/8 presymptomatic, 4/5 symptomatic cases
Dutey-Magni et al. (2020)[38]	Mass testing	951/9339 (10.2%)	526/951 (55.3%)	2075/9339 (22.2%) experienced infection symptoms
Eckardt et al. (2020)[20]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Cohorting	Survey 1: 5/105 (4.8%) Survey 2: 4/86 (4.7%) Survey 3: 1/85 (1.2%)		
Feaster & Goh (2020)[21]	Mass testing	408/582 (49.5%), 202/408 (49.5%) symptomatic 237/332 (71.4%) female residents positive, 121/237 (51.1%) asymptomatic		

		171/250 (68.4%) male residents positive, 81/171 (47.4%) asymptomatic		
Fisman et al. (2020)[42]	Facility characteristics		83/79498 (0.1%)	IRR (COVID-19 related death in LTCF residents) = 13.1 (95% CI: 9.9-17.3) compared with community-living adults older than 69 years
Graham et al (2020)[22]	Mass testing (two point-prevalence surveys) Cohorting	Survey 1: 126/313 (40%), 72/126 (57.1%) symptomatic, 50 typical symptoms, 22 atypical symptoms, 54/126 (42.9%) asymptomatic Survey 2: 5/176 (2.8%)	53/131 (40.4%)	Increased risk of death: men (48% of deaths vs. 34% in those who survived; whole group 38% male, p=0.02); the trend for median age to be greater among those who died (p = 0.058) Increased odds of COVID-19 positive: new onset anorexia (OR = 3.74, 95% CI: 1.5-9.8); cough and/or shortness of breath (OR = 3.72, 95% CI: 1.8-7.8); fever, altered mental state/behaviour, diarrhoea not associated with positive test
Hand et al. (2018)[23]	Symptom screening Hand hygiene, contact precautions	20/130 residents suspected cases, 13/20 tested 7/13 (54%) tested positive; 6/7 required hospitalization	3/7 (42.9%)	No new cases identified after November 18 2017
Harris et al. (2020)[24]	Facility characteristics	41/48 (85.4%) 18/48 residents hospitalised, 11/18 returned to facility from hospital	6/48 (12.5%)	13/48 (27.1%) of residents received telemedicine consultations
Heung et al. (2006)[46]	Hand hygiene, contact precautions	2 residents were positive during the outbreak, 0/67 residents positive for SARS-CoV antibodies upon screening		2/67 reported symptoms
Ho et al. (2004)[47]	PPE Cohorting	3 residents positive	2/3 (66.7%)	
Hoxha et al. (2020)[48]	Mass testing	5390/142100 (3.8%), 4059/5390 (75.3%) asymptomatic		Infection odds: Women compared to men OR = 1.2 (95% CI: 1.1-1.2); symptomatic compared to asymptomatic OR = 8.5 (95% CI: 8.0-9.0)

Kennelly et al. (2020)[50]	Mass testing Facility characteristics	710/1741 (40.1%), 54/1741 (3.1%) residents were suspected COVID-19, 193/710 (27.2%) asymptomatic, 396/710 (55.8%) had recovered by the completion of surveillance period	183/710 (25.8%)	Non-COVID-19 mortality rate similar between outbreak and non-outbreak NHS (5.1% vs. 4%, p=0.4)
Kimball et al. (2020)[25]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	23/76 (30.3%), 10/23 symptomatic (8/10 typical symptoms, 2/10 atypical symptoms), 3/23 asymptomatic, 10/23 presymptomatic		Symptoms: fever (61.5%), malaise (46.2%), cough (38.5), Presymptomatic mean interval from testing to symptom onset was 3 days
Klein et al. (2020)[49]	Mass testing PPE Visitor restrictions Cohorting	39/60 (65%)	8/39 (20.5%)	Symptoms: exhaustion, loss of appetite, dysphagia, fever, cough, colds, diarrhoea
Lennon et al. (2020)[26]	Mass testing	2654/16966 (15.5%), 1692/2654 (63.8%) asymptomatic, 699/2654 (26.3%) symptomatic, (263/2654 symptom data missing)		
Louie et al. (2020)[27]	Mass testing Symptom screening Visitor restrictions	214/431 (49.7%) residents and healthcare workers, 128/214 (59.8%) symptomatic (78/128 were residents), 86/214 (40.2%) asymptomatic Additional 156 asymptomatic residents subsequently tested: 63/156 COVID-19 positive	12/78 (15.4%) symptomatic residents died	22/78 (28.2%) symptomatic residents hospitalized
McMichael et al. (2020)a[28]	Mass testing PPE Cohorting	101/118 (58.6%)	34/101 (33.7%)	55/101 (54.5%) hospitalized; (37/101 no data on hospitalisation status)
Office for National Statistics (2020)[39]	Mass testing Facility characteristics	19.9% (95% CI: 18.5-21.3) in homes with a confirmed outbreak 10.7% (95% CI: 10.1-11.3) in all homes	15606 across all homes	Odds of resident infection: Each additional infected staff member at a home OR = 1.11 (95% CI: 1.0-1.17) Homes using bank or agency nurses most or all days OR = 1.58 (95% CI: 1.5-1.65) compared with homes never using these staff Homes outside of London had lower infection chance, except

				West Midlands (OR = 1.09, 95% CI: 1.0-1.17) Homes where staff receive sick pay OR = 0.82-0.93 (95% CI: unknown)
Patel et al. (2020)[29]	Mass testing Symptom screening Visitor restrictions Cohorting	33/118 (28.0%), 19/33 (58%) symptomatic (8 typical symptoms, 4 atypical symptoms, 10 both typical and atypical symptoms); 1/33 (3%) presymptomatic, 13/33 (39%) asymptomatic	10/35 (28.6%) (5/10 symptomatic) 30-day survival = 71% (95% CI 52-83)	1/91 negative residents reported symptoms 35/90 negative asymptomatic residents developed symptoms during 30-day surveillance, 2/35 COVID-19 positive upon re-testing 13/35 COVID-19 residents hospitalized
Roxby et al. (2020)[32]	Mass testing Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	Survey 1: 3/80 (3.8%), 1/3 reported resolved cough and loose stool during the preceding 14 days Survey 2: 1/77 (1.3%)		All residents clinically stable 14 days after second test 21 days after the test, all cases continued their usual state of health
Sacco et al. (2020)[45]	Mass testing PPE Visitor restrictions Hand hygiene, contact precautions Cohorting	41/87 (47.1%) 3/41 asymptomatic	11/41 (27%) All-cause mortality: 13% (95% CI 7.2-21.2), compared to 3% for the same period during the previous 5 years	Incidence rate for residents = 1.54 per 100 person-days 14/87 (16.1%) residents hospitalized
Sanchez et al (2020)[33]	Mass testing (two point-prevalence surveys) Cohorting	Survey 1: 716/2218 (32.3%), 344/716 (48%) symptomatic Survey 2: 115/637 (18.1%), 5/115 (4%) symptomatic Total surveillance period: 1207/2773 (44%)	287/2773 (24%)	446/2773 (37%) hospitalised
Stall et al. (2020)[43]	Facility characteristics	5218/75676 (6.9%) 3599/5218 (69.0%) for-profit home residents 1239/5218 (23.7%) non-profit home residents 380/5218 (7.3%) municipal home residents	1452/5218 (27.8%) 989/3599 (27.5%) for-profit home 368/1239 (29.7%) non-profit home 95/380 (25.0%) municipal home	

Stow et al. (2020)[40]	Facility characteristics		1532 COVID-19 related deaths	Highest correlation of increased NEWS and deaths observed for a two-week lag (r=0.82, p<0.05) Above baseline measures of high respiratory rate (r=0.73, p<0.05 for a two-week lag) and low oxygen saturation (r=0.8, p<0.05 for a two-week lag) appear to follow the pattern of COVID-19 and non-COVID-19 deaths
Telford et al (2020)[34]	Mass testing (15 facilities in response to outbreak, 13 facilities as prevention)	821/2868 (28.6%) Response group: 804/1703 (47.2%) Preventive group: 17/1133 (1.5%), (p<0.0001)	Response group: 131/804 (16.3%) Preventive group: 3/17 (17.6%)	Response group: 171/804 (21.3%) residents hospitalised Preventive group: 5/17 (29.4%) residents hospitalised

PPE, personal protective equipment; CI, confidence interval; IRR, incidence risk ratio; LTCF, long-term care facility; OR, odds ratio; NEWS, national early warning score.

Table 3b. Staff-specific outcomes of strategies to reduce transmission

Study	Interventions	Prevalence	Mortality	Other outcomes
Arons et al. (2020)[17]	Mass testing PPE	26/51 (51.0%) 17/26 (65%) were nursing staff, 9/26 (35%) had roles that provided care/therapies across multiple units		0/26 hospitalized
Blackman et al. (2020)[18]	PPE Symptom screening Visitor restrictions			26 staff members absent from work due to sickness
Borras-Bermejo et al (2020)[53]	Mass testing Visitor restrictions	403/2655 (15.2%), 144/403 (35.7%) asymptomatic		1772/2665 (66.7%) staff reported fever or respiratory symptoms in the preceding 14 days
Dora et al. (2020)[19]	Mass testing (three point-prevalence surveys) Symptom screening Visitor restrictions	8/136 (6%) 4/8 (50%) asymptomatic 3/8 nursing staff 5/8 licensed vocational nurses		

	Hand hygiene, contact precautions Cohorting		
Dutey-Magni et al. (2020)[38]	Mass testing	585/11604 (5.0%)	1892/11604 (16.3%) reported symptoms
Eckardt et al. (2020)[20]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Cohorting	Survey 1: 10/176 (5.7%), 10/10 (100%) asymptomatic Survey 2: 5/175 (2.9%), 5/5 (100%) asymptomatic Survey 3: 1/173 (0.6%), 1/1 (100%) asymptomatic	
Feaster & Goh (2020)[21]	Mass testing	223/356 (62.6%), 55/223 (24.7%) asymptomatic	Infection prevalence higher in staff with direct resident contact (150/219, 68.5%) compared with staff with no direct resident contact (25/52, 48.1%)
Fisman et al. (2020)[42]	Facility characteristics		Infection among LTCF staff was associated with death among residents with a 6-day lag (adjusted IRR for death per infected staff member, 1.17; 95% CI: 1.11-1.26) and a 2-day lag (relative increase in risk of death per staff member with infection, 1.20; 95% CI: 1.14-1.26)
Graham et al. (2020)[22]	Mass testing (two point-prevalence surveys) Cohorting	3/70 (4.3%) 3/3 (100%) asymptomatic	Staff absence due to sickness/self-isolation between March 1 and May 1 elevated relative to background level (215.9% increase, 95% CI: 80-352)
Guery et al. (2020)[44]	Mass testing	3/136 (2.2%) 1/3 (33.3%) asymptomatic 1/3 (33.3%) presymptomatic 1/3 (33.3%) symptomatic	
Harris et al. (2020)[25]	Facility characteristics	7 staff COVID-19 positive prior to intervention 0 further staff positive after intervention implemented	

Heung et al. (2006)[46]	Hand hygiene, contact precautions	1 staff member SARS-CoV positive during outbreak (a domestic worker) 0/26 staff positive for SARS-CoV antibodies		
Ho et al. (2004)[47]	PPE Cohorting	1 staff member SARS positive	1/1 (100%)	
Hoxha et al. (2020)[48]	Mass testing	2953/138327 (2.1%) 2185/2953 (74.0%) asymptomatic		
Kennelly et al. (2020)[50]	Mass testing Facility characteristics	675 staff COVID-19 positive 159/675 (23.6%) asymptomatic		Proportion of symptomatic staff correlated with number of residents with confirmed/suspected COVID-19, $\rho = 0.81$ ($p<0.001$)
Lennon et al. (2020)[26]	Mass testing	624/15514 (4.1%) 487/624 (78.0%) asymptomatic 40/624 (6.4%) symptomatic		
Louie et al. (2020)[27]	Mass testing Symptom screening Visitor restrictions	214/431 (49.7%) residents and staff COVID-19 positive 86/214 asymptomatic 128/214 symptomatic (50/128 were health care workers) Additional asymptomatic staff testing: 23/147 (15.6%) staff COVID-19 positive		0/50 symptomatic health care workers hospitalized
McMichael et al (2020)a[28]	Mass testing PPE Cohorting	50 staff COVID-19 positive	0/50 (0%)	3/50 (6%) hospitalised Staff roles for confirmed cases: therapists, nurses, nurse assistants, health information manager, physician, case manager
Office for National Statistics (2020)[39]	Mass testing Facility characteristics	Estimated 6.9% (95% CI 5.9-7.9%) staff COVID-19 positive across homes that reported an outbreak		Odds of staff infection: for each additional infected resident, staff infection OR = 1.04 (95% CI: 1.04-1.04) Care homes using bank or agency staff most or every day OR = 1.88 (95% CI: 1.77-2.0) compared to homes not using these staff Homes where staff work in other homes most or every day OR = 2.4 (95% CI: 1.92-3.0) compared to homes where staff never work elsewhere

				Staff at homes outside London had higher odds of COVID-19 infection
Patel et al. (2020)[29]	Mass testing Symptom screening Visitor restrictions Cohorting	19/42 (45.2%) 11/19 symptomatic (57.9%) 8/19 (42.1%) asymptomatic		
Quicke et al. (2020)[30]	Mass testing (five point-prevalence surveys)	Site A: all staff uninfected Site B: low prevalence in week 1, weeks 2-5 no infections detected, week 6 increase in cases Site C: initial infection prevalence was lower (6.9%), and the incidence declined to zero by week 3 Site D: 22.5% of workers at site D had prevalent infections at the start of the study and incidence was high initially (12.2 per 100 workers per week), declining over time Site E: low prevalence in week 1 saw an increase in cases in subsequent weeks		
Roxby et al. (2020)[32]	Mass testing Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	2/62 (3.2%) (1 worked in dining facilities, 1 was a health aide) 2/2 (100%) symptomatic		
Sacco et al (2020)[45]	Mass testing PPE Visitor restrictions Hand hygiene, contact precautions Cohorting	22 staff COVID-19 positive 9/22 (40.1%) asymptomatic	0/22 (0%)	Staff incidence: Care givers = 0.48/100 person-days Non-care givers with resident contact = 0.36/100 person-days Non-care givers with no resident contact = 0.04/100 person-days
Stall (2020)[43]	Facility characteristics			Outbreak involving staff and residents' for-profit homes 59/360 and staff only 44/360 Non-profit homes staff only 18/ 162. Municipal homes = outbreak staff only 16/101

Telford et al (2020)[34]	Mass testing (15 facilities in response to outbreak, 13 facilities as prevention)	264/2803 (9.4%) Response group: 249/264 (94.3%) Preventive group: 15/264 (5.7%) (d) Prevalence: Response group 12.8% vs Preventive group 1.7%, p<0.0001	1/264 (0.4%) Response group: 0/249 (0%) Preventive group: 1/15 (6.7%)	16/264 (6.1%) hospitalised Response group: 15/249 (6.0%) hospitalised Preventive group: 1/15 (6.7%) hospitalised15/249

LTCF, long-term care facility; IRR, incidence risk ratio; CI, confidence interval.

Table 3c. Visitor-specific outcomes following the implementation of strategies

Study	Interventions	Prevalence	Mortality	Other outcomes
Ho et al. (2004)[47]	PPE Cohorting	3 visitors SARS positive	0/3 (0%)	
McMichael et al (2020)a[28]	Mass testing PPE Cohorting	16 visitors COVID-19 positive	1/16 (6.2%)	8/16 (50%) hospitalized Underlying conditions: hypertension (2/8, 12.5%); cardiac disease (3/8, 18.8%); renal disease (2/8, 12.5%); obesity (3/8, 18.8%), pulmonary disease (2/8, 12.5%)

PPE, personal protective equipment

Quality review

The quality ratings of included studies are presented in Supplementary Table 2. Overall quality of evidence in this review is considered low based on MMAT assessment criteria.

Discussion

Evidence in this review indicates the impact of COVID-19 on LTCF, demonstrating the vulnerability of this setting. A novel outcome highlights the characteristics of LTCF associated with COVID-19 outbreaks, in addition to reporting the prevalence rates of COVID-19 and associated mortality and morbidity for residents, staff, and visitors. A variety of measures were implemented in LTCF, of which many were instigated locally by facility managers, and others through agile public health policy. Mass testing of residents with or without staff testing was the primary measure used to reduce transmission of COVID-19. This provides objective evidence of infection rates in facilities, and enables application of subsequent measures, including isolation of residents who are infected with re-designation of specific staff to care for them. Repeated point-prevalence testing allows facilities to grasp the spread of the virus along with the impact of their mitigation strategies.

Further measures implemented in facilities echoed public health recommendations to the broader community to limit the spread of the virus. These included guidance on hand hygiene, and contact and droplet precautions. Restricting visitor access to facilities was implemented generally to reduce the likelihood of introducing COVID-19 into LTCF, with assessment of body temperature and symptom screening of staff and visitors on entry.

The prevalence of COVID-19 infection varied throughout included studies, with no distinct pattern emerging between prevention strategies and infection prevalence. Similarly, the mortality rate varied widely among studies and prevention measures. However, patterns emerged regarding associations between facility characteristics and the risk of a COVID-19 outbreak and spread.

The facility size/number of beds was significantly associated with the probability of having a COVID-19 case, and the resulting size of an outbreak. For example, in a sample of 30 US nursing homes, the probability of having a COVID -19 case was increased in medium and large facilities compared with

small facilities,[16] while in 121 UK homes reporting an outbreak, facilities with ≥70 beds had 80% greater infection rates than facilities with <35 beds.[38] A sample of 623 Canadian nursing homes demonstrated facilities with a high crowding index had more infections and deaths than those with a low crowding index. Simulations conducted suggested nearly 20% of infections and deaths may have been averted by converting all 4-bed rooms into 2-bed rooms.[41] Similarly, facilities with a greater number of staff, staff who work in multiple facilities, and greater number of infected staff, were also more likely to experience a COVID -19 outbreak.[36,39,50] However, facilities where staff receive sick leave were shown to be less likely to have positive cases.[39] Reduced availability of PPE predicted the spread and increase in case number in facilities,[36] while for-profit status of facilities was commonly identified as increasing the odds of case outbreaks relative to non-profit status.[16,31,35,42,43]

Quality review

The quality of evidence in this review is technically low, primarily reported from observational studies, expert opinion, reporting of outbreaks and describing the process and management (Supplementary Table 2). Factors associated with lower quality of evidence includes the reliance of self-reporting of symptoms, recall bias, use of datasets which may be incomplete, and use of convenience sampling. However, confirmation of COVID-19 in the majority of studies was via laboratory testing. We did not remove any study following our review of quality and the evidence is consistent with real time reporting of data to learn from outbreaks. The Institute of Medicine (2004)[54] advocates for early detection of epidemics, effective communication to the public, and promotion of research and development for strategic planning.

Limitations in the review process

A key strength of this review is that it addresses a knowledge gap and has collated evidence from a broad methodological base to report the measures to reduce transmission of COVID-19 in LTFC and reports characteristics of facilities.

Due to the heterogeneity of studies, meta-analysis was not performed, while the descriptive nature of studies prevents identification of a causative relationship between measures and outcomes. Despite

this, the systematic approach to this review has identified the scope of interventions implemented in LTFC to reduce COVID -19 transmission.

Publication bias was minimized with inclusion of pre-published evidence, follow up contacts with authors for early reporting, and through the inclusion of observational study designs. Most studies reported are in English, we translated papers from German and Spanish as part of the assessment and review. Outbreak reports include convenience samples or smaller cohorts of residents in LTCF with limited data reported in brief reports and letters. However, real time reporting of outbreaks provides immediate evidence and shared understanding advocated by the Institute of Medicine.[54]

While the present review builds on a review by Salcher-Konrad, Jhass, Naci, Tan, El-Tawil, Comas-Herrera [55], a recent report from WHO,[56] and from an Irish review report,[57] data on the role of facilities in the transmission of COVID-19 are reported.

Conclusion

This novel, rapid review summarises the evidence base to date identifying specific factors for consideration as part of preparedness plans to reduce transmission of COVID-19 outbreaks in LTCF. Future research should incorporate methodologically robust study designs with longer follow up to assess the impact on reducing transmission.

Funding

Authors declare no funds were provided for the production of this review.

Author Contributions

CK, KF, and LM designed the study; KF and DS developed the search strategy; DS conducted the literature search; KF and LM screened titles and full texts to select studies, and extracted data; LM, EL, KF, and CK conducted quality ratings; all authors interpreted and synthesised data; all authors were involved in writing. All authors have approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest. CK was a member of an expert panel investigating COVID-19 in nursing homes in Ireland.

Data availability

No additional data available.

References

1. European Centre for Disease Prevention and Control (ECDC). Timeline of ECDC's response to COVID-19. 2020; https://www.ecdc.europa.eu/en/covid-19/timeline-ecdc-response. Accessed 4th October, 2020.
2. World Health Organization. *Coronavirus disease 2019 (COVID-19) Situation Report – 94.* 2020.
3. Nussbaumer-Streit B, Mayr V, Dobrescu AI, et al. Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *Cochrane Database Syst Rev.* 2020;4(4):Cd013574 doi: 10.1002/14651858.cd013574.
4. European Centre for Disease Prevention and Control (ECDC). Risk assessment: Outbreak of acute respiratory syndrome associated with a novel coronavirus, Wuhan, China. 2020; https://www.ecdc.europa.eu/en/publications-data/rapid-risk-assessment-cluster-pneumonia-cases-caused-novel-coronavirus-wuhan, 2020.
5. World Health Organization. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). . 2020; https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov).
6. Meng X, Deng Y, Dai Z, Meng Z. COVID-19 and anosmia: A review based on up-to-date knowledge. *Am J Otolaryngol.* 2020;41(5):102581-102581 doi: 10.1016/j.amjoto.2020.102581.
7. European Centre for Disease Prevention and Control (ECDC). COVID-19 situation update worldwide, as of 5 October 2020. 2020; https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases. Accessed 5th October, 2020.
8. European Centre for Disease Prevention and Control (ECDC). *Surveillance of COVID-19 at longterm care facilities in the EU/EEA. Technical Report.* 19 May 2020 2020.

9. ECDC Public Health Emergency Team, Danis K, Fonteneau L, et al. High impact of COVID-19 in long-term care facilities, suggestion for monitoring in the EU/EEA, May 2020. *Euro Surveillance.* 2020;25(22):2000956 doi: 10.2807/1560-7917.ES.2020.25.22.2000956.
10. United Nations. *Policy Brief: The Impact of COVID-19 on older persons.* May 2020.
11. World Health Organization. *Policy Brief: The Impact of COVID-19 on older persons.* May 2020 2020.
12. Frazer K, Mitchell L, Stokes D, Crawley E, Kelleher CC. Systematic review of measures to protect older people in long term care facilities from COVID 19. *PROSPERO: International prospective register of systematic reviews.* 2020;CRD42020191569
13. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine.* 2009;6(7):e1000097 doi: 10.1371/journal.pmed.1000097.
14. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information.* 2018;34:285-291 doi: 10.3233/EFI-180221.
15. Campbell M, McKenzie JE, Sowden A, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. *BMJ.* 2020;368:l6890 doi: 10.1136/bmj.l6890.
16. Abrams HR, Loomer L, Gandhi A, Grabowski DC. Characteristics of U.S. Nursing Homes with COVID-19 Cases. *Journal of the American Geriatrics Society.* 2020 doi: 10.1111/jgs.16661.
17. Arons MM, Hatfield KM, Reddy SC, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. *New England Journal of Medicine.* 2020;382(22):2081-2090 doi: 10.1056/NEJMoa2008457.
18. Blackman C, Farber S, Feifer RA, Mor V, White EM. An Illustration of SARS-CoV-2 Dissemination Within a Skilled Nursing Facility Using Heat Maps. *Journal of the American Geriatrics Society.* 2020;68(10):2174-2178 doi: 10.1111/jgs.16642.
19. Dora AV, Winnett A, Jatt LP, et al. Universal and Serial Laboratory Testing for SARS-CoV-2 at a Long-Term Care Skilled Nursing Facility for Veterans - Los Angeles, California, 2020. *MMWR Morbidity and mortality weekly report.* 2020;69(21):651-655 doi: 10.15585/mmwr.mm6921e1.
20. Eckardt P, Guran R, Hennemyre J, et al. Hospital affiliated long term care facility COVID-19 containment strategy by using prevalence testing and infection control best practices. *American Journal of Infection Control.* 2020 doi: https://doi.org/10.1016/j.ajic.2020.06.215.
21. Feaster M, Goh Y-Y. High Proportion of Asymptomatic SARS-CoV-2 Infections in 9 Long-Term Care Facilities, Pasadena, California, USA, April 2020. *Emerging Infectious Disease journal.* 2020;26(10):2416 doi: 10.3201/eid2610.202694.

22. Graham N, Junghans C, Downes R, et al. SARS-CoV-2 infection, clinical features and outcome of COVID-19 in United Kingdom nursing homes. *J Infect.* 2020 doi: 10.1016/j.jinf.2020.05.073.

23. Hand J, Rose EB, Salinas A, et al. Severe Respiratory Illness Outbreak Associated with Human Coronavirus NL63 in a Long-Term Care Facility. *Emerg Infect Dis.* 2018;24(10):1964-1966 doi: 10.3201/eid2410.180862.

24. Harris DA, Archbald-Pannone L, Kaur J, et al. Rapid Telehealth-Centered Response to COVID-19 Outbreaks in Postacute and Long-Term Care Facilities. *Telemedicine and e-Health.* 2020;0(0):null doi: 10.1089/tmj.2020.0236.

25. Kimball A, Hatfield KM, Arons M, et al. Asymptomatic and Presymptomatic SARS-CoV-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility - King County, Washington, March 2020. *MMWR Morbidity and mortality weekly report.* 2020;69(13):377-381 doi: 10.15585/mmwr.mm6913e1.

26. Lennon NJ, Bhattacharyya RP, Mina MJ, et al. Comparison of viral levels in individuals with or without symptoms at time of COVID-19 testing among 32,480 residents and staff of nursing homes and assisted living facilities in Massachusetts. *medRxiv.* 2020:2020.2007.2020.20157792 doi: 10.1101/2020.07.20.20157792.

27. Louie JK, Scott HM, DuBois A, et al. Lessons from Mass-Testing for COVID-19 in Long Term Care Facilities for the Elderly in San Francisco. *Clinical Infectious Diseases.* 2020 doi: 10.1093/cid/ciaa1020.

28. McMichael TM, Currie DW, Clark S, et al. Epidemiology of covid-19 in a long-term care facility in King County, Washington. *New England Journal of Medicine.* 2020;382(21):2008-2011 doi: 10.1056/NEJMoa2005412.

29. Patel MC, Chaisson LH, Borgetti S, et al. Asymptomatic SARS-CoV-2 Infection and COVID-19 Mortality During an Outbreak Investigation in a Skilled Nursing Facility. *Clinical Infectious Diseases.* 2020 doi: 10.1093/cid/ciaa763.

30. Quicke K, Gallichote E, Sexton N, et al. Longitudinal Surveillance for SARS-CoV-2 RNA Among Asymptomatic Staff in Five Colorado Skilled Nursing Facilities: Epidemiologic, Virologic and Sequence Analysis. *medRxiv.* 2020:2020.2006.2008.20125989 doi: 10.1101/2020.06.08.20125989.

31. Quigley DD, Dick A, Agarwal M, Jones KM, Mody L, Stone PW. COVID-19 Preparedness in Nursing Homes in the Midst of the Pandemic. *Journal of the American Geriatrics Society.* 2020;68(6):1164-1166 doi: 10.1111/jgs.16520.

32. Roxby AC, Greninger AL, Hatfield KM, et al. Outbreak Investigation of COVID-19 among Residents and Staff of an Independent and Assisted Living Community for Older Adults in Seattle, Washington. *JAMA Internal Medicine.* 2020 doi: 10.1001/jamainternmed.2020.2233.

33. Sanchez GV, Biedron C, Fink LR, et al. Initial and Repeated Point Prevalence Surveys to Inform SARS-CoV-2 Infection Prevention in 26 Skilled Nursing Facilities — Detroit, Michigan, March–May 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69:882-886 doi: http://dx.doi.org/10.15585/mmwr.mm6927e1external.

34. Telford CT, Onwubiko U, Holland D, et al. Mass Screening for SARS-CoV-2 Infection among Residents and Staff in Twenty-eight Long-term Care Facilities in Fulton County, Georgia. *medRxiv.* 2020:2020.2007.2001.20144162 doi: 10.1101/2020.07.01.20144162.

35. Unruh MA, Yun H, Zhang Y, Braun RT, Jung H-Y. Nursing Home Characteristics Associated With COVID-19 Deaths in Connecticut, New Jersey, and New York. *Journal of the American Medical Directors Association.* 2020;21(7):1001-1003 doi: https://doi.org/10.1016/j.jamda.2020.06.019.

36. Brainard JS, Rushton S, Winters T, Hunter PR. Introduction to and spread of COVID-19 in care homes in Norfolk, UK. *medRxiv.* 2020:2020.2006.2017.20133629 doi: 10.1101/2020.06.17.20133629.

37. Burton JK, Bayne G, Evans C, et al. Evolution and impact of COVID-19 outbreaks in care homes: population analysis in 189 care homes in one geographic region. *medRxiv.* 2020:2020.2007.2009.20149583 doi: 10.1101/2020.07.09.20149583.

38. Dutey-Magni PF, Williams H, Jhass A, et al. Covid-19 infection and attributable mortality in UK Long Term Care Facilities: Cohort study using active surveillance and electronic records (March-June 2020). *medRxiv.* 2020:2020.2007.2014.20152629 doi: 10.1101/2020.07.14.20152629.

39. Office for National Statistics. *Impact of coronavirus in care homes in England: 26 May to 19 June 2020.* 2020.

40. Stow D, Barker RO, Matthews FE, Hanratty B. National Early Warning Scores (NEWS / NEWS2) and COVID-19 deaths in care homes: a longitudinal ecological study. *medRxiv.* 2020:2020.2006.2015.20131516 doi: 10.1101/2020.06.15.20131516.

41. Brown KA, Jones A, Daneman N, et al. Association Between Nursing Home Crowding and COVID-19 Infection and Mortality in Ontario, Canada. *medRxiv.* 2020:2020.2006.2023.20137729 doi: 10.1101/2020.06.23.20137729.

42. Fisman DN, Bogoch I, Lapointe-Shaw L, McCready J, Tuite AR. Risk Factors Associated With Mortality Among Residents With Coronavirus Disease 2019 (COVID-19) in Long-term Care Facilities in Ontario, Canada. *JAMA Network Open.* 2020;3(7):e2015957-e2015957 doi: 10.1001/jamanetworkopen.2020.15957.

43. Stall NM, Jones A, Brown KA, Rochon PA, Costa AP. For-profit long-term care homes and the risk of COVID-19 outbreaks and resident deaths. *Cmaj.* 2020;192(33):E946-e955 doi: 10.1503/cmaj.201197.

44. Guery R, Delaye C, Brule N, et al. Limited effectiveness of systematic screening by nasopharyngeal RT-PCR of medicalized nursing home staff after a first case of COVID-19 in a resident. *Médecine et Maladies Infectieuses.* 2020 doi: https://doi.org/10.1016/j.medmal.2020.04.020.

45. Sacco G, Foucault G, Briere O, Annweiler C. COVID-19 in seniors: Findings and lessons from mass screening in a nursing home. *Maturitas.* 2020;141:46-52 doi: https://doi.org/10.1016/j.maturitas.2020.06.023.

46. Heung LC, Li T, Mak SK, Chan WM. Prevalence of subclinical infection and transmission of severe acute respiratory syndrome (SARS) in a residential care home for the elderly. *Hong Kong Med J.* 2006;12(3):201-207.

47. Ho WW, Hui E, Kwok TC, Woo J, Leung NW. An outbreak of severe acute respiratory syndrome in a nursing home. *J Am Geriatr Soc.* 2003;51(10):1504-1505 doi: 10.1046/j.1532-5415.2003.514841.x.

48. Hoxha A, Wyndham-Thomas C, Klamer S, et al. Asymptomatic SARS-CoV-2 infection in Belgian long-term care facilities. *The Lancet Infectious Diseases.* 2020 doi: https://doi.org/10.1016/S1473-3099(20)30560-0.

49. Klein A, Edler C, Fitzek A, et al. Der erste COVID-19-Hotspot in einer Hamburger Senioreneinrichtung. *Rechtsmedizin.* 2020;30(5):325-331 doi: 10.1007/s00194-020-00404-1.

50. Kennelly SP, Dyer AH, Martin R, et al. Asymptomatic carriage rates and case-fatality of SARS-CoV-2 infection in residents and staff in Irish nursing homes. *medRxiv.* 2020:2020.2006.2011.20128199 doi: 10.1101/2020.06.11.20128199.

51. Iritani O, Okuno T, Hama D, et al. Clusters of COVID-19 in long-term care hospitals and facilities in Japan from 16 January to 9 May 2020. *Geriatrics & Gerontology International.* 2020;20(7):715-719 doi: 10.1111/ggi.13973.

52. Kim T. Improving Preparedness for and Response to Coronavirus Disease 19 (COVID-19) in Long-Term Care Hospitals in the Korea. *Infect Chemother.* 2020.

53. Borras-Bermejo B, Martínez-Gómez X, San Miguel MG, et al. Asymptomatic SARS-CoV-2 Infection in Nursing Homes, Barcelona, Spain, April 2020. *Emerging Infectious Disease journal.* 2020;26(9):2281 doi: 10.3201/eid2609.202603.

54. Institute of Medicine (IOM). Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. In: Knobler S, Mahmoud A, Lemon S, Mack A, Sivitz L, Oberholtzer K, eds. *Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary*. Washington (DC): National Academies Press (US), Copyright © 2004, National Academy of Sciences.; 2004.

55. Salcher-Konrad M, Jhass A, Naci H, Tan M, El-Tawil Y, Comas-Herrera A. COVID-19 related mortality and spread of disease in long-term care: a living systematic review of

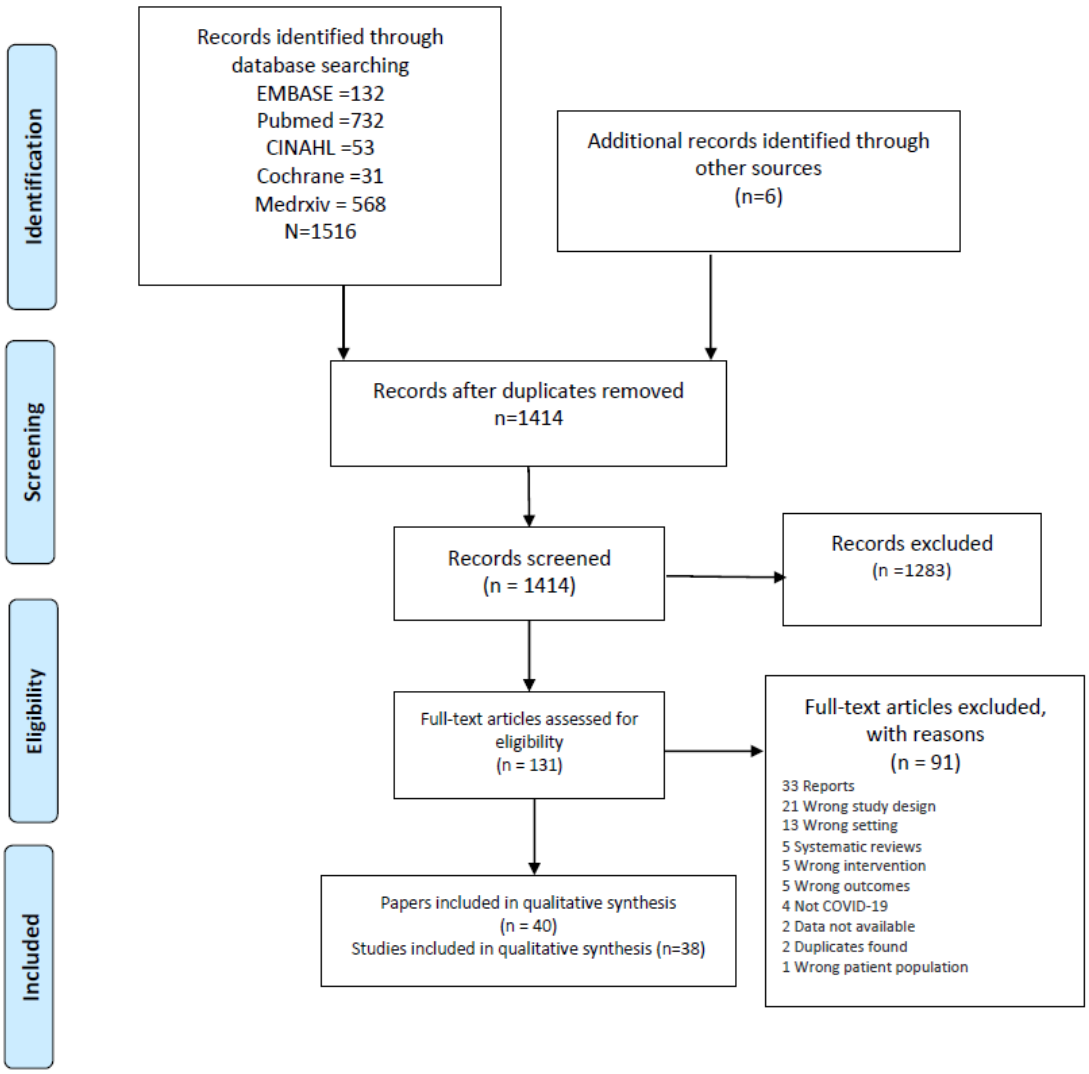
emerging evidence. *medRxiv.* 2020:2020.2006.2009.20125237 doi: 10.1101/2020.06.09.20125237.

56. World Health Organization. *Preventing and managing COVID-19 across long-term care services: policy brief.* Geneva2020. WHO/2019-nCoV/Policy_Brief/Long-term_Care/2020.1.

57. Kelleher CC, Doherty B, Donnelly P, Twomey C. *COVID-19 Nursing Homes Expert Panel. Examination of Measures to 2021. Report to the Minister for Health.* 2020.

Figure legends

Figure 1. PRISMA flowchart


Identification
Screening
Eligibility
Included
Records identified through database searching
EMBASE =132
Pubmed =732
CINAHL =53
Cochrane =31
Medrxiv = 568
N=1516
Additional records identified through other sources
(n=6)
Records after duplicates removed
n=1414
Records screened
(n = 1414)
Records excluded
(n =1283)
Full-text articles assessed for eligibility
(n = 131)
Full-text articles excluded, with reasons
(n = 91)
33 Reports
21 Wrong study design
13 Wrong setting
5 Systematic reviews
5 Wrong intervention
5 Wrong outcomes
4 Not COVID-19
2 Data not available
2 Duplicates found
1 Wrong patient population
Papers included in qualitative synthesis
(n = 40)
Studies included in qualitative synthesis (n=38)

Pubmed

Search #1

“Residential facilit*” OR “Residential aged care” OR Convalescent home* OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR Home* for the aged OR “Old Age Home*” OR “long-term care” OR "Nursing Homes"[Mesh] OR “long-term care”[MeSH] OR "Residential Facilities"[Mesh] OR "Housing for the Elderly"[Mesh]

213,035 Results

Intervention

Search #2

(“Infection control” OR Infection prevention and control* OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “Health care Delivery” OR transmission OR body substance isolation* OR physical barrier* OR physical intervention* OR physical protection* OR personal protection* OR person protection* OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR non-pharm intervention* OR non-pharmaceutical intervention* OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing or separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face mask* OR face-mask* OR "Delivery of Health Care" OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR “Personal Protective Equipment” OR mask* OR virucide* OR antivirus agent* OR Handwashing OR “Hand washing” OR “Hand Disinfection” OR “hand hygiene” OR distancing OR distances OR aerosol-generating procedure* OR patient isolation* OR patient isolator* OR person isolator* OR “individual isolation” OR individual isolator* OR filtering face piece* OR face protection* OR face shield* OR face protective device* OR face protective gear* OR eye protection* OR eye shield* OR eye protective device* OR eye protective gear* OR Eye mask* OR airborne precaution* OR droplet precaution* OR safety supply OR safety supplies* OR safety device* OR safety equipment* OR safety measure* OR safety gear* OR protective supply* OR protective supplies* OR protective device* OR protective equipment* OR protective measure* OR protective gear* OR “personal isolation” OR respirator* OR respiratory protection* OR respiratory protective device* OR “respiratory protective supply” OR “respiratory protective supplies” OR “respiratory protective equipment” OR “respiratory protective gear” OR “safely equipped” OR meter OR metre OR foot OR feet OR meters OR metres OR head cover* OR face cover* OR eye cover* OR goggle* OR protective clothing* OR "Infection Control"[Mesh] OR "Personal Protective Equipment"[Mesh] OR "Hand Disinfection"[Mesh] OR "Communicable Disease Control"[Mesh:NoExp] OR "Disease Transmission, Infectious"[Mesh] OR "Primary Prevention"[Mesh] OR "Delivery of Health Care"[Mesh:NoExp] OR "Fomites"[Mesh] OR "Ventilators, Mechanical"[Mesh] OR "Communicable Disease Control"[Mesh] OR "Primary Prevention"[Mesh] OR "Delivery of Health Care"[Mesh] OR "Patient Isolation"[Mesh] OR "Patient Safety"[Mesh] OR "Patient Harm"[Mesh])

5,741,706 results

And

Search #3

(Coronavirus* OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR coronaviridae OR "corona virus" OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR "COVID-19" [Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2" [Supplementary Concept] OR "Coronavirus Infections"[Mesh] OR "Coronavirus"[Mesh] OR "Middle East Respiratory Syndrome Coronavirus"[Mesh] OR "Coronavirus Infections"[Mesh] OR "SARS Virus"[Mesh] OR "Betacoronavirus"[Mesh])

595,661 results

Search #4 = #2 AND #3 116,217 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “infection risk” OR "Mortality"[Mesh:NoExp] OR "Morbidity"[Mesh]

3,204,107 results

Search #6 = #1 AND #4 AND #5

EMBASE

Search #1

“Residential facilit*” OR “Residential aged care” OR “Convalescent home*” OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR “Home* for the aged” OR “Old Age Home*” OR

"long-term care" OR 'residential home'/exp OR 'nursing home'/exp OR 'home for the aged'/exp OR 'skilled nursing facility'/exp OR 'long term care'/de

212,416 results

Intervention

Search #2

("Infection control" OR "Infection prevention and control*" OR "Patient Safety" OR "Patient harm" OR "Patient risk" OR "body substance isolation*" OR "physical barrier*" OR "physical intervention*" OR "physical protection*" OR "personal protection*" OR "person protection*" OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR "non-pharm intervention*" OR "non-pharmaceutical intervention*" OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing OR separation OR "Communicable Disease Control" OR "Primary Prevention" OR facemask* OR face-mask* OR "face mask*" OR "Delivery of Health Care" OR "Health Care Delivery" OR "Disease transmission" OR "Infectious Disease Transmission" OR PPE OR "Personal Protective Equipment" OR mask* OR virucide* OR antivirus agent* OR Handwashing OR "Hand washing" OR "Hand Disinfection" OR "hand hygiene" OR distancing OR distances OR "aerosol-generating procedure*" OR "patient isolation*" OR "patient isolator*" OR "person isolator*" OR "individual isolation" OR "individual isolator*" OR "filtering face piece*" OR "face protection*" OR "face shield*" OR "face protective device*" OR "face protective gear*" OR "eye protection*" OR "eye shield*" OR "eye protective device*" OR "eye protective gear*" OR "Eye mask*" OR "airborne precaution*" OR "droplet precaution*" OR "safety supply" OR "safety supplies*" OR "safety device*" OR "safety equipment*" OR "safety measure*" OR "safety gear*" OR "protective supply*" OR "protective supplies*" OR "protective device*" OR "protective equipment*" OR "protective measure*" OR "protective gear*" OR "personal isolation" OR respirator* OR "respiratory protection*" OR "respiratory protective device*" OR "respiratory protective supply" OR "respiratory protective supplies" OR "respiratory protective equipment" OR "respiratory protective gear" OR "safely equipped" OR meter OR metre OR foot OR feet OR meters OR metres OR "head cover*" OR "face cover*" OR "eye cover*" OR goggle* OR "protective clothing*" OR 'infection control'/exp OR 'patient safety'/exp OR 'disease transmission'/exp OR 'contamination'/exp OR 'shedding'/exp OR 'fomite'/exp OR 'shield'/exp OR 'ventilator'/exp OR 'space'/exp OR 'separation'/exp OR 'communicable disease control'/exp OR 'primary prevention'/exp OR 'face mask'/exp OR 'health care delivery'/exp OR 'protective equipment'/exp OR 'mask'/exp OR 'antivirus agent'/exp OR 'hand washing'/exp OR 'patient isolation'/exp OR 'face shield'/exp OR 'eye protective device'/exp OR 'ventilator'/exp OR 'respiratory protection'/exp OR 'goggle'/exp OR 'protective clothing'/exp)

6,030,646 results

And

Search #3

(Coronavirus* OR "Corona virus" OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR

coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR 'Coronavirinae'/exp OR 'Betacoronavirus'/exp OR 'severe acute respiratory syndrome'/exp OR 'covid 19'/exp OR 'Coronavirus infection'/exp)

45,801 results

Search #4 = #2 AND #3 27,921 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “Infection risk” OR 'mortality'/exp OR 'mortality rate'/exp OR 'morbidity'/exp OR 'infection risk'/exp

1,862,861results

Search #6 = #1 AND #4 AND #5

CINAHL

Search #1

“Residential facilit*” OR “Residential aged care” OR “Convalescent home*” OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR “Home* for the aged” OR “Old Age Home*” OR “long-term care” OR (MH "Residential Facilities") OR (MH "Nursing Homes+") OR (MH "Housing for the Elderly") OR (MH "Long Term Care")

83,231 results

Intervention

Search #2

(“Infection control” OR “Infection prevention and control*” OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “body substance isolation*” OR “physical barrier*” OR “physical intervention*” OR “physical protection*” OR “personal protection*” OR “person protection*” OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR “non-pharm intervention*” OR “non-pharmaceutical intervention*” OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing OR separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face-mask* OR “face mask*” OR "Delivery of Health Care" OR “Health Care Delivery” OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR “Personal Protective Equipment” OR mask* OR virucide* OR antivirus agent* OR Handwashing OR “Hand washing” OR “Hand Disinfection” OR “hand hygiene” OR distancing OR distances OR “aerosol-generating procedure*” OR “patient isolation*” OR “patient isolator*” OR “person isolator*” OR “individual isolation” OR “individual isolator*” OR “filtering face piece*” OR “face protection*” OR “face shield*” OR “face protective device*” OR “face protective gear*” OR “eye protection*” OR “eye shield*” OR “eye protective device*” OR “eye protective gear*” OR “Eye mask*” OR “airborne precaution*” OR “droplet precaution*” OR “safety supply” OR “safety supplies*” OR “safety device*” OR “safety equipment*” OR “safety measure*” OR “safety gear*” OR “protective supply*” OR “protective supplies*” OR “protective device*” OR “protective equipment*” OR “protective measure*” OR “protective gear*” OR “personal isolation” OR respirator* OR “respiratory protection*” OR “respiratory protective device*” OR “respiratory protective supply” OR “respiratory protective supplies” OR “respiratory protective equipment” OR “respiratory protective gear” OR “safely equipped” OR meter OR metre OR foot OR feet OR meters OR metres OR “head cover*” OR “face cover*” OR “eye cover*” OR goggle* OR “protective clothing*” OR (MH "Infection Control") OR (MH "Handwashing") OR (MH "Patient Safety") OR (MH "Disease Transmission+") OR (MH "Microbial Contamination") OR (MH "Ventilators, Mechanical") OR (MH "Masks") OR (MH "Health Care Delivery+") OR (MH "Protective Devices+") OR (MH "Patient Isolation+")

917,391 results

And

Search #3

(Coronavirus* OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR (MH "Coronavirus+") OR (MH "Coronaviridae Infections+"))

141,416 results

Search #4 = #2 AND #3 15,251 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “Infection risk” OR (MH "Mortality+") OR (MH "Morbidity+")

501,502 results

Search #6 = #1 AND #4 AND #5

Cochrane library

#1 MeSH descriptor: [Coronavirus Infections] explode all trees 179

#2 MeSH descriptor: [Coronavirus] explode all trees 18

#3 Coronavirus OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR coronaviridae OR "corona virus" OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" 1173

#4 #1 OR #2 OR #3 1173

#5 “Infection control” OR Infection prevention and control* OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “Health care Delivery” OR transmission OR body substance isolation* OR physical barrier* OR physical intervention* OR physical protection* OR personal protection* OR person protection* OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR non-pharm intervention* OR non-pharmaceutical intervention* OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing or separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face mask* OR face-mask* OR "Delivery of Health Care" OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR

"Personal Protective Equipment" OR mask* OR virucide* OR antivirus agent* OR Handwashing OR "Hand washing" OR "Hand Disinfection" OR "hand hygiene" OR distancing OR distances OR aerosol-generating procedure* OR patient isolation* OR patient isolator* OR person isolator* OR "individual isolation" OR individual isolator* OR filtering face piece* OR face protection* OR face shield* OR face protective device* OR face protective gear* OR eye protection* OR eye shield* OR eye protective device* OR eye protective gear* OR Eye mask* OR airborne precaution* OR droplet precaution* OR safety supply OR safety supplies* OR safety device* OR safety equipment* OR safety measure* OR safety gear* OR protective supply* OR protective supplies* OR protective device* OR protective equipment* OR protective measure* OR protective gear* OR "personal isolation" OR respirator* OR respiratory protection* OR respiratory protective device* OR "respiratory protective supply" OR "respiratory protective supplies" OR "respiratory protective equipment" OR "respiratory protective gear" OR "safely equipped" OR meter OR metre OR foot OR feet OR meters OR metres OR head cover* OR face cover* OR eye cover* OR goggle* OR protective clothing* 300480

#6 MeSH descriptor: [Infection Control] explode all trees 1147

#7 MeSH descriptor: [Personal Protective Equipment] explode all trees 2284

#8 MeSH descriptor: [Hand Disinfection] explode all trees 378

#9 MeSH descriptor: [Communicable Disease Control] explode all trees 4791

#10 MeSH descriptor: [Disease Transmission, Infectious] explode all trees 856

#11 MeSH descriptor: [Primary Prevention] explode all trees 4005

#12 MeSH descriptor: [Delivery of Health Care] explode all trees 44666

#13 MeSH descriptor: [Fomites] explode all trees 9

#14 MeSH descriptor: [Ventilators, Mechanical] explode all trees 264

#15 MeSH descriptor: [Patient Isolation] explode all trees 51

#16 MeSH descriptor: [Patient Safety] explode all trees 580

#17 MeSH descriptor: [Patient Harm] explode all trees 3

#18 #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 336372

#19 #18 AND #4 651

#20 residential facilit* OR residential aged care OR Convalescent home OR Nursing home* OR Homes for the aged OR Housing for the elderly OR Skilled nursing facilit* OR Long term care OR Longterm care OR Home* for the aged OR old age home OR Long-term care 121379

#21 MeSH descriptor: [Long-Term Care] explode all trees 1112

#22 MeSH descriptor: [Nursing Homes] explode all trees 1314

#23 MeSH descriptor: [Residential Facilities] explode all trees 1711

#24 MeSH descriptor: [Housing for the Elderly] explode all trees 39

#25 #20 OR #21 OR #22 OR #23 OR #24 121450

#26 Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “infection risk” 111129

#27 MeSH descriptor: [Mortality] explode all trees 12838

#28 MeSH descriptor: [Morbidity] explode all trees 14392

#29 #26 OR #27 OR #28 124060

#30 #19 AND #25 AND #29

Medrxiv

"((COVID-19 OR SARS-CoV-2) And ("Infection control")) AND (Mortality) AND ("nursing homes")"

Supplemental Table 2. Quality Review

		S1	*S2*	*3.1*	*3.2*	*3.3*	*3.4*	*3.5*	*4.1*	*4.2*	*4.3*	*4.4*	*4.5*	*Comments*
Abrams (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	CT	Y	
Arons (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y	
Blackman 2020	Quantitative descriptive	Y	Y						Y	N	Y	CT	Y*	*Data very limited to descriptive statistics (counts)
Borras-Bermejo 2020	Quantitative descriptive	Y	Y						Y	CT	Y	N	Y*	*Data minimal descriptive statistics. Reported as a brief letter.
Brainard+ (2020)	Non-randomised	Y	Y	CT	Y	Y	CT	Y						
Brown (2020) +	Non-randomised	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	
Burton (2020) +	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Dora (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data reporting descriptive data from an outbreak (counts and percentages)
Dutey-Magni (2020) +	Non-randomised	Y	Y	Y	Y	Y	N	Y						
Eckhardt (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Limited descriptive data (point prevalence data, counts &percentages)
Feaster (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Fisman (2020b)	Non-randomised	Y	Y	Y	Y	Y	N	Y						
Graham (2020)	Quantitative descriptive	Y	Y						Y	N	Y	Y	Y	
Guery (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Limited descriptive data reported. Outbreak reported as a published letter.
Hand (2018)	Quantitative descriptive	Y	CT											Research letter reporting minimal data.
Harris (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics
Heung (2006)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y*	*Limited descriptive data
Ho (2003)	Quantitative descriptive	Y	CT											Report of conference symposium. Limited details
Hoxha 2020	Quantitative descriptive	Y	Y						Y	Y	Y	CT	Y	
Iritani 2020	Non-randomised	Y	Y	N	CT	Y	Y	CT						
Kennelly (2020) +	Quantitative descriptive	Y	Y						CT	Y	Y	N	Y	
Kim (2020)	Quantitative descriptive	Y	CT						N	N	N	N	N	
Kimball (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics (counts/ percentages) brief report

Klein (2020)	Quantitative descriptive	N	N											Autopsy reporting
Lennon (2020) +	Quantitative descriptive	Y	Y						Y	CT	Y	Y	Y	
Louie (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics presented in a brief report
McMichael (2020b)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y*	*Data limited to descriptive statistics
Office National Statistics (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	CT	Y	
Patel (2020)	Longitudinal, Descriptive quantitative	Y	Y						Y	Y	Y	Y	Y	
Quicke (2020) +	Quantitative descriptive	Y	Y						CT	CT	CT	CT	Y	Limited data reported and virologic assay.
Quigley (2020)	Quantitative descriptive	Y	Y						Y	N	Y	N	Y*	*Limited descriptive data reported in a research letter
Roxby (2020) JAMA	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Descriptive data reported
Sacco (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Sanchez (2020)	Quantitative descriptive	Y	Y						CT	CT	Y	CT	Y*	*Descriptive data reported on prevalence (counts/ percentages)
Stall (2020) (CMAJ)	Non-randomised	Y	Y	CT	Y	Y	CT	Y						
Stow (2020) +	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Telford (2020)	Non-randomised	Y	Y	CT	Y	Y	N	Y						
Unruh (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	Y	Y	

Y = Yes, N= No, CT= Can't tell

+ pre published manuscript available

BMJ Open

A rapid systematic review of measures to protect older people in long term care facilities from COVID-19

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-047012.R1
Article Type:	Original research
Date Submitted by the Author:	15-Apr-2021
Complete List of Authors:	Frazer, Kate; University College Dublin Mitchell, Lachlan; University College Dublin, Stokes, Diarmuid; University College Dublin Lacey, Ella; University College Dublin Crowley, Eibhlin; University College Dublin Kelleher, Cecily; University College Dublin,
Primary Subject Heading:	Public health
Secondary Subject Heading:	Global health, Health policy
Keywords:	COVID-19, Public health < INFECTIOUS DISEASES, GERIATRIC MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

A rapid systematic review of measures to protect older people in long term care facilities from COVID-19

Kate Frazer[1*], Lachlan Mitchell[2,3*], Diarmuid Stokes[4], Ella Lacey[5], Eibhlin Crowley[6], Cecily Kelleher[2,3].

1. School of Nursing, Midwifery and Health Systems, University College Dublin, Belfield, Dublin 4, Ireland
2. National Nutrition Surveillance Centre, University College Dublin, Belfield, Dublin 4, Ireland
3. School of Public Health, Physiotherapy and Sport Science, University College Dublin, Belfield, Dublin 4, Ireland
4. Health Sciences Library, University College Dublin, Belfield, Dublin 4, Ireland
5. School of Medicine, University College Dublin, Belfield, Dublin 4, Ireland
6. Office for Health Affairs, College of Health and Agricultural Science, University College Dublin, Belfield, Dublin 4, Ireland

*Equal contribution

Corresponding author: Lachlan Mitchell

Lachlan.mitchell@ucd.ie

National Nutrition Surveillance Centre, University College Dublin, Belfield, Dublin 4, Ireland

Running title: Measures to protect older people from COVID-19

Word count: 2873

Abstract word count: 265

Keywords: Coronavirus, COVID-19, nursing homes, transmission

Abstract

Objectives: The global COVID-19 pandemic produced large-scale health and economic complications. Older people and those with comorbidities are particularly vulnerable to this virus, with nursing homes and long term care facilities experiencing significant morbidity and mortality associated with COVID-19 outbreaks. The aim of this rapid systematic review was to investigate measures implemented in long term care facilities to reduce transmission of COVID-19 and their effect on morbidity and mortality of residents, staff, and visitors.

Setting: Long term care facilities.

Participants: Residents, staff and visitors of facilities.

Primary and secondary outcome measures: Databases (PubMed, EMBASE, CINAHL, Cochrane Databases and repositories and MedRXiv pre-published database) were systematically searched from inception to July 27 2020 to identify studies reporting assessment of interventions to reduce transmission of COVID-19 in nursing homes among residents, staff, or visitors. Outcome measures include facility characteristics, morbidity data, case fatalities, and transmission rates. Due to study quality and heterogeneity, no meta-analysis was conducted.

Results: The search yielded 1414 articles, with 38 studies included. Reported interventions include mass testing, use of personal protective equipment, symptom screening, visitor restrictions, hand hygiene and droplet/contact precautions, and resident cohorting. Prevalence rates ranged from 1.2-85.4% in residents and 0.6-62.6% in staff. Mortality rates ranged from 5.3-55.3% in residents.

Conclusions: Novel evidence in this review details the impact of facility size, availability of staff and practices of operating between multiple facilities, and for-profit status of facilities as factors contributing to the size and number of COVID-19 outbreaks. No causative relationships can be determined; however, this review provides evidence of interventions that reduce transmission of COVID-19 in long term care facilities.

Trial registration: The protocol is registered on PROSPERO (CRD42020191569).

Strengths and Limitations of the Study

- Evidence from 38 studies identifies the measures taken to reduce transmission of COVID-19 in long term care facilities.
- No limitations were placed on study type, and all languages were eligible for inclusion.
- Study quality was formally examined using the MMAT tool.
- Due to heterogeneity of included studies, meta-analysis was not able to be performed.

Introduction

Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) is a novel virus, first identified in China in 2019, resulting in the current global pandemic in 2020.[1] The ensuing disease associated with infection from SARS-CoV-2, termed COVID-19, has produced large-scale public health and worldwide economic effects.[2]

The virus spreads between people through close contact and droplet transmission (coughs and sneezes). While most infected people will experience mild flu-like symptoms, others may become seriously ill and die.[3] At-risk groups include older people and those with underlying medical conditions, while men appear to have more susceptibility than women. Symptom severity varies; several individuals remain asymptomatic. Others experience fever, cough, sore throat, general weakness, and fatigue, while more severe respiratory illnesses and infections may result, which can be fatal.[4 5] Deterioration in clinical presentations can occur rapidly, leading to poorer health outcomes. Anosmia and ageusia are reported in evidence from South Korea, China, and Italy in patients with confirmed SARS-CoV-2 infection, in some cases in the absence of other symptoms.[6]

The World Health Organization (WHO) declared the COVID-19 outbreak constituted a Public Health Emergency of International Concern (PHEIC) on January 30, 2020.[5] Two primary goals of action were 1) to accelerate innovative research to help contain the spread and facilitate care for all affected, and 2) to support research priorities globally the learning from the pandemic response for preparedness. Globally, up to March 25, 2021, there are 123 636 852 cases of COVID-19 (following the applied case definitions and testing strategies in the affected countries) including 2 721 891 deaths.[7] Within Europe, over 25 220 376 cases are reported, with 592 929 deaths.[7]

Given the infection and mortality figures noted, preventing and limiting transmission of the SARS-CoV-2 virus is advocated. International and national evidence mandates physical distancing, regular hand hygiene and cough etiquette, and limiting touching eyes, nose or mouth; in addition to regular cleaning of surfaces.[8]

As noted older people are an at-risk group for COVID-19, and throughout the pandemic, the impact on this population has resulted in increased mortality, specifically those living in long term care facilities (LTCF) where a high proportion of outbreaks with increased rates of morbidity and case fatality in residents are recorded.[9] In several EU/EEA countries, LTCF deaths among residents, associated with COVID-19, account for 37% to 66% of all COVID-19-related fatalities.[9] The specific rationale for their increased susceptibility is less clear. Comorbidities including cardiovascular disease and diabetes *may increase the chances of fatal disease, but they alone do not explain why age is an independent risk factor*.[10] Molecular, biological, and immunological changes inform emergent viable hypotheses.[10] The United Nations (UN) (2020) acknowledge that COVID-19 exposes the inequalities in society and the failures expressed in the 2030 Agenda for Sustainable Development. The UN report the disproportionate fatality rates in those aged over 80 years as five times the global average[11] and suggest a need for a more *inclusive, equitable and age-friendly society, anchored in human rights* (p.16).[12]

The aim of this rapid review of the literature was to assess the extent to which measures implemented in LTCF reduced transmission of COVID-19 (SARS-CoV-2) among residents, staff, and visitors, and the effect of these measures on morbidity and mortality outcomes.

Methods

The protocol is registered on PROSPERO (CRD42020191569)[13] and reporting follows PRISMA guidelines.[14] Ethical approval was not required for this systematic review.

Search strategy

Search strategies comprised search terms both for keywords and controlled-vocabulary search terms MESH and EMTREE (see Supplementary Table 1 for full search terms). EMBASE (via OVID), PubMed (via OVID), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Database and Repository, and MedRXiv pre-published databases were searched. No time limits were imposed, and databases were searched up to July 27, 2020. Reference lists of included evidence were checked for further articles.

Eligibility criteria

All study designs (experimental, observational, and qualitative) are included, and no exclusions placed on language. Included studies report an assessment of measures to reduce transmission of COVID-19 (including SARS or MERS) in residents, employees, or visitors of LTCF. To provide as comprehensive a review of the evidence we included any intervention implemented to reduce the transmission of COVID-19 in long-term residential care facilities, including facility measures, social distancing, use of personal protective equipment, and hand hygiene.

Primary outcome measures

Primary outcome measures are morbidity data, case fatality rates, reductions in reported transmission rates, and facility characteristics associated with COVID-19 incidence.

Selection of studies and data extraction

Two authors developed search strings (DS & KF); all database searches were completed by one author (DS) (Supplementary Table 1). Following de-duplication, references were uploaded into Covidence management platform (LM), and two authors independently screened all titles and abstracts (LM & KF). Full texts of all potentially eligible studies were independently reviewed by two authors (LM & KF). Disagreements were resolved by discussion with a third author (CK). Data from included studies were independently extracted in duplicate (LM & KF). A data extraction form was developed and modified from documents used previously by authors (KF & CK). Extracted data included study characteristics (title, lead author, year of publication, country, study setting, study design), description of the intervention, number and characteristics of participants, outcomes, duration of follow-up, sources of funding, peer review status). Study design (required for review of quality) was independently assessed by two authors (LM & KF), with disagreements resolved by a third author (CK).

Assessment of Quality

Two review authors (LM & EL) independently assessed the quality of included studies using Mixed Methods Assessment Tool (MMAT),[15] with disagreements resolved by a third author (KF) and discussed with the lead author (CK) (Supplementary Table 2). The MMAT is used widely and considered a valid indicator of methodological quality using instruments for non-randomised and descriptive studies.

Data synthesis

Meta-analysis was not possible due to heterogeneity in study designs, participants, outcomes, and nature of the interventions and no attempt was made to transform statistical data. The SWiM criteria[16] guide a narrative summary, with data presented in tabular format and subgroup reporting of population groups.

Patient and public involvement

No patients were involved in this study.

Results

We identified 1414 articles, and 131 full-text articles were selected for review. After an evaluation against our inclusion criteria, 38 studies (40 papers) are included in this systematic review (Figure 1).

Study characteristics

Geographically we report evidence from eleven countries; the majority (20 studies) are from USA[17-36] and UK.[37-41] We report evidence from Canada,[42-44] France,[45 46] Hong Kong,[47 48] Belgium,[49] Germany,[50] Ireland,[51] Japan,[52] Korea,[53] and Spain[54] (Table 1).

Infection control measures

Twenty studies report the nature of LTCFs related to outbreaks and transmission of COVID-19 infection (Table 2; [17 24 29 30 32 34 36-40 42-44 46-48 51-53]). Thirty studies (Table 3a; [18-30 33-35 38-44 46-51 54]) report evidence of measures to reduce transmission of COVID-19 in long-term residential care facilities for

residents, 25 studies (Table 3b; [18-23 25 27-31 33 35 39 40 43-49 51 54]) report evidence for employee outcomes, and two studies report evidence for visitors (Table 3c; [29 48]).

A variety of infection control measures are described (Tables 1 and 3a-c) including: mass testing/point-prevalence testing (22 studies; [18 20-23 26-31 33-35 39 40 45 46 49-51 54]), use of personal protective equipment (10 studies; [18 19 21 26 29 30 33 46 48 50]), screening of residents, staff, or visitors for symptoms (8 studies; [19-21 24 26 28 30 33]), restrictions on visitor entry (10 studies; [19-21 26 28 30 33 46 50 54]), hand hygiene and contact and droplet precautions (6 studies; [20 24 26 33 46 47]), and cohorting/isolation of residents (11 studies; [20 21 23 26 29 30 33 34 46 48 50]). Thirteen studies examined characteristics of LTCF and their association with COVID-19 infection and risk [17 25 32 36-38 40-44 52 53].

Table 1. Characteristics of studies including infection control measures

Study ID	Country	Study Design	Setting	Population	Intervention/infection control strategy	Outcome groups	Outcome measures
Abrams et al. (2020)[17]	USA	Cross sectional	Nursing homes	Nursing homes across 30 USA States (n=9395 nursing homes). N=6446 facilities without COVID-19 cases; n=2949 facilities with COVID-19 cases.	Nursing homes characteristics associated with COVID-19 outbreaks	Facilities	Estimates on the relationship of nursing home characteristics and documented COVID-19 cases
Arons et al. (2020)[18]	USA, King County, Washington	Cross sectional cohort	Nursing home facility	Residents N=89 N=76 participated in point-prevalence testing.	PPE (eye protection, gown, gloves, face masks); mass testing.	Residents, staff	COVID-19 prevalence, testing, symptoms, hospitalization, mortality
Blackman et al. (2020)[19]	USA	Cross sectional	Skilled nursing facility	A 150-bedded skilled nursing facility. Single story building with four units.	Employee and visitor screening on entry; visitor restrictions; review of PPE and infection control in the building; use of heat maps in a facility to track staff and residents' symptoms	Residents, staff	COVID-19 prevalence, testing, mortality
Borras-Bermejo et al. (2020)[54]	Spain	Cross sectional cohort	Nursing homes	N=69 nursing homes in Barcelona. N=3214 residents and N=2655 staff	Surveillance testing program for COVID- 19 in nursing homes; introduction of restrictions for visitors	Residents, staff	COVID-19 prevalence, testing, symptoms

Brainard et al. (2020)[37]	England, Norfolk	Retrospective cohort	Care homes	N=248 care homes	Statistical modelling assessing detection of COVID-19 infection relative to PPE availability and impact of staffing by non-care workers	Facilities	Descriptive data and statistical modelling for COVID-19, staffing levels, access to PPE
Brown et al. (2020)[42]	Canada, Ontario	Retrospective cohort	Nursing homes	N=623 nursing homes. N=78,607 residents	Impact of home crowding on COVID-19 infection and mortality using nursing home crowding index score	Residents, facilities	COVID-19 incidence, modelling mortality and overcrowding adjusting for facility characteristics
Burton et al. (2020)[40]	Scotland	Cross sectional cohort	Nursing homes	N=189 nursing homes included and data for 109 homes (57.7%) for older people reported, representing 5227 beds (89.5% of total beds in 189 care homes)	Surveillance data to understand the evolution of COVID-19 following outbreaks and care home characteristics in one health board	Facilities, residents	COVID-19 outbreaks, mortality, and facility characteristics
Dora et al. (2020)[20]	USA, California	Cross sectional	Veterans Affairs Greater Los Angeles Healthcare System	N=3 skilled nursing facilities (n=150 long term beds) N=99 residents (95% male, age range 50 to 100 years) N=136 staff Visitors	Three point-prevalence surveys; visitor restrictions (initially all visitors screened, then no visitors permitted into buildings); staff screening; hand hygiene, droplet, and contact precautions; cohorting	Residents, staff	COVID-19 prevalence, symptoms, mortality
Dutey-Magni et al. (2020)[39]	UK (England, Scotland, and Northern Ireland)	Cohort	Long term care facilities	N=8713 resident's health records Daily counts of infection in 9339 residents and for 11604 staff across 179 LTCF.	The home testing program introduced for all staff and residents in Four Seasons Healthcare Group (representing 9% of all	Residents, staff, and facilities	Cumulative incidence of COVID-19, Kaplan-Meier estimates mortality and symptoms.

					long-term care beds). All tested at least once.		
Eckardt et al (2020)[21]	USA, Florida	Cross sectional cohort	Long term care	120-bedded long-term care facility.	PPE; staff and visitor screening; visitor restrictions; distancing of residents; cohorting exposed residents; point-prevalence testing.	Residents, staff	COVID-19 prevalence
Feaster & Goh (2020)[22]	USA, Pasadena	Cross sectional cohort	Long term care homes	Residents and staff (n=1093) of LTCF (n=9) N=608 residents (age 78 ± 13.3 years; n=332 female) N=485 staff (age 41.8 ± 13.3 years; n=249 female)	Mass surveillance testing	Residents, staff	COVID-19 prevalence, symptoms
Fisman et al. (2020)[43]	Canada, Ontario	Cohort	Long term care facilities	N=269 total individuals who died of COVID-19 in Ontario to April 11, 2020, and n=83 individuals who died of COVID-19 in Ontario LTCF to April 7, 2020. Denominators not available for long-term care residents approximated as the total number of long-term care facility beds in Ontario (79 498), assuming complete occupancy. Median beds 120 [9 to 543]	Surveillance data analysed to evaluate the risk of death and identification of risk factors for prevention strategies	Residents, staff, facilities	COVID-19–specific mortality incidence rate ratios (IRRs) of long term care residents were calculated with community-living Ontarians older than 69 years as the comparator group.

Graham et al. (2020)[23]	England	Cross sectional cohort	Four nursing homes in London, England	N=4 nursing homes. N=394 residents (37.6% male, median age 83 years [IQR 15], 75.4% white) N=596 staff.	Mass surveillance testing; isolation of infected residents	Residents, staff	COVID-19 prevalence, symptoms, mortality. Multivariable logistic regression of presenting symptoms in those who had an available test
Guery et al (2020)[45]	France, Nantes	Cross sectional cohort	Nursing home	N=136 staff (age 39 years [IQR 27-48.5], n=112 female)	Surveillance testing of staff following confirmed index case	Staff	COVID-19 prevalence, symptoms
Hand et al. (2018)[24]	USA, Louisiana	Cross sectional cohort	Long term care facility	Long term care facility provides services for up to 130 residents: report on 20 resident cases	Outbreak surveillance after 20 cases reported. Adherence to standard droplet precautions for symptomatic residents	Residents, facilities	Prevalence of Coronavirus NL63 symptoms, hospitalizations, mortality
Harris et al. (2020)[25]	USA, Virginia	Cross sectional cohort	Long term care facility	N=41 of 48 residents (median age 75 years [44-104], 52.1% female (25/48). 60.4% White (29/48)) N=7 staff	Following an outbreak, response developed for the management of residents and the use of telemedicine. Early identification of residents for escalation of care; monitoring and treating patients safe to remain in a facility; care coordination - bidirectional; daily needs assessment related to technology, infection control and staff wellbeing	Residents, staff	COVID-19 prevalence, mortalities, comorbidities, telemedicine consultations

Heung et al (2006)[47]	Hong Kong	Cross sectional cohort	Residential care home	N=90 residents N=32 staff N=67/90 residents participated; n=7 (10%) aged 65 -75 years, n=32 (48%) 76-85 years, n=28 (42%) >85 years; n=53 (79%) females. Staff 26/32 participated; n=18 (69%) aged 31-50 years, n=8 (31%) >50 years; 85% females; 54% nursing care role, 46% assistance in daily activities.	Surveillance screening in a residential care home with the introduction of infection control precautions: droplet and contact precautions	Resident, staff, facilities	Seroprevalence of SARS-CoV antibodies. Symptoms, transmission, and mortality
Ho et al. (2004)[48]	Hong Kong	Cross sectional cohort	Nursing home	N=7 residents, staff, visitors in one nursing home (n=4 females aged in their 60s to 90s; n=3 males aged in their 20s to 80s)	Proposed intervention for future management. Community-based outreach teams led by geriatricians, nurses to closely monitor nursing home residents discharged from hospital	Residents, staff, visitors, facilities	Descriptive data on seven cases, the onset of illness, transmission and outcome including mortality
Hoxha et al. (2020)[49]	Belgium	Cross sectional cohort	Long Term Care Facilities	Reporting for 2074 of 2500 invited facilities; 280,427 COVID-19 tests. 51% residents (N=142,100) and 49% staff (N=138,327)	Mass testing	Residents and staff	COVID-19 prevalence, symptoms, characteristics associated with positive test outcome
Iritani et al. (2020)[52]	Japan	Cross sectional cohort	Across long term care hospitals/facilities, general medical/welfare facilities, and non-	381 clusters with 3786 infected cases accounting for 23.9% of 15,852 cases	Following government recommendation suspension or restricting temporary use of LTCF in areas where infection prevalent	Facilities	Descriptive data on clusters reported, mortality data

			medical/welfare facilities				
Kennelly et al. (2020)[51]	Ireland	Cross sectional cohort	Nursing homes	Nursing home residents in three community health organizations in Ireland (N=28 nursing homes). Represents 2043 residents & 2303 beds	Mass surveillance testing; post testing program	Staff, residents, facilities	COVID-19 prevalence, symptoms, clinical outcomes, including mortality. Characteristics of facilities associated with transmission.
Kim (2020)[53]	Korea (South)	Cross sectional cohort	Nursing home	N=142 nursing home residents N=85 health care workers and caregivers working in one facility	Procedures identified to reduce transmission of COVID-19 following confirmed case in a staff member	Facilities	Data on the preparedness of the facility to reduce transmission.
Kimball et al. (2020)[26]	USA, King County, Washington	Cross sectional cohort	Long-Term Care Skilled Nursing Facility	Nursing home. N=82 residents; 76/82 (92.7%) underwent symptom assessment and testing; three (3.7%) refused testing	Surveillance testing; PPE; hand hygiene; visitor restrictions; staff screening; daily resident symptom assessments; isolation of positive residents	Residents	COVID-19 prevalence and symptoms
Klein et al (2020)[52]	Germany, Hamburg	Cross sectional	Residential care facility	N=60 resident and report from eight deceased residents.	Mass testing; PPE; resident cohorting; visitor restrictions	Residents	COVID-19 prevalence and symptoms, management

Lennon et al. (2020)[327]	USA, Massachusetts	Cross sectional cohort	Skilled facilities, nursing homes and assisted living facilities	N=366 skilled nursing facilities N=32,480 residents and staff tested once, and 6.7% tested subsequently. N=16,966 residents (mean age 82 ± 13; 65% female). N=15,514 staff (mean age 45 ± 15; 76% female).	Mass testing and recording of symptoms, comparison of viral levels	Residents, staff	COVID-19 prevalence, symptoms
Louie et al. (2020)[28]	USA, San Francisco	Cohort	Three skilled nursing facilities and one assisted living facility	N=431 residents and staff tested as part of initial surveillance. Follow up testing of n=303 asymptomatic cases.	Mass surveillance testing; restrictions on visitors & non-essential staff; increased monitoring/screening of people entering/residing in a facility	Residents, staff	COVID-19 prevalence, hospitalizations, fatalities, management
McMichael et al. (2020) a[29]	USA, King County, Washington	Cross sectional cohort	Skilled Nursing Facility	N=167 N=101 residents (median aged 83 (51-100), n=32 (31.7%) male, n=69 (68.3%) female). N=50 health care personnel (median age 43.5 (21-79), n=12 (24%) males, n=38 (76%) female). N=16 visitors (median age 72.5 (52-88), n=11 (68.7%) male, n=5 (31.2%) females).	Mass surveillance testing; contact tracing; quarantine of exposed persons; isolation of confirmed and suspected cases; on-site enhancement of PPE/infection prevention and control.	Residents, staff, visitors, facilities	COVID-19 prevalence, symptoms, mortality, hospitalizations, management

Office for National Statistics (2020)[40]	England	Cross sectional cohort	Care homes providing care for older residents and those with dementia only.	N=9081 care homes for people aged 65 years and older - representing 292,301 residents (95% CI 293,168 to 293,434) and 441,498 staff. N=5126 homes participated (56%)	Prevalence of COVID-19 in residents and staff. Factors associated with higher levels of infection.	Residents, staff, facilities	COVID-19 prevalence in residents aged 65 years and older and employees.
Patel et al. (2020)[30]	USA, Illinois	Cross sectional cohort	Nursing home (150 bedded unit)	N=127 residents. 9% (n=11) single occupancy rooms, 91% (n=116) double occupancy rooms.	Mass surveillance testing; screening of staff and visitors; visitor restrictions; cohorting of residents; PPE	Residents, staff, facilities	COVID-19 prevalence, symptoms, hospitalizations and survival rates, management
Quicke et al. (2020)[31]	USA, Colorado	Longitudinal cohort	Five skilled nursing facilities	N=454 staff	Weekly surveillance nasopharyngeal swabs tests were collected.	Staff	COVID-19 prevalence and incidence, symptoms and information on genomic epidemiology
Quigley et al (2020)[32]	USA, 29 States	Cross sectional cohort	Nursing homes	N=56 nursing homes from 29 States: Midwest (30%), West (25%), Northeast (23%), South (22%).	Reported on preparedness for COVID-19, testing, supplies and staffing levels	Facilities	Preparedness of nursing home facilities during COVID-19

Roxby et al. (2020)[33]	USA, Seattle, Washington	Cross sectional cohort	Assisted living community older adults	Older aged residents and staff in an assisted living community. N=80 residents (mean age 86 years (range, 69-102); n=62 (77%) female). N=62 staff (mean age 40.0 ± 15; n=42 (68%) female). N=83 private apartments, n=45 independent, n=38 assisted living	Mass testing; resident cohorting/isolation; PPE; staff screening; visitor screening; additional hand hygiene stations.	Residents, staff	COVID-19 prevalence and symptoms
Sacco et al (2020)[46]	France, Maine-et-Loire	Cross sectional cohort	Nursing home	N=87 residents (age 87.9 ± 7.2; 71% female) N=92 staff (age 38.3 ± 11.7; 89% female)	Mass testing; PPE; visitor restrictions; hand hygiene; resident isolation	Residents, staff, facilities	COVID-19 prevalence and case-fatality rates. Resident's clinical signs and symptoms obtained from retrospective chart audit.
Sanchez et al (2020)[34]	USA, Detroit	Time series cohort	Skilled Nursing Facilities	N=26 skilled nursing facilities N=2773 residents' tests reported at baseline (median age 72 years [IQR 64-82 years]); n=2218 1st follow up; n=637 2nd follow up	Two point-prevalence surveys; follow up in 12 facilities following PPE guidelines; resident cohorting	Residents, facilities	COVID-19 prevalence, hospitalizations, and deaths pre and post introduction of testing

Stall (2020)[44]	Canada, Ontario	Retrospective cohort	Nursing homes	N=623 nursing homes (n=75,676 residents); 360/623 (57.7%) for-profit homes, 162/623 (26.0%) non-profit, 101/623 (16.2%) municipal homes. Mean number residents: n=113.2 (for profit); n=119.6 (non-profit); n=101 (municipal).	Impact of profit status at the level of a home rather than a resident. Using data from the Ontario Ministries of Health and Long-Term Care as part of the province's emergency "modelling table."	Facilities, residents, and staff	Descriptive data on outbreaks, facility characteristics and mortality rates. Nursing home profit status (for-profit, non-profit or municipal), nursing home COVID-19 outbreaks (at least one resident case), COVID-19 outbreak sizes (total number of confirmed resident cases amongst homes with outbreaks), and the total number of COVID-19 resident deaths (amongst homes with outbreaks). Outbreaks in staff reported. Death rates for residents
Stow (2020)[41]	England	Longitudinal ecological study	Care home units from 46 local authority areas in England.	N=460 care home units N=6,464 residents	Use of National Early Warning Score (NEWS) for identification of at-risk/surveillance to reduce mortality	Residents	Descriptive data NEWS surveillance on reducing mortality. Time-series comparison with Office for National Statistics weekly reported registered deaths of care home residents and COVID-19 was the underlying cause of death, and all other deaths (excluding COVID-19) up to 10/05/2020.

Telford et al. (2020)[35]	USA State of Georgia (Fulton County and City of Atlanta)	Cross sectional cohort	Nursing homes	N=28 nursing homes. N=5671 participants; n=2868 (50.6%) residents, n=2803 (49.4%) staff.	Mass surveillance testing of staff and residents	Residents, staff	COVID-19 prevalence, hospitalizations, and deaths.
Unruh et al. (2020)[36]	USA States New Jersey, New York, Connecticut	Case study	Nursing homes with ≥100 beds	N=1162 nursing home facilities	Nursing home characteristics associated with mortality rates	Facilities	Mortality data. Predicted probabilities with Logistic Regression, Independent variables compared on characteristics of facilities

Study setting is presented as defined in original study. PPE, personal protective equipment; LTCF, long term care facilities; IQR, inter quartile range; NEWS, national early warning score.

Table 2. COVID-19 outcomes related to the nature of long term care facilities.

Study	Facilities	Outcomes
Abrams et al. (2020)[17]	Facilities	Average number of cases was 19.8 (range 1 to 256). New Jersey (88.6%, OR 7.16) and Massachusetts (78.0%, OR 4.36) had a higher number of affected facilities. Probability of having a COVID-19 case: Facility size (relative to small): Large OR=6.52; Medium OR=2.63 Location (relative to rural): Urban OR=3.22 % African American residents (relative to low %): Greater % OR=2.05 Nursing home chain status (relative to non-chain status): Chain status OR=0.89 State were significantly related to the probability of having COVID case

		Outbreak size associations: Facility size (relative to small facility size): Large= -15.88; medium= -10.8 (percentage point change) For-profit status (relative to non-profit status) =1.88 State. Medicaid dependency, ownership, five-star rating, and prior infection violation were not significantly related to COVID-19 cases.
Brainard et al. (2020)[37]	Facilities	Risk of infection: Facility employee numbers (relative to <10 workers): 11-20 non-care workers HR = 6.502 (95%CI 2.614 -16.17); 21-30 non-care workers HR = 9.870 (95% CI 3.224 -30.22); >30 non-care workers HR = 18.927 (95% CI 2.358 -151.90). Predictors of spread and increase in cases per unit after 5th April risk increased 1.0347 (95% CI 1.02-1.05) p < 0.001, reduced availability of PPE for eye protection increased risk 1.6571 (95% CI 1.29-2.13) p < 0.001, PPE for facemasks 1.2602 (95% CI 1.09-1.46) p = 0.002, count of care workers employed 1.0379 (95% CI 1.02-1.05) p < 0.001 count of nurses employed (in bands of 0-10,11-20, 21-30 and 31+) 1.1814 (95% CI 1.13-1.24) p < 0.001.
Brown et al. (2020)[42]	Facilities	Incidence in high crowding index homes was 9.7% versus 4.5% in low crowding index homes (p<0.001), while COVID-19 mortality was 2.7% versus 1.3%. Likelihood of COVID-19 introduction did not differ (31.3% vs 30.2%, p=0.79). After adjustment for a regional nursing home, and resident covariates, the crowding index remained associated with increased risk of infection (RR=1.72, 95% CI: 1.11-2.65) and mortality (RR=1.72, 95% CI: 1.03-2.86). Simulations suggested that converting all 4-bed rooms to 2-bed rooms would have averted 988 (18.9%) infections of COVID-19 and 271 (18.7%) deaths.
Burton et al. (2020)[38]	Facilities	Significant associations between the presence of an outbreak and number of beds (OR per 20-bed increase 3.50), a history of multiple previous outbreaks (OR 3.76), and regulatory risk assessment score (OR high-risk vs low 2.19). However, in the adjusted analysis, only number of beds (OR per 20-bed increase 3.50, 95%CI 2.06 to 5.94 per 20-bed increase).
Dutey-Magni et al. (2020)[39]	Facilities	COVID-19 outbreak recorded in 121 of 179 facilities (67.6%). Large LTCF had greater rates of infection (aHR=1.8 [95% CI: 1.4-2.4] for LTCF with ≥70 beds versus <35 beds. The adjusted hazard ratio for confirmed infection was 2.5 times [95% CI: 1.9-3.3] greater in LTCF with 0·85-1 resident per room versus LTCF with 0.7-0.85 resident per room. A ten-percentage point increase in the bed to staff ratio was associated with a 23% increase in infection (aHR=1·23 [95% CI: 1.17-1.31]).
Fisman et al. (2020)[43]	Facilities	Covid-19 cases higher in for-profit operators 165/361 (45.7%) compared to charitable 18/57 (31.6%).
Hand et al. (2018)[24]	Facilities	Residents noted to share rooms, walk throughout the facility and spent time in shared areas (e.g., gym, dining rooms, and recreational rooms). Because all case-patients had visited the gym at the facility for recreation or physical therapy before becoming ill, environmental cleaning of this area was performed.

Heung et al. (2006)[47]	Facilities	67 of 90 residents participated. 26 of 32 staff participated. 2 residents and one staff member were positive during the outbreak. None of the remaining participants was positive for SARS-CoV antibodies. Residents were aged 65+ years, 79% were female, 93% were ambulant, 90% did activities with others, 79% went out. Review of residents who died: Resident A transferred from the hospital and was chair bound and dependent with care needs. Resident B was chair bound and had not left home or had visitors. She was brought to a shared sitting room during mealtimes. This was only time residents A and B were located near each other. One resident shared a room with patient B and tested positive. Staff C was a domestic worker, and contact was via clinical waste in resident A room. Low seroprevalence attributed to precautionary measures taken in the facility to reduce droplet and prevent contact transmission. Risks noted of SARS via fomites possible.
Ho et al. (2004)[48]	Facilities	3 residents positive for SARS. 1 employee positive for SARS. 3 visitors positive for SARS. The index case was a single resident who was infected during a hospital stay, returned to the LTCF, and the virus spread to another 6 people. Transmission of the virus occurred due to lack of isolation rooms in nursing homes, lack of restricted movement of other patients and relatives, lack of infection control precautions, lack of knowledge among staff.
Iritani et al. (2020)[52]	Facilities	Larger cluster sizes in long term care hospitals/facilities were significantly positively associated with higher morbidity ($\rho = 0.336$, $P = 0.006$) and higher mortality ($\rho = 0.317$, $P = 0.009$). Multivariate logistic regression showed larger cluster size (OR = 1.077, 95% CI: 1.017-1.145) and larger cluster number (OR = 2.019, 95% CI: 1.197-3.404) associated with mortality.
Kennelly et al. (2020)[51]	Facilities	Outbreak recorded in 75.0% (21/28) of facilities – four public and seventeen private. During the study period, 40.1% of residents in 21 nursing homes with outbreaks had a laboratory diagnosis of COVID-19. Correlation between the proportion of symptomatic staff and number of residents with confirmed/suspected COVID-19 (ρ=0.81). No significant correlation between the proportion of asymptomatic staff and number of residents with confirmed/suspected COVID-19 (ρ=0.18 p=0.61).
Kim (2020)[53]	Facilities	After the management of the outbreak, there were no more infected persons. All patients and employees tested negative 14 days from the start of quarantine.
McMichael et al. (2020) a[29]	Facilities	February 28, 2020, four cases COVID-19 identified in County. One person identified as index case from Facility A. Staff roles for confirmed cases reported: therapists, nurses, nurse assistants, health information manager, physician, and case manager. Paper reports that 30 facilities in County had confirmed cases and provides detail on first 9 (Facilities A to I). Facility A shared staff with another facility and two resident transfers from facility A. Surveillance reported inadequate PPE, training, infection control practices, lack of documentation signs and symptoms, working in unfamiliar facilities or sharing staff. On March 10, 2020, the governor of Washington implemented mandatory screening of health care workers and visitor restrictions for all licensed nursing homes and assisted living facilities including screening, testing, policies around visiting, excluding symptomatic staff, close monitoring of residents, testing, training and PPE. Monitoring of staff absences.
Office for National Statistics (2020)[40]	Facilities	For each additional member of infected staff working at the care home, the odds of resident infection increase by 11%, i.e. OR = 1.11 (95% CI: 1.1-1.11). Care homes using bank or agency nurses or carers most or every day more likely to have cases in residents (OR= 1.58, 95% CI: 1.5 - 1.65) compared to those who never use bank or agency staff. Residents in care homes outside of London had a lower chance of infection, except West Midlands (OR = 1.09, 95% CI: 1.0 - 1.17). Homes where staff receive sick pay are less likely to have resident cases (OR= 0.82 to 0.93, 95% CI: 7-18%), compared to homes where no sick leave. For each additional infected resident at a home, the odds of staff infection increase by 4% OR=1.04 (95% CI: 4 - 4%). Care homes using bank or agency staff most or every day OR=1.88 (95% CI: 1.77-2.0) compared to homes not using. Homes where staff regularly work elsewhere

		(most or every day) increase odds (OR=2.4, 95% CI: 1.92 - 3.0) compared to homes who never work elsewhere. Staff at homes outside London had higher odds of COVID-19 infection.
Patel et al. (2020)[30]	Facilities	First resident unwell March 9, female aged in her 60s with cough and fever. Hospitalized March 11 and tested positive COVID-19 March 13. 14 residents who were positive developed symptoms over 30 day follow up. 21% (n=7) confirmed cases lived in single occupancy rooms. 55% (n=18) were in a double room with another confirmed case, and 24% (n=8) were in a double room with a resident who was negative March 15. Screening visitors and staff for symptoms, restricting visiting hours from March 6. No visitor access from March 12. Universal masking of all staff and residents from March 14. 15th -19th March on-site team implemented assessment of symptoms, resident cohorting. Staff testing positive isolated and return 7 days or after 72 hours of symptoms resolving. Education and training to staff in facility A infection control, PPE, vital signs
Quigley et al. (2020)[32]	Facilities	For-profit = 67.86%, non-profit = 26.79% and government-owned = 5.36%. 37.5% were part of a chain. 54% have COVID-19 plans. All had staff training for COVID-19 and 100% processes to restrict/ limit visitors. 29% conducted COVID-19 simulation training. Communication with local Public Health - 96%, and 68% linked to local hospital referral. 66% reported access to COVID-19 tests - available for all residents and 53% of staff. 72% reported inadequate PPE supplies. 83% expected staff shortages. Solutions for staff included staff volunteer for more shifts (55%), non-clinical staff used (45%). 19% reported they would use agency staff.
Sacco et al. (2020)[46]	Facilities	Restrictions on residents from March 16 - social distancing, remain in single rooms, no communal dining or group activities. No visitors since March 10, individual walks outside only in the presence of one staff member. Mail and packages stored 24 hours before being delivered to residents. Enhanced hygiene and cleaning. Staff had permanent face masks and additional hand hygiene
Sanchez et al. (2020)[34]	Facilities	Of the 12 facilities in the final survey, eight had implemented cohorting in a dedicated COVID-19 unit before 1st follow up. 4 remaining initiating cohorting after receiving results. 4 facilities did not assign dedicated personnel to care for residents with COVID-19 due to staff shortages. Final survey census 80 residents (range 36 to 147). 373 of 1063 (35%) had received positive results 1st follow up.
Stall (2020)[44]	Facilities	Adjusted modelling odds of COVID-19 outbreak associated with for-profit status aOR 1.01 (95% CI: 0.64-1.57), Municipal aOR 0.83 (95% CI: 0.45-1.54). Model 2 + Health Region aOR 2.02 (95% CI: 1.20-3.38) population <10,000 rural aOR 0.27 (95% CI: 0.13-0.58); and model 3 + home characteristics. Number of residents (unit of 50) aOR 1.38 (95% CI: 1.18-1.61), older design aOR 1.55 (95% CI: 1.01-2.38), chain ownership vs single home aOR 1.47 (95% CI: 0.86 to 2.51) and staff (full time equivalent/ bed ratio aOR 1.98 (95% CI: 0.39-9.97). The extent of a COVID-19 outbreak with profit aRR 1.83 (95% CI: 1.18-2.84) vs municipal aRR 0.60 (95% CI: 0.28 -1.30) compared with non-profit. Health Region aRR 1.65 (95% CI: 1.02- 2.67), older design standards aRR (95% CI: 1.27 -2.79), chain ownership aRR 1.84 (95% CI: 1.08-3.15) and staff/ bed ratio a RR 0.73 (95% CI: 0.10-5.35). Deaths accounted for 6.5% of all residents in for-profit homes vs 5.5 % in non-profit vs 1.7% municipal LTCF. For-profit associated with total COVID-19 deaths aRR 1.78, (95% CI: 1.03 - 2.07). Adjusted model increased risk of death with for-profit aRR 0.82, (95% CI: 0.44- 1.54), older design facilities aRR 2.08 (95% CI: 1.28-3.36) and chain ownership aRR 1.89, (95% CI: 1.00- 3.59). Number of active residents was protective aRR 0.81, (95% CI: 0.70 -0.95) / 50 beds.
Unruh et al. (2020)[36]	Facilities	184 nursing homes (15.8%) had 6 or more COVID-19 deaths. Deaths associated with Medicaid patients (quintile 5: 8.6 PP greater probability vs quintile 1). Patients with higher ADL scores (2.6 (95% CI: 1.4-3.8) PP, p<0.001), more total beds (0.1 (95% CI: 0.0 to 0.1) PP, p<0.001), higher occupancy (0.3 (95% CI: 0.1-0.5) PP, p<0.009), for-profit status (4.8 (95% CI: 0.8-8.8) PP, p=0.019). Comparing States: Higher mortality in those with Medicaid (quintile 5: 6.1 (95% CI: 0.0-12.1) PP, p=0.048). Not significant for

		other States. More direct care hours per patient day associated with lower COVID-19 deaths All States (-4.8 95% CI: -9.4 - -0.03) PP, p<0.04).

OR, odds ratio; HR, hazard ratio; PPE, personal protective equipment; CI, confidence interval; LTCF, long-term care facility; aHR, adjusted hazard ratio; aRR, adjusted relative risk; ADL, activities of daily living; PP, percentage points.

Morbidity and mortality

Morbidity and mortality results from included studies are presented for residents (Table 3a), staff (Table 3b), and visitors (Table 3c). Prevalence of COVID-19 infection was reported in 29 studies, including prevalence in residents (27 studies; [18-30 33-35 39 40 42 44 46-51 54]) and staff (22 studies; [18 20-23 25 27-31 33 35 39 40 45-49 51 54]), with 2 studies reporting absolute case numbers in visitors.[29 48] Prevalence rates ranged from 3.8% in a sample of 2074 LTCF[49] and 1.2% in the third point-prevalence survey at a single facility[21] to 85.4% in a single facility that implemented a telemedicine service to limit transmission.[25] Staff prevalence ranged from 0.6% in a point-prevalence survey in a single facility[21] to 62.6% in a group of nine LTCF.[22] One study reported 16 COVID-19 positive visitor cases,[29] while a study that examined SARS infection following an outbreak in a Hong Kong facility reported three positive visitor cases.[48]

The symptom status (symptomatic/presymptomatic/asymptomatic, typical/atypical symptoms) of participants was reported in 16 studies, with resident and staff symptom status reported in 15 [18-20 22 23 26-28 30 33 34 46 49 51 54] and 13 studies,[20-23 27 28 30 33 45 46 49 51 54] respectively. No studies reported symptom status of visitors. The proportion of COVID-19 positive residents presenting with symptoms ranged from 26.3%[20 27] to 59.8% (a sample of both residents and healthcare workers).[28] Asymptomatic cases in residents were reported in 13 studies,[18 20 22 23 26-28 30 33 46 49 51 54] with proportions of COVID-19 positive residents presenting with no symptoms varying from 2.4%[46] to 75.3%.[49] Among COVID-19 positive staff, the proportion of symptomatic cases ranged from 6.4%[27] to 100%,[33] and asymptomatic cases ranged from 23.6%[51] to 100%.[21 23]

Mortality results were reported in 22 studies, including information on mortality of residents (22 studies; [18-20 23-25 28-30 34 35 38-44 46 48 50 51]), staff (4 studies; [29 35 46 48]), and visitors (2 studies; [29 48]). Mortality rates in COVID-19 positive residents ranged from 5.3%[20] to 55.3%.[39] One study reported a 66.7% death rate in residents who tested positive for the SARS virus.[48] A study examining the mortality risk in Ontario LTCF reported a death rate of 0.1% across all residents.[43] Across the three studies which presented mortality results in COVID-19 positive staff, mortality rates were 0%.[29 35 46] One study presenting mortality rates in a nursing home following a SARS outbreak reported one death of a

member of staff.[48] Mortality rates reported in visitors in two studies was 0%[48] and 6.2%,[29] respectively.

Characteristics of LTCFs on COVID-19 transmission

Numerous facility-specific characteristics were linked with risk of COVID-19 cases (Table 2). These include size of LTCF;[17 38 39 52] staffing levels and/or use of agency care staff;[29 32 37 39 40 44 51] part of larger chain of organisations and/or for profit status;[17 32 36 43 44 51] and related staffing, crowding, or availability of single rooms.[24 30 40 42 44 46-48]

Table 3a. Resident-specific outcomes of strategies implemented in nursing homes

Study	Interventions	Prevalence	Mortality	Other outcomes
Arons et al. (2020)[18]	Mass testing (two point-prevalence surveys) PPE	48/76 (63%) across two surveys, 17/48 typical symptoms, 4/48 atypical symptoms, 3/48 asymptomatic, 24/48 presymptomatic 57/89 through point-prevalence, clinical evaluation, post-mortem	15/57 (26%)	Common symptoms: fever (71%), cough (54%), malaise (42%) Estimated doubling time: 3.4 days (95% CI: 2.5-5.3)
Blackman et al. (2020)[19]	PPE Symptom screening Visitor restrictions	12 positive cases, 2 awaiting results, 47 symptomatic residents	3 COVID-19 related deaths	
Borras-Bermejo et al (2020)[54]	Mass testing Visitor restrictions	768/3214 (23.9%), 486 (69.5% of those with symptom information) were asymptomatic		2624 of all residents reported symptoms in the previous 14 days
Brown et al. (2020)[42]	Facility characteristics	5218/78607 (6.6%)	1452/5218 (27.8%)	
Burton et al. (2020)[38]	Facility characteristics		403 deaths recorded in care homes	472 excess deaths in care homes with an outbreak (399 COVID-19 related)
Dora et al. (2020)[20]	Mass testing (three point-prevalence surveys) Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	19/96 (19.8%) across three surveys, 5/19 symptomatic, 8/19 presymptomatic, 6/19 asymptomatic	1/19 (5.3%)	Symptoms: fever (58%), myalgia (58%), cough (47%), dyspnoea (32%), nausea (32%) Oxygen therapy required for 4/8 presymptomatic, 4/5 symptomatic cases
Dutey-Magni et al. (2020)[39]	Mass testing	951/9339 (10.2%)	526/951 (55.3%)	2075/9339 (22.2%) experienced infection symptoms
Eckardt et al. (2020)[21]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Cohorting	Survey 1: 5/105 (4.8%) Survey 2: 4/86 (4.7%) Survey 3: 1/85 (1.2%)		
Feaster & Goh (2020)[22]	Mass testing	408/582 (49.5%), 202/408 (49.5%) symptomatic		

		237/332 (71.4%) female residents positive, 121/237 (51.1%) asymptomatic 171/250 (68.4%) male residents positive, 81/171 (47.4%) asymptomatic		
Fisman et al. (2020)[43]	Facility characteristics		83/79498 (0.1%)	IRR (COVID-19 related death in LTCF residents) = 13.1 (95% CI: 9.9-17.3) compared with community-living adults older than 69 years
Graham et al (2020)[23]	Mass testing (two point-prevalence surveys) Cohorting	Survey 1: 126/313 (40%), 72/126 (57.1%) symptomatic, 50 typical symptoms, 22 atypical symptoms, 54/126 (42.9%) asymptomatic Survey 2: 5/176 (2.8%)	53/131 (40.4%)	Increased risk of death: men (48% of deaths vs. 34% in those who survived; whole group 38% male, p=0.02); the trend for median age to be greater among those who died (p = 0.058) Increased odds of COVID-19 positive: new onset anorexia (OR = 3.74, 95% CI: 1.5-9.8); cough and/or shortness of breath (OR = 3.72, 95% CI: 1.8-7.8); fever, altered mental state/behaviour, diarrhoea not associated with positive test
Hand et al. (2018)[24]	Symptom screening Hand hygiene, contact precautions	20/130 residents suspected cases, 13/20 tested 7/13 (54%) tested positive; 6/7 required hospitalization	3/7 (42.9%)	No new cases identified after November 18 2017
Harris et al. (2020)[25]	Facility characteristics	41/48 (85.4%) 18/48 residents hospitalised, 11/18 returned to facility from hospital	6/48 (12.5%)	13/48 (27.1%) of residents received telemedicine consultations
Heung et al. (2006)[47]	Hand hygiene, contact precautions	2 residents were positive during the outbreak, 0/67 residents positive for SARS-CoV antibodies upon screening		2/67 reported symptoms
Ho et al. (2004)[48]	PPE Cohorting	3 residents positive	2/3 (66.7%)	
Hoxha et al. (2020)[49]	Mass testing	5390/142100 (3.8%), 4059/5390 (75.3%) asymptomatic		Infection odds: Women compared to men OR = 1.2 (95% CI: 1.1-1.2); symptomatic compared to

				asymptomatic OR = 8.5 (95% CI: 8.0-9.0)
Kennelly et al. (2020)[51]	Mass testing Facility characteristics	710/1741 (40.1%), 54/1741 (3.1%) residents were suspected COVID-19, 193/710 (27.2%) asymptomatic, 396/710 (55.8%) had recovered by the completion of surveillance period	183/710 (25.8%)	Non-COVID-19 mortality rate similar between outbreak and non-outbreak NHS (5.1% vs. 4%, p=0.4)
Kimball et al. (2020)[32]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	23/76 (30.3%), 10/23 symptomatic (8/10 typical symptoms, 2/10 atypical symptoms), 3/23 asymptomatic, 10/23 presymptomatic		Symptoms: fever (61.5%), malaise (46.2%), cough (38.5), Presymptomatic mean interval from testing to symptom onset was 3 days
Klein et al. (2020)[50]	Mass testing PPE Visitor restrictions Cohorting	39/60 (65%)	8/39 (20.5%)	Symptoms: exhaustion, loss of appetite, dysphagia, fever, cough, colds, diarrhoea
Lennon et al. (2020)[27]	Mass testing	2654/16966 (15.5%), 1692/2654 (63.8%) asymptomatic, 699/2654 (26.3%) symptomatic, (263/2654 symptom data missing)		
Louie et al. (2020)[28]	Mass testing Symptom screening Visitor restrictions	214/431 (49.7%) residents and healthcare workers, 128/214 (59.8%) symptomatic (78/128 were residents), 86/214 (40.2%) asymptomatic Additional 156 asymptomatic residents subsequently tested: 63/156 COVID-19 positive	12/78 (15.4%) symptomatic residents died	22/78 (28.2%) symptomatic residents hospitalized
McMichael et al. (2020)a[29]	Mass testing PPE Cohorting	101/118 (58.6%)	34/101 (33.7%)	55/101 (54.5%) hospitalized; (37/101 no data on hospitalisation status)
Office for National Statistics (2020)[40]	Mass testing Facility characteristics	19.9% (95% CI: 18.5-21.3) in homes with a confirmed outbreak 10.7% (95% CI: 10.1-11.3) in all homes	15606 across all homes	Odds of resident infection: Each additional infected staff member at a home OR = 1.11 (95% CI: 1.0-1.17) Homes using bank or agency nurses most or all days OR = 1.58

				(95% CI: 1.5-1.65) compared with homes never using these staff Homes outside of London had lower infection chance, except West Midlands (OR = 1.09, 95% CI: 1.0-1.17) Homes where staff receive sick pay OR = 0.82-0.93 (95% CI: unknown)
Patel et al. (2020)[30]	Mass testing Symptom screening Visitor restrictions Cohorting	33/118 (28.0%), 19/33 (58%) symptomatic (8 typical symptoms, 4 atypical symptoms, 10 both typical and atypical symptoms); 1/33 (3%) presymptomatic, 13/33 (39%) asymptomatic	10/35 (28.6%) (5/10 symptomatic) 30-day survival = 71% (95% CI 52-83)	1/91 negative residents reported symptoms 35/90 negative asymptomatic residents developed symptoms during 30-day surveillance, 2/35 COVID-19 positive upon re-testing 13/35 COVID-19 residents hospitalized
Roxby et al. (2020)[33]	Mass testing Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	Survey 1: 3/80 (3.8%), 1/3 reported resolved cough and loose stool during the preceding 14 days Survey 2: 1/77 (1.3%)		All residents clinically stable 14 days after second test 21 days after the test, all cases continued their usual state of health
Sacco et al. (2020)[46]	Mass testing PPE Visitor restrictions Hand hygiene, contact precautions Cohorting	41/87 (47.1%) 3/41 asymptomatic	11/41 (27%) All-cause mortality: 13% (95% CI 7.2-21.2), compared to 3% for the same period during the previous 5 years	Incidence rate for residents = 1.54 per 100 person-days 14/87 (16.1%) residents hospitalized
Sanchez et al (2020)[34]	Mass testing (two point-prevalence surveys) Cohorting	Survey 1: 716/2218 (32.3%), 344/716 (48%) symptomatic Survey 2: 115/637 (18.1%), 5/115 (4%) symptomatic Total surveillance period: 1207/2773 (44%)	287/2773 (24%)	446/2773 (37%) hospitalised
Stall et al. (2020)[44]	Facility characteristics	5218/75676 (6.9%) 3599/5218 (69.0%) for-profit home residents	1452/5218 (27.8%)	

		1239/5218 (23.7%) non-profit home residents 380/5218 (7.3%) municipal home residents	989/3599 (27.5%) for-profit home 368/1239 (29.7%) non-profit home 95/380 (25.0%) municipal home	
Stow et al. (2020)[41]	Facility characteristics		1532 COVID-19 related deaths	Highest correlation of increased NEWS and deaths observed for a two-week lag (r=0.82, p<0.05) Above baseline measures of high respiratory rate (r=0.73, p<0.05 for a two-week lag) and low oxygen saturation (r=0.8, p<0.05 for a two-week lag) appear to follow the pattern of COVID-19 and non-COVID-19 deaths
Telford et al (2020)[35]	Mass testing (15 facilities in response to outbreak, 13 facilities as prevention)	821/2868 (28.6%) Response group: 804/1703 (47.2%) Preventive group: 17/1133 (1.5%), (p<0.0001)	Response group: 131/804 (16.3%) Preventive group: 3/17 (17.6%)	Response group: 171/804 (21.3%) residents hospitalised Preventive group: 5/17 (29.4%) residents hospitalised

PPE, personal protective equipment; CI, confidence interval; IRR, incidence risk ratio; LTCF, long-term care facility; OR, odds ratio; NEWS, national early warning score.

Table 3b. Staff-specific outcomes of strategies to reduce transmission

Study	Interventions	Prevalence	Mortality	Other outcomes
Arons et al. (2020)[18]	Mass testing PPE	26/51 (51.0%) 17/26 (65%) were nursing staff, 9/26 (35%) had roles that provided care/therapies across multiple units		0/26 hospitalized
Blackman et al. (2020)[19]	PPE Symptom screening Visitor restrictions			26 staff members absent from work due to sickness
Borras-Bermejo et al (2020)[54]	Mass testing Visitor restrictions	403/2655 (15.2%), 144/403 (35.7%) asymptomatic		1772/2665 (66.7%) staff reported fever or respiratory symptoms in the preceding 14 days

Dora et al. (2020)[20]	Mass testing (three point-prevalence surveys) Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	8/136 (6%) 4/8 (50%) asymptomatic 3/8 nursing staff 5/8 licensed vocational nurses		
Dutey-Magni et al. (2020)[39]	Mass testing	585/11604 (5.0%)		1892/11604 (16.3%) reported symptoms
Eckardt et al. (2020)[21]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Cohorting	Survey 1: 10/176 (5.7%), 10/10 (100%) asymptomatic Survey 2: 5/175 (2.9%), 5/5 (100%) asymptomatic Survey 3: 1/173 (0.6%), 1/1 (100%) asymptomatic		
Feaster & Goh (2020)[22]	Mass testing	223/356 (62.6%), 55/223 (24.7%) asymptomatic		Infection prevalence higher in staff with direct resident contact (150/219, 68.5%) compared with staff with no direct resident contact (25/52, 48.1%)
Fisman et al. (2020)[43]	Facility characteristics			Infection among LTCF staff was associated with death among residents with a 6-day lag (adjusted IRR for death per infected staff member, 1.17; 95% CI: 1.11-1.26) and a 2-day lag (relative increase in risk of death per staff member with infection, 1.20; 95% CI: 1.14-1.26)
Graham et al. (2020)[23]	Mass testing (two point-prevalence surveys) Cohorting	3/70 (4.3%) 3/3 (100%) asymptomatic		Staff absence due to sickness/self-isolation between March 1 and May 1 elevated relative to background level (215.9% increase, 95% CI: 80-352)
Guery et al. (2020)[45]	Mass testing	3/136 (2.2%) 1/3 (33.3%) asymptomatic		

		1/3 (33.3%) presymptomatic 1/3 (33.3%) symptomatic		
Harris et al. (2020)[26]	Facility characteristics	7 staff COVID-19 positive prior to intervention 0 further staff positive after intervention implemented		
Heung et al. (2006)[47]	Hand hygiene, contact precautions	1 staff member SARS-CoV positive during outbreak (a domestic worker) 0/26 staff positive for SARS-CoV antibodies		
Ho et al. (2004)[48]	PPE Cohorting	1 staff member SARS positive	1/1 (100%)	
Hoxha et al. (2020)[49]	Mass testing	2953/138327 (2.1%) 2185/2953 (74.0%) asymptomatic		
Kennelly et al. (2020)[51]	Mass testing Facility characteristics	675 staff COVID-19 positive 159/675 (23.6%) asymptomatic		Proportion of symptomatic staff correlated with number of residents with confirmed/suspected COVID-19, $\rho = 0.81$ ($p<0.001$)
Lennon et al. (2020)[27]	Mass testing	624/15514 (4.1%) 487/624 (78.0%) asymptomatic 40/624 (6.4%) symptomatic		
Louie et al. (2020)[28]	Mass testing Symptom screening Visitor restrictions	214/431 (49.7%) residents and staff COVID-19 positive 86/214 asymptomatic 128/214 symptomatic (50/128 were health care workers) Additional asymptomatic staff testing: 23/147 (15.6%) staff COVID-19 positive		0/50 symptomatic health care workers hospitalized
McMichael et al. (2020)a[29]	Mass testing PPE Cohorting	50 staff COVID-19 positive	0/50 (0%)	3/50 (6%) hospitalised Staff roles for confirmed cases: therapists, nurses, nurse assistants, health information manager, physician, case manager
Office for National Statistics (2020)[40]	Mass testing Facility characteristics	Estimated 6.9% (95% CI 5.9-7.9%) staff COVID-19 positive across homes that reported an outbreak		Odds of staff infection: for each additional infected resident, staff infection OR = 1.04 (95% CI: 1.04-1.04) Care homes using bank or agency staff most or every day OR = 1.88

				(95% CI: 1.77-2.0) compared to homes not using these staff Homes where staff work in other homes most or every day OR = 2.4 (95% CI: 1.92-3.0) compared to homes where staff never work elsewhere Staff at homes outside London had higher odds of COVID-19 infection
Patel et al. (2020)[30]	Mass testing Symptom screening Visitor restrictions Cohorting	19/42 (45.2%) 11/19 symptomatic (57.9%) 8/19 (42.1%) asymptomatic		
Quicke et al. (2020)[31]	Mass testing (five point-prevalence surveys)	Site A: all staff uninfected Site B: low prevalence in week 1, weeks 2-5 no infections detected, week 6 increase in cases Site C: initial infection prevalence was lower (6.9%), and the incidence declined to zero by week 3 Site D: 22.5% of workers at site D had prevalent infections at the start of the study and incidence was high initially (12.2 per 100 workers per week), declining over time Site E: low prevalence in week 1 saw an increase in cases in subsequent weeks		
Roxby et al. (2020)[33]	Mass testing Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	2/62 (3.2%) (1 worked in dining facilities, 1 was a health aide) 2/2 (100%) symptomatic		
Sacco et al (2020)[46]	Mass testing PPE Visitor restrictions Hand hygiene, contact precautions Cohorting	22 staff COVID-19 positive 9/22 (40.1%) asymptomatic	0/22 (0%)	Staff incidence: Care givers = 0.48/100 person-days Non-care givers with resident contact = 0.36/100 person-days Non-care givers with no resident contact = 0.04/100 person-days

Stall (2020)[44]	Facility characteristics			Outbreak involving staff and residents' for-profit homes 59/360 and staff only 44/360 Non-profit homes staff only 18/ 162. Municipal homes = outbreak staff only 16/101
Telford et al (2020)[35]	Mass testing (15 facilities in response to outbreak, 13 facilities as prevention)	264/2803 (9.4%) Response group: 249/264 (94.3%) Preventive group: 15/264 (5.7%) (d) Prevalence: Response group 12.8% vs Preventive group 1.7%, p<0.0001	1/264 (0.4%) Response group: 0/249 (0%) Preventive group: 1/15 (6.7%)	16/264 (6.1%) hospitalised Response group: 15/249 (6.0%) hospitalised Preventive group: 1/15 (6.7%) hospitalised15/249

LTCF, long-term care facility; IRR, incidence risk ratio; CI, confidence interval.

Table 3c. Visitor-specific outcomes following the implementation of strategies

Study	Interventions	Prevalence	Mortality	Other outcomes
Ho et al. (2004)[48]	PPE Cohorting	3 visitors SARS positive	0/3 (0%)	
McMichael et al (2020)a[29]	Mass testing PPE Cohorting	16 visitors COVID-19 positive	1/16 (6.2%)	8/16 (50%) hospitalized Underlying conditions: hypertension (2/8, 12.5%); cardiac disease (3/8, 18.8%); renal disease (2/8, 12.5%); obesity (3/8, 18.8%), pulmonary disease (2/8, 12.5%)

PPE, personal protective equipment

Quality review

The quality ratings of included studies are presented in Supplementary Table 2. Overall quality of evidence in this review is considered low based on MMAT assessment criteria.

Discussion

Evidence in this review indicates the impact of COVID-19 on LTCF, demonstrating the vulnerability of this setting in 11 countries. A novel outcome highlights the characteristics of LTCF associated with COVID-19 outbreaks, in addition to reporting the prevalence rates of COVID-19 and associated mortality and morbidity for residents, staff, and visitors. A variety of measures were implemented in LTCF, of which many were instigated locally by facility managers, and others through agile public health policy. Mass testing of residents with or without staff testing was the primary measure used to reduce transmission of COVID-19. This provides objective evidence of infection rates in facilities, and enables application of subsequent measures, including isolation of residents who are infected with re-designation of specific staff to care for them. Repeated point-prevalence testing allows facilities to grasp the spread of the virus along with the impact of their mitigation strategies.

Further measures implemented in facilities echoed public health recommendations to the broader community to limit the spread of the virus. These included guidance on hand hygiene, contact and droplet precautions, and restricting staff, including agency workers, to working in only one facility.[55] Restricting visitor access to facilities was implemented generally to reduce the likelihood of introducing COVID-19 into LTCF, assessing body temperature and symptom screening of staff and visitors on entry.

The prevalence of COVID-19 infection varied throughout included studies, with no distinct pattern emerging between prevention strategies and infection prevalence. Similarly, the mortality rate varied widely among studies and prevention measures. However, patterns emerged regarding associations between facility characteristics and the risk of a COVID-19 outbreak and spread. Sepulveda (2020) reports the disproportionately higher risk of contracting COVID-19 for residents of LTCF, calculating a 12-country average mortality rate of 2772 per 100, 000 LTCF residents compared to 122 per 100,

000 for community dwelling older persons.[56] This represented an average 24.2 fold higher rate of death (range 14.2 (Germany) to 73.7 (Canada)). Higher LTCF mortality rates in Canada (78.4% compared to the OECD 12 country average of 43.7%) are explained by poorer services in care facilities and includes limited staffing and funding.[56]

Evidence identified the facility size/number of beds was significantly associated with the probability of having a COVID-19 case, and the resulting size of an outbreak. For example, in a sample of 30 US nursing homes, the probability of having a COVID -19 case was increased in medium and large facilities compared with small facilities,[17] while in 121 UK homes reporting an outbreak, facilities with ≥70 beds had 80% greater infection rates than facilities with <35 beds.[39] A sample of 623 Canadian nursing homes demonstrated facilities with a high crowding index had more infections and deaths than those with a low crowding index. Simulations conducted suggested nearly 20% of infections and deaths may have been averted by converting all 4-bed rooms into 2-bed rooms.[42] Similarly, facilities with a greater number of employees, staff who work in multiple facilities, and an increased number of infected staff, were also more likely to experience a COVID -19 outbreak.[37 40 51] However, facilities where staff receive sick leave were shown to be less likely to have positive cases.[40] Reduced availability of PPE predicted the spread and increase in case number in facilities,[37] while for-profit status of facilities was commonly identified as increasing the odds of case outbreaks relative to non-profit status.[17 32 36 43 44]

Rapid development of COVID-19 vaccines was recognised in early March 2020.[57] Lurie et al. (2020) note previous success in the development of H1N1 vaccination, and similarly the challenges for SARS, Ebola, and Zika vaccines.[57] The speed of developments is acknowledged, and Public Health England (2021) report that at the end of February 2021 up to 5900 deaths were averted in people aged 80 years and older, with over 200 deaths prevented in those aged 7- to 79 years.[58] Montano (2021) advises that an accelerated pace of vaccine developments may not lead to total eradication of the virus, citing smallpox as the only virus that has been eliminated worldwide.[59] Given this, the transmission reduction measures highlighted in the present review are of crucial importance for the continued management of COVID-19 in LTCF.

Quality review

The quality of evidence in this review is technically low, primarily reported from observational studies, expert opinion, reporting of outbreaks and describing the process and management (Supplementary Table 2). Factors associated with lower quality of evidence include the reliance on self-reporting of symptoms, recall bias, use of datasets which may be incomplete, and use of convenience sampling. However, confirmation of COVID-19 in the majority of studies was via laboratory testing. We did not remove any study following our review of quality and the evidence is consistent with real-time reporting of data to learn from outbreaks. Papers included from MEDRXIV pre publishing repository are acknowledged; however, as papers were subsequently published in peer review journals we reviewed accordingly. The Institute of Medicine (2004)[60] advocates for early detection of epidemics, effective communication to the public, and promotion of research and development for strategic planning.

Limitations in the review process

A key strength of this review is that it addresses a knowledge gap and has collated evidence from a broad methodological base to report the measures to reduce transmission of COVID-19 in LTFC and reports characteristics of facilities.Due to the heterogeneity of included studies, meta-analysis was not performed, while the descriptive nature of studies prevents identification of a causative relationship between measures and outcomes. We acknowledge that while a summary of facility characteristics and COVID-19 outcomes are presented, data do not allow for presentation of specific measures. Despite this, the systematic approach to this review has identified the scope of interventions implemented in LTFC to reduce COVID -19 transmission.

Publication bias was minimized with inclusion of pre-published evidence, follow up contacts with authors for early reporting, and through the inclusion of observational study designs. Most studies reported are in English, we translated papers from German and Spanish as part of the assessment and review. Outbreak reports include convenience samples or smaller cohorts of residents in LTCF with

limited data reported in brief reports and letters. However, real-time reporting of outbreaks provides immediate evidence and shared understanding advocated by the Institute of Medicine.[60]

Evidence in this review builds on publications from Salcher-Konrad, et al. [61], a report from WHO,[62] and an Irish Expert Panel review,[55] furthermore, data on the role of facilities in the transmission of COVID-19 are presented.

Conclusion

This novel, rapid review summarises the evidence base to date identifying specific factors for consideration as part of preparedness plans to reduce transmission of COVID-19 outbreaks in LTCF. Future research should incorporate methodologically robust study designs with longer follow up to assess the impact on reducing transmission.

Funding

Authors declare no funds were provided for the production of this review.

Author Contributions

CK, KF, and LM designed the study; KF and DS developed the search strategy; DS conducted the literature search; KF and LM screened titles and full texts to select studies, and extracted data; LM, EL, KF, and CK conducted quality ratings; KF, LM, DS, EL, EC, CK interpreted and synthesised data; KF, LM, DS, EL, EC, CK were involved in writing. All authors have approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest. CK was a member of an expert panel investigating COVID-19 in nursing homes in Ireland.

Data availability

No additional data available.

References

Figure legends

Figure 1. PRISMA flowchart

1. European Centre for Disease Prevention and Control (ECDC). Timeline of ECDC's response to COVID-19 2020 [cited 2020 4th October]. Available from: https://www.ecdc.europa.eu/en/covid-19/timeline-ecdc-response accessed 4th October 2020.
2. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report – 94, 2020.
3. Nussbaumer-Streit B, Mayr V, Dobrescu AI, et al. Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *The Cochrane database of systematic reviews* 2020;4(4):Cd013574. doi: 10.1002/14651858.cd013574 [published Online First: 2020/04/09]
4. European Centre for Disease Prevention and Control (ECDC). Risk assessment: Outbreak of acute respiratory syndrome associated with a novel coronavirus, Wuhan, China. Stockholm: ECDC; 2020 [updated 22 January 2020 Available from: https://www.ecdc.europa.eu/en/publications-data/rapid-risk-assessment-cluster-pneumonia-cases-caused-novel-coronavirus-wuhan2020.
5. World Health Organization. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). Geneva: WHO; 2020 [Available from: https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov).
6. Meng X, Deng Y, Dai Z, et al. COVID-19 and anosmia: A review based on up-to-date knowledge. *Am J Otolaryngol* 2020;41(5):102581-81. doi: 10.1016/j.amjoto.2020.102581 [published Online First: 06/02]
7. European Centre for Disease Prevention and Control (ECDC). COVID-19 situation update worldwide, as of week 12, updated 1 April 2021 2021 [Available from: https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases accessed 8th April 2021.

8. European Centre for Disease Prevention and Control (ECDC). Surveillance of COVID-19 at longterm care facilities in the EU/EEA. Technical Report, 2020.
9. ECDC Public Health Emergency Team, Danis K, Fonteneau L, et al. High impact of COVID-19 in long-term care facilities, suggestion for monitoring in the EU/EEA, May 2020. *Euro Surveill* 2020;25(22):2000956. doi: 10.2807/1560-7917.ES.2020.25.22.2000956
10. Mueller AL, McNamara MS, Sinclair DA. Why does COVID-19 disproportionately affect older people? *Aging* 2020;12(10):9959-81. doi: 10.18632/aging.103344 [published Online First: 2020/05/30]
11. United Nations. Policy Brief: The Impact of COVID-19 on older persons, 2020.
12. World Health Organization. Policy Brief: The Impact of COVID-19 on older persons, 2020.
13. Frazer K, Mitchell L, Stokes D, et al. Systematic review of measures to protect older people in long term care facilities from COVID 19. *PROSPERO: International prospective register of systematic reviews* 2020;CRD42020191569
14. Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine* 2009;6(7):e1000097. doi: 10.1371/journal.pmed.1000097
15. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information* 2018;34:285-91. doi: 10.3233/EFI-180221
16. Campbell M, McKenzie JE, Sowden A, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. *BMJ* 2020;368:l6890. doi: 10.1136/bmj.l6890
17. Abrams HR, Loomer L, Gandhi A, et al. Characteristics of U.S. Nursing Homes with COVID-19 Cases. *Journal of the American Geriatrics Society* 2020 doi: 10.1111/jgs.16661
18. Arons MM, Hatfield KM, Reddy SC, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. *New England Journal of Medicine* 2020;382(22):2081-90. doi: 10.1056/NEJMoa2008457
19. Blackman C, Farber S, Feifer RA, et al. An Illustration of SARS-CoV-2 Dissemination Within a Skilled Nursing Facility Using Heat Maps. *Journal of the American Geriatrics Society* 2020;68(10):2174-78. doi: 10.1111/jgs.16642
20. Dora AV, Winnett A, Jatt LP, et al. Universal and Serial Laboratory Testing for SARS-CoV-2 at a Long-Term Care Skilled Nursing Facility for Veterans - Los Angeles, California, 2020. *MMWR Morbidity and mortality weekly report* 2020;69(21):651-55. doi: 10.15585/mmwr.mm6921e1
21. Eckardt P, Guran R, Hennemyre J, et al. Hospital affiliated long term care facility COVID-19 containment strategy by using prevalence testing and infection control best practices. *American Journal of Infection Control* 2020 doi: https://doi.org/10.1016/j.ajic.2020.06.215

22. Feaster M, Goh Y-Y. High Proportion of Asymptomatic SARS-CoV-2 Infections in 9 Long-Term Care Facilities, Pasadena, California, USA, April 2020. *Emerging Infectious Disease journal* 2020;26(10):2416. doi: 10.3201/eid2610.202694

23. Graham N, Junghans C, Downes R, et al. SARS-CoV-2 infection, clinical features and outcome of COVID-19 in United Kingdom nursing homes. *J Infect* 2020 doi: 10.1016/j.jinf.2020.05.073 [published Online First: 2020/06/07]

24. Hand J, Rose EB, Salinas A, et al. Severe Respiratory Illness Outbreak Associated with Human Coronavirus NL63 in a Long-Term Care Facility. *Emerg Infect Dis* 2018;24(10):1964-66. doi: 10.3201/eid2410.180862 [published Online First: 2018/09/19]

25. Harris DA, Archbald-Pannone L, Kaur J, et al. Rapid Telehealth-Centered Response to COVID-19 Outbreaks in Postacute and Long-Term Care Facilities. *Telemedicine and e-Health* 2020;0(0):null. doi: 10.1089/tmj.2020.0236

26. Kimball A, Hatfield KM, Arons M, et al. Asymptomatic and Presymptomatic SARS-CoV-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility - King County, Washington, March 2020. *MMWR Morbidity and mortality weekly report* 2020;69(13):377-81. doi: 10.15585/mmwr.mm6913e1

27. Lennon NJ, Bhattacharyya RP, Mina MJ, et al. Comparison of viral levels in individuals with or without symptoms at time of COVID-19 testing among 32,480 residents and staff of nursing homes and assisted living facilities in Massachusetts. *medRxiv* 2020:2020.07.20.20157792. doi: 10.1101/2020.07.20.20157792

28. Louie JK, Scott HM, DuBois A, et al. Lessons from Mass-Testing for COVID-19 in Long Term Care Facilities for the Elderly in San Francisco. *Clinical Infectious Diseases* 2020 doi: 10.1093/cid/ciaa1020

29. McMichael TM, Currie DW, Clark S, et al. Epidemiology of covid-19 in a long-term care facility in King County, Washington. *New England Journal of Medicine* 2020;382(21):2008-11. doi: 10.1056/NEJMoa2005412

30. Patel MC, Chaisson LH, Borgetti S, et al. Asymptomatic SARS-CoV-2 Infection and COVID-19 Mortality During an Outbreak Investigation in a Skilled Nursing Facility. *Clinical Infectious Diseases* 2020 doi: 10.1093/cid/ciaa763

31. Quicke K, Gallichote E, Sexton N, et al. Longitudinal Surveillance for SARS-CoV-2 RNA Among Asymptomatic Staff in Five Colorado Skilled Nursing Facilities: Epidemiologic, Virologic and Sequence Analysis. *medRxiv* 2020:2020.06.08.20125989. doi: 10.1101/2020.06.08.20125989

32. Quigley DD, Dick A, Agarwal M, et al. COVID-19 Preparedness in Nursing Homes in the Midst of the Pandemic. *Journal of the American Geriatrics Society* 2020;68(6):1164-66. doi: 10.1111/jgs.16520

33. Roxby AC, Greninger AL, Hatfield KM, et al. Outbreak Investigation of COVID-19 among Residents and Staff of an Independent and Assisted Living Community for Older Adults in Seattle, Washington. *JAMA Internal Medicine* 2020 doi: 10.1001/jamainternmed.2020.2233

34. Sanchez GV, Biedron C, Fink LR, et al. Initial and Repeated Point Prevalence Surveys to Inform SARS-CoV-2 Infection Prevention in 26 Skilled Nursing Facilities — Detroit, Michigan, March–May 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:882-86. doi: http://dx.doi.org/10.15585/mmwr.mm6927e1external

35. Telford CT, Onwubiko U, Holland D, et al. Mass Screening for SARS-CoV-2 Infection among Residents and Staff in Twenty-eight Long-term Care Facilities in Fulton County, Georgia. *medRxiv* 2020:2020.07.01.20144162. doi: 10.1101/2020.07.01.20144162

36. Unruh MA, Yun H, Zhang Y, et al. Nursing Home Characteristics Associated With COVID-19 Deaths in Connecticut, New Jersey, and New York. *Journal of the American Medical Directors Association* 2020;21(7):1001-03. doi: https://doi.org/10.1016/j.jamda.2020.06.019

37. Brainard JS, Rushton S, Winters T, et al. Introduction to and spread of COVID-19 in care homes in Norfolk, UK. *Journal of Public Health* 2020;fdaa218 doi: 10.1093/pubmed/fdaa218

38. Burton JK, Bayne G, Evans C, et al. Evolution and impact of COVID-19 outbreaks in care homes: population analysis in 189 care homes in one geographic region of the UK. *Lancet Healthy Longevity* 2020;1(1):e21-31. doi: 10.1016/S2666-7568(20)30012-X

39. Dutey-Magni PF, Williams H, Jhass A, et al. Covid-19 infection and attributable mortality in UK Long Term Care Facilities: Cohort study using active surveillance and electronic records (March-June 2020). *Age and Ageing* 2021;afab060 doi: 10.1093/ageing/afab060

40. Office for National Statistics. Impact of coronavirus in care homes in England: 26 May to 19 June 2020. They Vivaldi study., 2020.

41. Stow D, Barker RO, Matthews FE, et al. National Early Warning Scores (NEWS / NEWS2) and COVID-19 deaths in care homes: a longitudinal ecological study. *medRxiv* 2020:2020.06.15.20131516. doi: 10.1101/2020.06.15.20131516

42. Brown KA, Jones A, Daneman N, et al. Association Between Nursing Home Crowding and COVID-19 Infection and Mortality in Ontario, Canada. *JAMA Internal Medicine* 2021;181(2):229-36. doi: 10.1001/jamainternmed.2020.6466

43. Fisman DN, Bogoch I, Lapointe-Shaw L, et al. Risk Factors Associated With Mortality Among Residents With Coronavirus Disease 2019 (COVID-19) in Long-term Care Facilities in Ontario, Canada. *JAMA Network Open* 2020;3(7):e2015957-e57. doi: 10.1001/jamanetworkopen.2020.15957

44. Stall NM, Jones A, Brown KA, et al. For-profit long-term care homes and the risk of COVID-19 outbreaks and resident deaths. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne* 2020;192(33):E946-e55. doi: 10.1503/cmaj.201197 [published Online First: 2020/07/24]

45. Guery R, Delaye C, Brule N, et al. Limited effectiveness of systematic screening by nasopharyngeal RT-PCR of medicalized nursing home staff after a first case of COVID-19 in a resident. *Médecine et Maladies Infectieuses* 2020 doi: https://doi.org/10.1016/j.medmal.2020.04.020

46. Sacco G, Foucault G, Briere O, et al. COVID-19 in seniors: Findings and lessons from mass screening in a nursing home. *Maturitas* 2020;141:46-52. doi: https://doi.org/10.1016/j.maturitas.2020.06.023

47. Heung LC, Li T, Mak SK, et al. Prevalence of subclinical infection and transmission of severe acute respiratory syndrome (SARS) in a residential care home for the elderly. *Hong Kong Med J* 2006;12(3):201-7. [published Online First: 2006/06/09]

48. Ho WW, Hui E, Kwok TC, et al. An outbreak of severe acute respiratory syndrome in a nursing home. *J Am Geriatr Soc* 2003;51(10):1504-5. doi: 10.1046/j.1532-5415.2003.514841.x [published Online First: 2003/09/27]

49. Hoxha A, Wyndham-Thomas C, Klamer S, et al. Asymptomatic SARS-CoV-2 infection in Belgian long-term care facilities. *The Lancet Infectious Diseases* 2020 doi: https://doi.org/10.1016/S1473-3099(20)30560-0

50. Klein A, Edler C, Fitzek A, et al. Der erste COVID-19-Hotspot in einer Hamburger Senioreneinrichtung. *Rechtsmedizin* 2020;30(5):325-31. doi: 10.1007/s00194-020-00404-1

51. Kennelly SP, Dyer AH, Noonan C, et al. Asymptomatic carriage rates and case-fatality of SARS-CoV-2 infection in residents and staff in Irish nursing homes. *Age and Ageing* 2021;50(1):49-54. doi: 10.1093/ageing/afaa220

52. Iritani O, Okuno T, Hama D, et al. Clusters of COVID-19 in long-term care hospitals and facilities in Japan from 16 January to 9 May 2020. *Geriatrics & Gerontology International* 2020;20(7):715-19. doi: 10.1111/ggi.13973

53. Kim T. Improving Preparedness for and Response to Coronavirus Disease 19 (COVID-19) in Long-Term Care Hospitals in the Korea. *Infect Chemother* 2020 [published Online First: 2020/05/15]

54. Borras-Bermejo B, Martínez-Gómez X, San Miguel MG, et al. Asymptomatic SARS-CoV-2 Infection in Nursing Homes, Barcelona, Spain, April 2020. *Emerging Infectious Disease journal* 2020;26(9):2281. doi: 10.3201/eid2609.202603

55. Kelleher CC, Doherty B, Donnelly P, et al. COVID-19 Nursing Homes Expert Panel. Examination of Measures to 2021. Report to the Minister for Health, 2020.

56. Sepulveda ER, Stall NM, Sinha SK. A Comparison of COVID-19 Mortality Rates Among Long-Term Care Residents in 12 OECD Countries. *Journal of the American Medical Directors Association* 2020;21(11):1572-74.e3. doi: 10.1016/j.jamda.2020.08.039 [published Online First: 09/12]

57. Lurie N, Saville M, Hatchett R, et al. Developing Covid-19 Vaccines at Pandemic Speed. *New England Journal of Medicine* 2020;382(21):1969-73. doi: 10.1056/NEJMp2005630

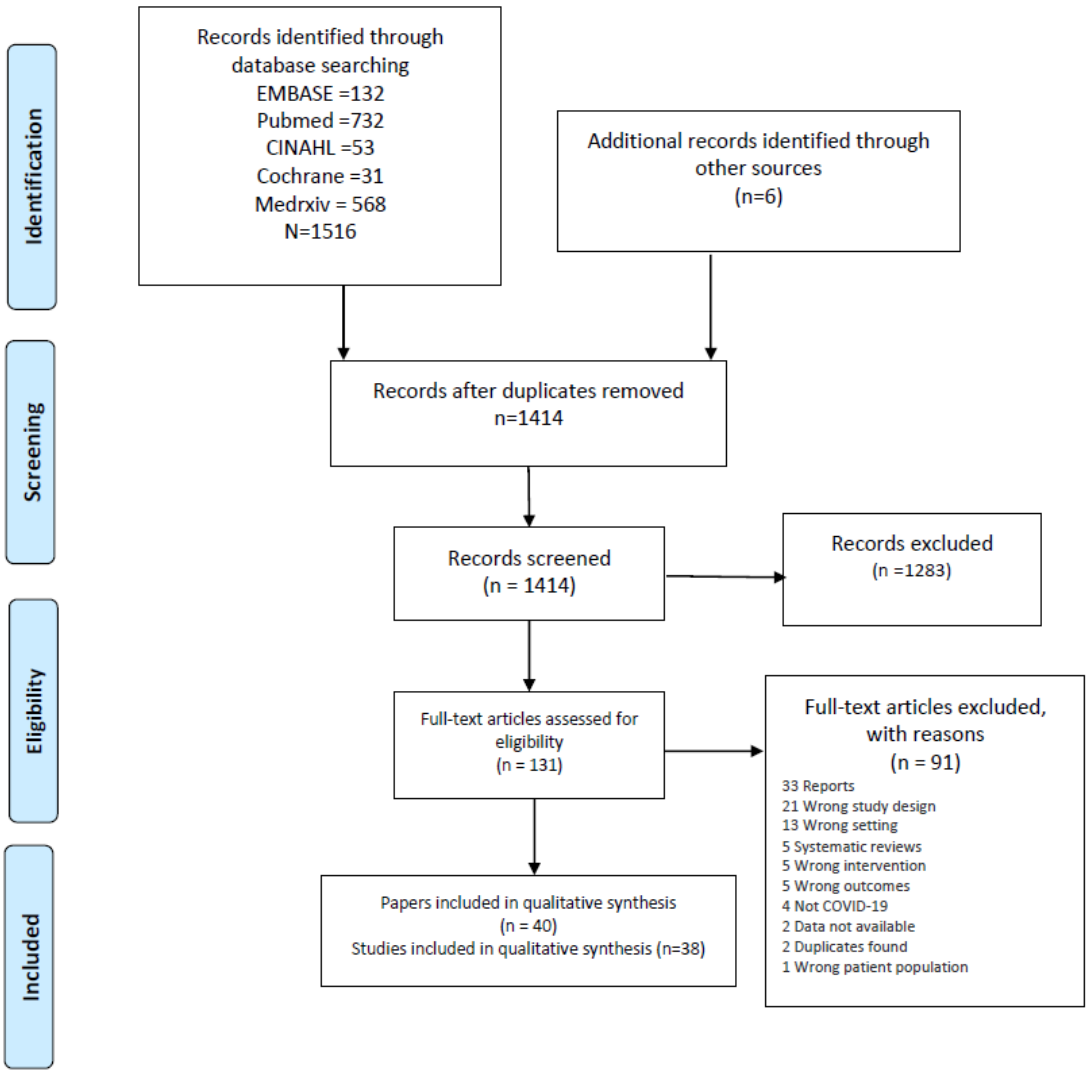
58. Public Health England. Impact of COVID-19 vaccines on mortality in England December 2020 to February 2021. London, 2021.

59. Montano M. Pressing Questions and Challenges in the HIV-1 and SARS-CoV-2 Syndemic. *AIDS Research and Human Retroviruses* 2021;Ahead of Print doi: 10.1089/aid.2021.0005

60. Institute of Medicine (IOM). Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. In: Knobler S, Mahmoud A, Lemon S, et al., eds. Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. Washington (DC): National Academies Press (US), Copyright © 2004, National Academy of Sciences. 2004.

61. 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. *medRxiv* 2020:2020.06.09.20125237. doi: 10.1101/2020.06.09.20125237

62. World Health Organization. Preventing and managing COVID-19 across long-term care services: policy brief. Geneva, 2020.


Identification
Screening
Eligibility
Included
Records identified through database searching
EMBASE =132
Pubmed =732
CINAHL =53
Cochrane =31
Medrxiv = 568
N=1516
Additional records identified through other sources
(n=6)
Records after duplicates removed
n=1414
Records screened
(n = 1414)
Records excluded
(n =1283)
Full-text articles assessed for eligibility
(n = 131)
Full-text articles excluded, with reasons
(n = 91)
33 Reports
21 Wrong study design
13 Wrong setting
5 Systematic reviews
5 Wrong intervention
5 Wrong outcomes
4 Not COVID-19
2 Data not available
2 Duplicates found
1 Wrong patient population
Papers included in qualitative synthesis
(n = 40)
Studies included in qualitative synthesis (n=38)

Pubmed

Search #1

“Residential facilit*” OR “Residential aged care” OR Convalescent home* OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR Home* for the aged OR “Old Age Home*” OR “long-term care” OR "Nursing Homes"[Mesh] OR “long-term care”[MeSH] OR "Residential Facilities"[Mesh] OR "Housing for the Elderly"[Mesh]

213,035 Results

Intervention

Search #2

(“Infection control” OR Infection prevention and control* OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “Health care Delivery” OR transmission OR body substance isolation* OR physical barrier* OR physical intervention* OR physical protection* OR personal protection* OR person protection* OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR non-pharm intervention* OR non-pharmaceutical intervention* OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing or separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face mask* OR face-mask* OR "Delivery of Health Care" OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR “Personal Protective Equipment” OR mask* OR virucide* OR antivirus agent* OR Handwashing OR “Hand washing” OR “Hand Disinfection” OR “hand hygiene” OR distancing OR distances OR aerosol-generating procedure* OR patient isolation* OR patient isolator* OR person isolator* OR “individual isolation” OR individual isolator* OR filtering face piece* OR face protection* OR face shield* OR face protective device* OR face protective gear* OR eye protection* OR eye shield* OR eye protective device* OR eye protective gear* OR Eye mask* OR airborne precaution* OR droplet precaution* OR safety supply OR safety supplies* OR safety device* OR safety equipment* OR safety measure* OR safety gear* OR protective supply* OR protective supplies* OR protective device* OR protective equipment* OR protective measure* OR protective gear* OR “personal isolation” OR respirator* OR respiratory protection* OR respiratory protective device* OR “respiratory protective supply” OR “respiratory protective supplies” OR “respiratory protective equipment” OR “respiratory protective gear” OR “safely equipped” OR meter OR metre OR foot OR feet OR meters OR metres OR head cover* OR face cover* OR eye cover* OR goggle* OR protective clothing* OR "Infection Control"[Mesh] OR "Personal Protective Equipment"[Mesh] OR "Hand Disinfection"[Mesh] OR "Communicable Disease Control"[Mesh:NoExp] OR "Disease Transmission, Infectious"[Mesh] OR "Primary Prevention"[Mesh] OR "Delivery of Health Care"[Mesh:NoExp] OR "Fomites"[Mesh] OR "Ventilators, Mechanical"[Mesh] OR "Communicable Disease Control"[Mesh] OR "Primary Prevention"[Mesh] OR "Delivery of Health Care"[Mesh] OR "Patient Isolation"[Mesh] OR "Patient Safety"[Mesh] OR "Patient Harm"[Mesh])

5,741,706 results

And

Search #3

(Coronavirus* OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR coronaviridae OR "corona virus" OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR "COVID-19" [Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2" [Supplementary Concept] OR "Coronavirus Infections"[Mesh] OR "Coronavirus"[Mesh] OR "Middle East Respiratory Syndrome Coronavirus"[Mesh] OR "Coronavirus Infections"[Mesh] OR "SARS Virus"[Mesh] OR "Betacoronavirus"[Mesh])

595,661 results

Search #4 = #2 AND #3 116,217 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “infection risk” OR "Mortality"[Mesh:NoExp] OR "Morbidity"[Mesh]

3,204,107 results

Search #6 = #1 AND #4 AND #5

EMBASE

Search #1

“Residential facilit*” OR “Residential aged care” OR “Convalescent home*” OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR “Home* for the aged” OR “Old Age Home*” OR

"long-term care" OR 'residential home'/exp OR 'nursing home'/exp OR 'home for the aged'/exp OR 'skilled nursing facility'/exp OR 'long term care'/de

212,416 results

Intervention

Search #2

("Infection control" OR "Infection prevention and control*" OR "Patient Safety" OR "Patient harm" OR "Patient risk" OR "body substance isolation*" OR "physical barrier*" OR "physical intervention*" OR "physical protection*" OR "personal protection*" OR "person protection*" OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR "non-pharm intervention*" OR "non-pharmaceutical intervention*" OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing OR separation OR "Communicable Disease Control" OR "Primary Prevention" OR facemask* OR face-mask* OR "face mask*" OR "Delivery of Health Care" OR "Health Care Delivery" OR "Disease transmission" OR "Infectious Disease Transmission" OR PPE OR "Personal Protective Equipment" OR mask* OR virucide* OR antivirus agent* OR Handwashing OR "Hand washing" OR "Hand Disinfection" OR "hand hygiene" OR distancing OR distances OR "aerosol-generating procedure*" OR "patient isolation*" OR "patient isolator*" OR "person isolator*" OR "individual isolation" OR "individual isolator*" OR "filtering face piece*" OR "face protection*" OR "face shield*" OR "face protective device*" OR "face protective gear*" OR "eye protection*" OR "eye shield*" OR "eye protective device*" OR "eye protective gear*" OR "Eye mask*" OR "airborne precaution*" OR "droplet precaution*" OR "safety supply" OR "safety supplies*" OR "safety device*" OR "safety equipment*" OR "safety measure*" OR "safety gear*" OR "protective supply*" OR "protective supplies*" OR "protective device*" OR "protective equipment*" OR "protective measure*" OR "protective gear*" OR "personal isolation" OR respirator* OR "respiratory protection*" OR "respiratory protective device*" OR "respiratory protective supply" OR "respiratory protective supplies" OR "respiratory protective equipment" OR "respiratory protective gear" OR "safely equipped" OR meter OR metre OR foot OR feet OR meters OR metres OR "head cover*" OR "face cover*" OR "eye cover*" OR goggle* OR "protective clothing*" OR 'infection control'/exp OR 'patient safety'/exp OR 'disease transmission'/exp OR 'contamination'/exp OR 'shedding'/exp OR 'fomite'/exp OR 'shield'/exp OR 'ventilator'/exp OR 'space'/exp OR 'separation'/exp OR 'communicable disease control'/exp OR 'primary prevention'/exp OR 'face mask'/exp OR 'health care delivery'/exp OR 'protective equipment'/exp OR 'mask'/exp OR 'antivirus agent'/exp OR 'hand washing'/exp OR 'patient isolation'/exp OR 'face shield'/exp OR 'eye protective device'/exp OR 'ventilator'/exp OR 'respiratory protection'/exp OR 'goggle'/exp OR 'protective clothing'/exp)

6,030,646 results

And

Search #3

(Coronavirus* OR "Corona virus" OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR

coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR 'Coronavirinae'/exp OR 'Betacoronavirus'/exp OR 'severe acute respiratory syndrome'/exp OR 'covid 19'/exp OR 'Coronavirus infection'/exp)

45,801 results

Search #4 = #2 AND #3 27,921 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “Infection risk” OR 'mortality'/exp OR 'mortality rate'/exp OR 'morbidity'/exp OR 'infection risk'/exp

1,862,861results

Search #6 = #1 AND #4 AND #5

CINAHL

Search #1

“Residential facilit*” OR “Residential aged care” OR “Convalescent home*” OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR “Home* for the aged” OR “Old Age Home*” OR “long-term care” OR (MH "Residential Facilities") OR (MH "Nursing Homes+") OR (MH "Housing for the Elderly") OR (MH "Long Term Care")

83,231 results

Intervention

Search #2

(“Infection control” OR “Infection prevention and control*” OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “body substance isolation*” OR “physical barrier*” OR “physical intervention*” OR “physical protection*” OR “personal protection*” OR “person protection*” OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR “non-pharm intervention*” OR “non-pharmaceutical intervention*” OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing OR separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face-mask* OR “face mask*” OR "Delivery of Health Care" OR “Health Care Delivery” OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR “Personal Protective Equipment” OR mask* OR virucide* OR antivirus agent* OR Handwashing OR “Hand washing” OR “Hand Disinfection” OR “hand hygiene” OR distancing OR distances OR “aerosol-generating procedure*” OR “patient isolation*” OR “patient isolator*” OR “person isolator*” OR “individual isolation” OR “individual isolator*” OR “filtering face piece*” OR “face protection*” OR “face shield*” OR “face protective device*” OR “face protective gear*” OR “eye protection*” OR “eye shield*” OR “eye protective device*” OR “eye protective gear*” OR “Eye mask*” OR “airborne precaution*” OR “droplet precaution*” OR “safety supply” OR “safety supplies*” OR “safety device*” OR “safety equipment*” OR “safety measure*” OR “safety gear*” OR “protective supply*” OR “protective supplies*” OR “protective device*” OR “protective equipment*” OR “protective measure*” OR “protective gear*” OR “personal isolation” OR respirator* OR “respiratory protection*” OR “respiratory protective device*” OR “respiratory protective supply” OR “respiratory protective supplies” OR “respiratory protective equipment” OR “respiratory protective gear” OR “safely equipped” OR meter OR metre OR foot OR feet OR meters OR metres OR “head cover*” OR “face cover*” OR “eye cover*” OR goggle* OR “protective clothing*” OR (MH "Infection Control") OR (MH "Handwashing") OR (MH "Patient Safety") OR (MH "Disease Transmission+") OR (MH "Microbial Contamination") OR (MH "Ventilators, Mechanical") OR (MH "Masks") OR (MH "Health Care Delivery+") OR (MH "Protective Devices+") OR (MH "Patient Isolation+")

917,391 results

And

Search #3

(Coronavirus* OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR (MH "Coronavirus+") OR (MH "Coronaviridae Infections+"))

141,416 results

Search #4 = #2 AND #3 15,251 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “Infection risk” OR (MH "Mortality+") OR (MH "Morbidity+")

501,502 results

Search #6 = #1 AND #4 AND #5

Cochrane library

#1 MeSH descriptor: [Coronavirus Infections] explode all trees 179

#2 MeSH descriptor: [Coronavirus] explode all trees 18

#3 Coronavirus OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR coronaviridae OR "corona virus" OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" 1173

#4 #1 OR #2 OR #3 1173

#5 “Infection control” OR Infection prevention and control* OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “Health care Delivery” OR transmission OR body substance isolation* OR physical barrier* OR physical intervention* OR physical protection* OR personal protection* OR person protection* OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR non-pharm intervention* OR non-pharmaceutical intervention* OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing or separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face mask* OR face-mask* OR "Delivery of Health Care" OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR

"Personal Protective Equipment" OR mask* OR virucide* OR antivirus agent* OR Handwashing OR "Hand washing" OR "Hand Disinfection" OR "hand hygiene" OR distancing OR distances OR aerosol-generating procedure* OR patient isolation* OR patient isolator* OR person isolator* OR "individual isolation" OR individual isolator* OR filtering face piece* OR face protection* OR face shield* OR face protective device* OR face protective gear* OR eye protection* OR eye shield* OR eye protective device* OR eye protective gear* OR Eye mask* OR airborne precaution* OR droplet precaution* OR safety supply OR safety supplies* OR safety device* OR safety equipment* OR safety measure* OR safety gear* OR protective supply* OR protective supplies* OR protective device* OR protective equipment* OR protective measure* OR protective gear* OR "personal isolation" OR respirator* OR respiratory protection* OR respiratory protective device* OR "respiratory protective supply" OR "respiratory protective supplies" OR "respiratory protective equipment" OR "respiratory protective gear" OR "safely equipped" OR meter OR metre OR foot OR feet OR meters OR metres OR head cover* OR face cover* OR eye cover* OR goggle* OR protective clothing* 300480

#6 MeSH descriptor: [Infection Control] explode all trees 1147

#7 MeSH descriptor: [Personal Protective Equipment] explode all trees 2284

#8 MeSH descriptor: [Hand Disinfection] explode all trees 378

#9 MeSH descriptor: [Communicable Disease Control] explode all trees 4791

#10 MeSH descriptor: [Disease Transmission, Infectious] explode all trees 856

#11 MeSH descriptor: [Primary Prevention] explode all trees 4005

#12 MeSH descriptor: [Delivery of Health Care] explode all trees 44666

#13 MeSH descriptor: [Fomites] explode all trees 9

#14 MeSH descriptor: [Ventilators, Mechanical] explode all trees 264

#15 MeSH descriptor: [Patient Isolation] explode all trees 51

#16 MeSH descriptor: [Patient Safety] explode all trees 580

#17 MeSH descriptor: [Patient Harm] explode all trees 3

#18 #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 336372

#19 #18 AND #4 651

#20 residential facilit* OR residential aged care OR Convalescent home OR Nursing home* OR Homes for the aged OR Housing for the elderly OR Skilled nursing facilit* OR Long term care OR Longterm care OR Home* for the aged OR old age home OR Long-term care 121379

#21 MeSH descriptor: [Long-Term Care] explode all trees 1112

#22 MeSH descriptor: [Nursing Homes] explode all trees 1314

#23 MeSH descriptor: [Residential Facilities] explode all trees 1711

#24 MeSH descriptor: [Housing for the Elderly] explode all trees 39

#25 #20 OR #21 OR #22 OR #23 OR #24 121450

#26 Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “infection risk” 111129

#27 MeSH descriptor: [Mortality] explode all trees 12838

#28 MeSH descriptor: [Morbidity] explode all trees 14392

#29 #26 OR #27 OR #28 124060

#30 #19 AND #25 AND #29

Medrxiv

"((COVID-19 OR SARS-CoV-2) And ("Infection control")) AND (Mortality) AND ("nursing homes")"

Supplemental Table 2. Quality Review

		S1	*S2*	*3.1*	*3.2*	*3.3*	*3.4*	*3.5*	*4.1*	*4.2*	*4.3*	*4.4*	*4.5*	*Comments*
Abrams (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	CT	Y	
Arons (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y	
Blackman 2020	Quantitative descriptive	Y	Y						Y	N	Y	CT	Y*	*Data very limited to descriptive statistics (counts)
Borras-Bermejo 2020	Quantitative descriptive	Y	Y						Y	CT	Y	N	Y*	*Data minimal descriptive statistics. Reported as a brief letter.
Brainard (2020)	Non-randomised	Y	Y	CT	Y	Y	CT	Y						
Brown (2021)	Non-randomised	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	
Burton (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Dora (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data reporting descriptive data from an outbreak (counts and percentages)
Dutey-Magni (2021)	Non-randomised	Y	Y	Y	Y	Y	N	Y						
Eckhardt (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Limited descriptive data (point prevalence data, counts &percentages)
Feaster (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Fisman (2020b)	Non-randomised	Y	Y	Y	Y	Y	N	Y						
Graham (2020)	Quantitative descriptive	Y	Y						Y	N	Y	Y	Y	
Guery (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Limited descriptive data reported. Outbreak reported as a published letter.
Hand (2018)	Quantitative descriptive	Y	CT											Research letter reporting minimal data.
Harris (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics
Heung (2006)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y*	*Limited descriptive data
Ho (2003)	Quantitative descriptive	Y	CT											Report of conference symposium. Limited details
Hoxha 2020	Quantitative descriptive	Y	Y						Y	Y	Y	CT	Y	
Iritani 2020	Non-randomised	Y	Y	N	CT	Y	Y	CT						
Kennelly (2021)	Quantitative descriptive	Y	Y						CT	Y	Y	N	Y	
Kim (2020)	Quantitative descriptive	Y	CT						N	N	N	N	N	
Kimball (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics (counts/ percentages) brief report

Klein (2020)	Quantitative descriptive	N	N											Autopsy reporting
Lennon (2020) +	Quantitative descriptive	Y	Y						Y	CT	Y	Y	Y	
Louie (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics presented in a brief report
McMichael (2020b)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y*	*Data limited to descriptive statistics
Office for National Statistics (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	CT	Y	
Patel (2020)	Longitudinal, Descriptive quantitative	Y	Y						Y	Y	Y	Y	Y	
Quicke (2020) +	Quantitative descriptive	Y	Y						CT	CT	CT	CT	Y	Limited data reported and virologic assay.
Quigley (2020)	Quantitative descriptive	Y	Y						Y	N	Y	N	Y*	*Limited descriptive data reported in a research letter
Roxby (2020) JAMA	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Descriptive data reported
Sacco (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Sanchez (2020)	Quantitative descriptive	Y	Y						CT	CT	Y	CT	Y*	*Descriptive data reported on prevalence (counts/ percentages)
Stall (2020) (CMAJ)	Non-randomised	Y	Y	CT	Y	Y	CT	Y						
Stow (2020) +	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Telford (2020) +	Non-randomised	Y	Y	CT	Y	Y	N	Y						
Unruh (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	Y	Y	

Y = Yes, N= No, CT= Can't tell

+ pre published manuscript available

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary material
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5, 6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6, figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Supplementary table 2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	17-33
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Supplementary table 2
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	33-35
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	35
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	35
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	35

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

BMJ Open

A rapid systematic review of measures to protect older people in long term care facilities from COVID-19

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-047012.R2
Article Type:	Original research
Date Submitted by the Author:	18-Aug-2021
Complete List of Authors:	Frazer, Kate; University College Dublin Mitchell, Lachlan; University College Dublin, Stokes, Diarmuid; University College Dublin Lacey, Ella; University College Dublin Crowley, Eibhlin; University College Dublin Kelleher, Cecily; University College Dublin,
Primary Subject Heading:	Public health
Secondary Subject Heading:	Global health, Health policy
Keywords:	COVID-19, Public health < INFECTIOUS DISEASES, GERIATRIC MEDICINE

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

A rapid systematic review of measures to protect older people in long term care facilities from COVID-19

Kate Frazer[1*], Lachlan Mitchell[2,3*], Diarmuid Stokes[4], Ella Lacey[5], Eibhlin Crowley[6], Cecily Kelleher[2,3].

1. School of Nursing, Midwifery and Health Systems, University College Dublin, Belfield, Dublin 4, Ireland
2. National Nutrition Surveillance Centre, University College Dublin, Belfield, Dublin 4, Ireland
3. School of Public Health, Physiotherapy and Sport Science, University College Dublin, Belfield, Dublin 4, Ireland
4. Health Sciences Library, University College Dublin, Belfield, Dublin 4, Ireland
5. School of Medicine, University College Dublin, Belfield, Dublin 4, Ireland
6. Office for Health Affairs, College of Health and Agricultural Science, University College Dublin, Belfield, Dublin 4, Ireland

*Equal contribution

Corresponding author: Lachlan Mitchell

Lachlan.mitchell@ucd.ie

National Nutrition Surveillance Centre, University College Dublin, Belfield, Dublin 4, Ireland

Running title: Measures to protect older people from COVID-19

Word count: 2873

Abstract word count: 265

Keywords: Coronavirus, COVID-19, nursing homes, transmission

Abstract

Objectives: The global COVID-19 pandemic produced large-scale health and economic complications. Older people and those with comorbidities are particularly vulnerable to this virus, with nursing homes and long term care facilities experiencing significant morbidity and mortality associated with COVID-19 outbreaks. The aim of this rapid systematic review was to investigate measures implemented in long term care facilities to reduce transmission of COVID-19 and their effect on morbidity and mortality of residents, staff, and visitors.

Setting: Long term care facilities.

Participants: Residents, staff and visitors of facilities.

Primary and secondary outcome measures: Databases (PubMed, EMBASE, CINAHL, Cochrane Databases and repositories and MedRXiv pre-published database) were systematically searched from inception to July 27 2020 to identify studies reporting assessment of interventions to reduce transmission of COVID-19 in nursing homes among residents, staff, or visitors. Outcome measures include facility characteristics, morbidity data, case fatalities, and transmission rates. Due to study quality and heterogeneity, no meta-analysis was conducted.

Results: The search yielded 1414 articles, with 38 studies included. Reported interventions include mass testing, use of personal protective equipment, symptom screening, visitor restrictions, hand hygiene and droplet/contact precautions, and resident cohorting. Prevalence rates ranged from 1.2-85.4% in residents and 0.6-62.6% in staff. Mortality rates ranged from 5.3-55.3% in residents.

Conclusions: Novel evidence in this review details the impact of facility size, availability of staff and practices of operating between multiple facilities, and for-profit status of facilities as factors contributing to the size and number of COVID-19 outbreaks. No causative relationships can be determined; however, this review provides evidence of interventions that reduce transmission of COVID-19 in long term care facilities.

Trial registration: The protocol is registered on PROSPERO (CRD42020191569).

Strengths and Limitations of the Study

- Evidence from 38 studies identifies the measures taken to reduce transmission of COVID-19 in long term care facilities.
- No limitations were placed on study type, and all languages were eligible for inclusion.
- Study quality was formally examined using the MMAT tool.
- Due to heterogeneity of included studies, meta-analysis was not able to be performed.

Introduction

Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) is a novel virus, first identified in China in 2019, resulting in the current global pandemic in 2020.[1] The ensuing disease associated with infection from SARS-CoV-2, termed COVID-19, has produced large-scale public health and worldwide economic effects.[2]

The virus spreads between people through close contact and droplet transmission (coughs and sneezes). While most infected people will experience mild flu-like symptoms, others may become seriously ill and die.[3] At-risk groups include older people and those with underlying medical conditions, while men appear to have more susceptibility than women. Symptom severity varies; several individuals remain asymptomatic. Others experience fever, cough, sore throat, general weakness, and fatigue, while more severe respiratory illnesses and infections may result, which can be fatal.[4 5] Deterioration in clinical presentations can occur rapidly, leading to poorer health outcomes. Anosmia and ageusia are reported in evidence from South Korea, China, and Italy in patients with confirmed SARS-CoV-2 infection, in some cases in the absence of other symptoms.[6]

The World Health Organization (WHO) declared the COVID-19 outbreak constituted a Public Health Emergency of International Concern (PHEIC) on January 30, 2020.[5] Two primary goals of action were 1) to accelerate innovative research to help contain the spread and facilitate care for all affected, and 2) to support research priorities globally the learning from the pandemic response for preparedness. Globally, up to March 25, 2021, there are 123 636 852 cases of COVID-19 (following the applied case definitions and testing strategies in the affected countries) including 2 721 891 deaths.[7] Within Europe, over 25 220 376 cases are reported, with 592 929 deaths.[7]

Given the infection and mortality figures noted, preventing and limiting transmission of the SARS-CoV-2 virus is advocated. International and national evidence mandates physical distancing, regular hand hygiene and cough etiquette, and limiting touching eyes, nose or mouth; in addition to regular cleaning of surfaces.[8]

As noted older people are an at-risk group for COVID-19, and throughout the pandemic, the impact on this population has resulted in increased mortality, specifically those living in long term care facilities (LTCF) where a high proportion of outbreaks with increased rates of morbidity and case fatality in residents are recorded.[9] In several EU/EEA countries, LTCF deaths among residents, associated with COVID-19, account for 37% to 66% of all COVID-19-related fatalities.[9] The specific rationale for their increased susceptibility is less clear. Comorbidities including cardiovascular disease and diabetes *may increase the chances of fatal disease, but they alone do not explain why age is an independent risk factor*.[10] Molecular, biological, and immunological changes inform emergent viable hypotheses.[10] The United Nations (UN) (2020) acknowledge that COVID-19 exposes the inequalities in society and the failures expressed in the 2030 Agenda for Sustainable Development. The UN report the disproportionate fatality rates in those aged over 80 years as five times the global average[11] and suggest a need for a more *inclusive, equitable and age-friendly society, anchored in human rights* (p.16).[12]

The aim of this rapid review of the literature was to assess the extent to which measures implemented in LTCF reduced transmission of COVID-19 (SARS-CoV-2) among residents, staff, and visitors, and the effect of these measures on morbidity and mortality outcomes.

Methods

The protocol is registered on PROSPERO (CRD42020191569)[13] and reporting follows PRISMA guidelines.[14] Ethical approval was not required for this systematic review.

Search strategy

Search strategies comprised search terms both for keywords and controlled-vocabulary search terms MESH and EMTREE (see Supplementary Table 1 for full search terms). EMBASE (via OVID), PubMed (via OVID), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Database and Repository, and MedRXiv pre-published databases were searched. No time limits were imposed, and databases were searched up to July 27, 2020. Reference lists of included evidence were checked for further articles.

Eligibility criteria

All study designs (experimental, observational, and qualitative) are included, and no exclusions placed on language. Included studies report an assessment of measures to reduce transmission of COVID-19 (including SARS or MERS) in residents, employees, or visitors of LTCF. To provide as comprehensive a review of the evidence we included any intervention implemented to reduce the transmission of COVID-19 in LTCF, including facility measures, social distancing, use of personal protective equipment, and hand hygiene.

A broad definition of LTCF was adopted for this review noting ECDC guidance[8] including institutions such as nursing homes, skilled nursing facilities, retirement homes, assisted-living facilities, residential care homes or other facilities providing care in a congregated setting for older aged adults.

Primary outcome measures

Primary outcome measures are morbidity data, case fatality rates, and reductions in reported transmission rates.

Secondary outcomes

Secondary outcomes reported are facility characteristics associated with COVID-19 transmission.

Selection of studies and data extraction

Two authors developed search strings (DS & KF); all database searches were completed by one author (DS) (Supplementary Table 1). Following de-duplication, references were uploaded into Covidence management platform (LM), and two authors independently screened all titles and abstracts (LM & KF). Full texts of all potentially eligible studies were independently reviewed by two authors (LM & KF). Disagreements were resolved by discussion with a third author (CK). Data from included studies were independently extracted in duplicate (LM & KF). A data extraction form was developed and modified from documents used previously by authors (KF & CK). Extracted data included study characteristics (title, lead author, year of publication, country, study setting, study

design), description of the intervention, number and characteristics of participants, outcomes, duration of follow-up, sources of funding, peer review status). Study design (required for review of quality) was independently assessed by two authors (LM & KF), with disagreements resolved by a third author (CK).

Assessment of Quality

Two review authors (LM & EL) independently assessed the quality of included studies using Mixed Methods Assessment Tool (MMAT),[15] with disagreements resolved by a third author (KF) and discussed with the lead author (CK) (Supplementary Table 2). The MMAT is used widely and considered a valid indicator of methodological quality using instruments for non-randomised and descriptive studies.

Data synthesis

Meta-analysis was not possible due to heterogeneity in study designs, participants, outcomes, and nature of the interventions and no attempt was made to transform statistical data. The SWiM criteria[16] guide a narrative summary, with data presented in tabular format and subgroup reporting of population groups.

Patient and public involvement

No patients were involved in this study.

Results

We identified 1414 articles, and 131 full-text articles were selected for review. After an evaluation against our inclusion criteria, 38 studies (40 papers) are included in this systematic review (Figure 1).

Study characteristics

Geographically we report evidence from eleven countries; the majority (20 studies) are from USA[17-36] and UK.[37-41] We report evidence from Canada,[42-44] France,[45 46] Hong Kong,[47 48] Belgium,[49] Germany,[50] Ireland,[51] Japan,[52] Korea,[53] and Spain[54] (Table 1).

Infection control measures

Twenty studies report the nature of LTCFs related to outbreaks and transmission of COVID-19 infection (Table 2; [17 24 29 30 32 34 36-40 42-44 46-48 51-53]). Thirty studies (Table 3a; [18-30 33-35 38-44 46-51 54]) report evidence of measures to reduce transmission of COVID-19 in long-term residential care facilities for residents, 25 studies (Table 3b; [18-23 25 27-31 33 35 39 40 43-49 51 54]) report evidence for employee outcomes, and two studies report evidence for visitors (Table 3c; [29 48]).

A variety of infection control measures are described (Tables 1 and 3a-c) including: mass testing/point-prevalence testing (22 studies; [18 20-23 26-31 33-35 39 40 45 46 49-51 54]), use of personal protective equipment (10 studies; [18 19 21 26 29 30 33 46 48 50]), screening of residents, staff, or visitors for symptoms (8 studies; [19-21 24 26 28 30 33]), restrictions on visitor entry (10 studies; [19-21 26 28 30 33 46 50 54]), hand hygiene and contact and droplet precautions (6 studies; [20 24 26 33 46 47]), and cohorting/isolation of residents (11 studies; [20 21 23 26 29 30 33 34 46 48 50]). Thirteen studies examined characteristics of LTCF and their association with COVID-19 infection and risk [17 25 32 36-38 40-44 52 53].

Table 1. Characteristics of studies including infection control measures

Study ID	Country	Study Design	Setting	Population	Intervention/infection control strategy	Outcome groups	Primary outcome measure	Secondary outcome
Abrams et al. (2020)[17]	USA	Cross sectional	Nursing homes	Nursing homes across 30 USA States (n=9395 nursing homes). N=6446 facilities without COVID-19 cases; n=2949 facilities with COVID-19 cases.	Nursing homes characteristics associated with COVID-19 outbreaks	Facilities	Prevalence of COVD-19	Estimates on the relationship of nursing home characteristics and documented COVID-19 cases
Arons et al. (2020)[18]	USA, King County, Washington	Cross sectional cohort	Nursing home facility	Residents N=89 N=76 participated in point-prevalence testing.	PPE (eye protection, gown, gloves, face masks); mass testing.	Residents, staff	COVID-19 prevalence, testing, symptoms, hospitalization, mortality	
Blackman et al. (2020)[19]	USA	Cross sectional	Skilled nursing facility	A 150-bedded skilled nursing facility. Single story building with four units.	Employee and visitor screening on entry; visitor restrictions; review of PPE and infection control in the building; use of heat maps in a facility to track staff and residents' symptoms	Residents, staff	COVID-19 prevalence, testing, mortality	
Borras-Bermejo et al. (2020)[54]	Spain	Cross sectional cohort	Nursing homes	N=69 nursing homes in Barcelona. N=3214 residents and N=2655 staff	Surveillance testing program for COVID- 19 in nursing homes; introduction of restrictions for visitors	Residents, staff	COVID-19 prevalence, testing, symptoms	

Brainard et al. (2020)[37]	England, Norfolk	Retrospective cohort	Care homes	N=248 care homes	Statistical modelling assessing detection of COVID-19 infection relative to PPE availability and impact of staffing by non-care workers	Facilities	Descriptive data and statistical modelling for COVID-19, staffing levels, access to PPE	
Brown et al. (2020)[42]	Canada, Ontario	Retrospective cohort	Nursing homes	N=623 nursing homes. N=78,607 residents	Impact of home crowding on COVID-19 infection and mortality using nursing home crowding index score	Residents, facilities	COVID-19 incidence, modelling mortality	Facility characteristics, overcrowding and transmission
Burton et al. (2020)[40]	Scotland	Cross sectional cohort	Nursing homes	N=189 nursing homes included and data for 109 homes (57.7%) for older people reported, representing 5227 beds (89.5% of total beds in 189 care homes)	Surveillance data to understand the evolution of COVID-19 following outbreaks and care home characteristics in one health board	Facilities, residents	COVID-19 outbreaks, mortality,	Facility characteristics associated with transmission
Dora et al. (2020)[20]	USA, California	Cross sectional	Veterans Affairs Greater Los Angeles Healthcare System	N=3 skilled nursing facilities (n=150 long term beds) N=99 residents (95% male, age range 50 to 100 years) N=136 staff Visitors	Three point-prevalence surveys; visitor restrictions (initially all visitors screened, then no visitors permitted into buildings); staff screening; hand hygiene, droplet, and contact precautions; cohorting	Residents, staff	COVID-19 prevalence, symptoms, mortality	
Dutey-Magni et al. (2020)[39]	UK (England, Scotland, and Northern Ireland)	Cohort	Long term care facilities	N=8713 resident's health records Daily counts of infection in 9339 residents and for 11604 staff across 179 LTCF.	The home testing program introduced for all staff and residents in Four Seasons Healthcare Group (representing 9% of all long-term care beds). All tested at least once.	Residents, staff, and facilities	Cumulative incidence of COVID-19, Kaplan-Meier estimates mortality and symptoms.	

Eckardt et al (2020)[21]	USA, Florida	Cross sectional cohort	Long term care	120-bedded long-term care facility.	PPE; staff and visitor screening; visitor restrictions; distancing of residents; cohorting exposed residents; point-prevalence testing.	Residents, staff	COVID-19 prevalence	
Feaster & Goh (2020)[22]	USA, Pasadena	Cross sectional cohort	Long term care homes	Residents and staff (n=1093) of LTCF (n=9) N=608 residents (age 78 ± 13.3 years; n=332 female) N=485 staff (age 41.8 ± 13.3 years; n=249 female)	Mass surveillance testing	Residents, staff	COVID-19 prevalence, symptoms	
Fisman et al. (2020)[43]	Canada, Ontario	Cohort	Long term care facilities	N=269 total individuals who died of COVID-19 in Ontario to April 11, 2020, and n=83 individuals who died of COVID-19 in Ontario LTCF to April 7, 2020. Denominators not available for long-term care residents approximated as the total number of long-term care facility beds in Ontario (79 498), assuming complete occupancy. Median beds 120 [9 to 543]	Surveillance data analysed to evaluate the risk of death and identification of risk factors for prevention strategies	Residents, staff, facilities	COVID-19–specific mortality incidence rate ratios (IRRs) of long term care residents were calculated with community-living Ontarians older than 69 years as the comparator group.	

Graham et al. (2020)[23]	England	Cross sectional cohort	Four nursing homes in London, England	N=4 nursing homes. N=394 residents (37.6% male, median age 83 years [IQR 15], 75.4% white) N=596 staff.	Mass surveillance testing; isolation of infected residents	Residents, staff	COVID-19 prevalence, symptoms, mortality. Multivariable logistic regression of presenting symptoms in those who had an available test	
Guery et al (2020)[45]	France, Nantes	Cross sectional cohort	Nursing home	N=136 staff (age 39 years [IQR 27-48.5], n=112 female)	Surveillance testing of staff following confirmed index case	Staff	COVID-19 prevalence, symptoms	
Hand et al. (2018)[24]	USA, Louisiana	Cross sectional cohort	Long term care facility	Long term care facility provides services for up to 130 residents: report on 20 resident cases	Outbreak surveillance after 20 cases reported. Adherence to standard droplet precautions for symptomatic residents	Residents, facilities	Prevalence of Coronavirus NL63 symptoms, hospitalizations, mortality	
Harris et al. (2020)[25]	USA, Virginia	Cross sectional cohort	Long term care facility	N=41 of 48 residents (median age 75 years [44-104], 52.1% female (25/48). 60.4% White (29/48)) N=7 staff	Following an outbreak, response developed for the management of residents and the use of telemedicine. Early identification of residents for escalation of care; monitoring and treating patients safe to remain in a facility; care coordination - bidirectional; daily needs assessment related to technology, infection control and staff wellbeing	Residents, staff	COVID-19 prevalence, mortalities, comorbidities, telemedicine consultations	

Heung et al (2006)[47]	Hong Kong	Cross sectional cohort	Residential care home	N=90 residents N=32 staff N=67/90 residents participated; n=7 (10%) aged 65 -75 years, n=32 (48%) 76-85 years, n=28 (42%) >85 years; n=53 (79%) females. Staff 26/32 participated; n=18 (69%) aged 31-50 years, n=8 (31%) >50 years; 85% females; 54% nursing care role, 46% assistance in daily activities.	Surveillance screening in a residential care home with the introduction of infection control precautions: droplet and contact precautions	Resident, staff, facilities	Seroprevalence of SARS-CoV antibodies. Symptoms, transmission, and mortality	
Ho et al. (2004)[48]	Hong Kong	Cross sectional cohort	Nursing home	N=7 residents, staff, visitors in one nursing home (n=4 females aged in their 60s to 90s; n=3 males aged in their 20s to 80s)	Proposed intervention for future management. Community-based outreach teams led by geriatricians, nurses to closely monitor nursing home residents discharged from hospital	Residents, staff, visitors, facilities	Descriptive data on seven cases, the onset of illness, transmission and outcome including mortality	
Hoxha et al. (2020)[49]	Belgium	Cross sectional cohort	Long Term Care Facilities	Reporting for 2074 of 2500 invited facilities; 280,427 COVID-19 tests. 51% residents (N=142,100) and 49% staff (N=138,327)	Mass testing	Residents and staff	COVID-19 prevalence, symptoms, characteristics associated with positive test outcome	
Iritani et al. (2020)[52]	Japan	Cross sectional cohort	Across long term care hospitals/facilities, general medical/welfare facilities, and non-	381 clusters with 3786 infected cases accounting for 23.9% of 15,852 cases	Following government recommendation suspension or restricting temporary use of LTCF in areas where infection prevalent	Facilities	Descriptive data on clusters reported, mortality data	

			medical/welfare facilities					
Kennelly et al. (2020)[51]	Ireland	Cross sectional cohort	Nursing homes	Nursing home residents in three community health organizations in Ireland (N=28 nursing homes). Represents 2043 residents & 2303 beds	Mass surveillance testing; post testing program	Staff, residents, facilities	COVID-19 prevalence, symptoms, clinical outcomes, including mortality.	Characteristics of facilities associated with transmission.
Kim (2020)[53]	Korea (South)	Cross sectional cohort	Nursing home	N=142 nursing home residents N=85 health care workers and caregivers working in one facility	Procedures identified to reduce transmission of COVID-19 following confirmed case in a staff member	Facilities		Data on the preparedness of the facility to reduce transmission.
Kimball et al. (2020)[26]	USA, King County, Washington	Cross sectional cohort	Long-Term Care Skilled Nursing Facility	Nursing home. N=82 residents; 76/82 (92.7%) underwent symptom assessment and testing; three (3.7%) refused testing	Surveillance testing; PPE; hand hygiene; visitor restrictions; staff screening; daily resident symptom assessments; isolation of positive residents	Residents	COVID-19 prevalence and symptoms	
Klein et al (2020)[52]	Germany, Hamburg	Cross sectional	Residential care facility	N=60 resident and report from eight deceased residents.	Mass testing; PPE; resident cohorting; visitor restrictions	Residents	COVID-19 prevalence and symptoms, management	

Lennon et al. (2020)[27]	USA, Massachusetts	Cross sectional cohort	Skilled facilities, nursing homes and assisted living facilities	N=366 skilled nursing facilities N=32,480 residents and staff tested once, and 6.7% tested subsequently. N=16,966 residents (mean age 82 ± 13; 65% female). N=15,514 staff (mean age 45 ± 15; 76% female).	Mass testing and recording of symptoms, comparison of viral levels	Residents, staff	COVID-19 prevalence, symptoms	
Louie et al. (2020)[28]	USA, San Francisco	Cohort	Three skilled nursing facilities and one assisted living facility	N=431 residents and staff tested as part of initial surveillance. Follow up testing of n=303 asymptomatic cases.	Mass surveillance testing; restrictions on visitors & non-essential staff; increased monitoring/screening of people entering/residing in a facility	Residents, staff	COVID-19 prevalence, hospitalizations, fatalities, management	
McMichael et al. (2020) a[29]	USA, King County, Washington	Cross sectional cohort	Skilled Nursing Facility	N=167 N=101 residents (median aged 83 (51-100), n=32 (31.7%) male, n=69 (68.3%) female). N=50 health care personnel (median age 43.5 (21-79), n=12 (24%) males, n=38 (76%) female). N=16 visitors (median age 72.5 (52-88), n=11 (68.7%) male, n=5 (31.2%) females).	Mass surveillance testing; contact tracing; quarantine of exposed persons; isolation of confirmed and suspected cases; on-site enhancement of PPE/infection prevention and control.	Residents, staff, visitors, facilities	COVID-19 prevalence, symptoms, mortality, hospitalizations, management	

Office for National Statistics (2020)[40]	England	Cross sectional cohort	Care homes providing care for older residents and those with dementia only.	N=9081 care homes for people aged 65 years and older - representing 292,301 residents (95% CI 293,168 to 293,434) and 441,498 staff. N=5126 homes participated (56%)	Prevalence of COVID-19 in residents and staff. Factors associated with higher levels of infection.	Residents, staff, facilities	COVID-19 prevalence in residents aged 65 years and older and employees.	
Patel et al. (2020)[30]	USA, Illinois	Cross sectional cohort	Nursing home (150 bedded unit)	N=127 residents. 9% (n=11) single occupancy rooms, 91% (n=116) double occupancy rooms.	Mass surveillance testing; screening of staff and visitors; visitor restrictions; cohorting of residents; PPE	Residents, staff, facilities	COVID-19 prevalence, symptoms, hospitalizations and survival rates, management	
Quicke et al. (2020)[31]	USA, Colorado	Longitudinal cohort	Five skilled nursing facilities	N=454 staff	Weekly surveillance nasopharyngeal swabs tests were collected.	Staff	COVID-19 prevalence and incidence, symptoms and information on genomic epidemiology	
Quigley et al (2020)[32]	USA, 29 States	Cross sectional cohort	Nursing homes	N=56 nursing homes from 29 States: Midwest (30%), West (25%), Northeast (23%), South (22%).	Reported on preparedness for COVID-19, testing, supplies and staffing levels	Facilities		Preparedness of nursing home facilities during COVID-19 to reduce transmission

Roxby et al. (2020)[33]	USA, Seattle, Washington	Cross sectional cohort	Assisted living community older adults	Older aged residents and staff in an assisted living community. N=80 residents (mean age 86 years (range, 69-102); n=62 (77%) female). N=62 staff (mean age 40.0 ± 15; n=42 (68%) female). N=83 private apartments, n=45 independent, n=38 assisted living	Mass testing; resident cohorting/isolation; PPE; staff screening; visitor screening; additional hand hygiene stations.	Residents, staff	COVID-19 prevalence and symptoms	
Sacco et al (2020)[46]	France, Maine-et-Loire	Cross sectional cohort	Nursing home	N=87 residents (age 87.9 ± 7.2; 71% female) N=92 staff (age 38.3 ± 11.7; 89% female)	Mass testing; PPE; visitor restrictions; hand hygiene; resident isolation	Residents, staff, facilities	COVID-19 prevalence and case-fatality rates. Resident's clinical signs and symptoms obtained from retrospective chart audit.	
Sanchez et al (2020)[34]	USA, Detroit	Time series cohort	Skilled Nursing Facilities	N=26 skilled nursing facilities N=2773 residents' tests reported at baseline (median age 72 years [IQR 64-82 years]); n=2218 1st follow up; n=637 2nd follow up	Two point-prevalence surveys; follow up in 12 facilities following PPE guidelines; resident cohorting	Residents, facilities	COVID-19 prevalence, hospitalizations, and deaths pre and post introduction of testing	

Stall (2020)[44]	Canada, Ontario	Retrospective cohort	Nursing homes	N=623 nursing homes (n=75,676 residents); 360/623 (57.7%) for-profit homes, 162/623 (26.0%) non-profit, 101/623 (16.2%) municipal homes. Mean number residents: n=113.2 (for profit); n=119.6 (non-profit); n=101 (municipal).	Impact of profit status at the level of a home rather than a resident. Using data from the Ontario Ministries of Health and Long-Term Care as part of the province's emergency "modelling table."	Facilities, residents, and staff	Descriptive data on outbreaks and mortality rate. Nursing home COVID-19 outbreaks (at least one resident case), COVID-19 outbreak sizes (total number of confirmed resident cases amongst homes with outbreaks), and the total number of COVID-19 resident deaths (amongst homes with outbreaks). Outbreaks in staff reported. Death rates for residents	Facility characteristics including nursing home profit status (for profit, non-profit, or municipal) associated with transmission
Stow (2020)[41]	England	Longitudinal ecological study	Care home units from 46 local authority areas in England.	N=460 care home units N=6,464 residents	Use of National Early Warning Score (NEWS) for identification of at-risk/surveillance to reduce mortality	Residents	Descriptive data NEWS surveillance on reducing mortality. Time-series comparison with Office for National Statistics weekly reported registered deaths of care home residents and COVID-19 was the underlying cause of death, and all other deaths (excluding COVID-19) up to 10/05/2020.	
Telford et al. (2020)[35]	USA State of Georgia (Fulton County and	Cross sectional cohort	Nursing homes	N=28 nursing homes. N=5671 participants; n=2868 (50.6%) residents, n=2803 (49.4%) staff.	Mass surveillance testing of staff and residents	Residents, staff	COVID-19 prevalence, hospitalizations, and deaths.	

	City of Atlanta)							
Unruh et al. (2020)[36]	USA States New Jersey, New York, Connecticut	Case study	Nursing homes with ≥100 beds	N=1162 nursing home facilities	Nursing home characteristics associated with mortality rates	Facilities	Mortality data. Predicted probabilities with Logistic Regression, Independent variables compared on characteristics of facilities	

Study setting is presented as defined in original study. PPE, personal protective equipment; LTCF, long term care facilities; IQR, inter quartile range; NEWS, national early warning score.

Table 2. COVID-19 outcomes related to the nature of long term care facilities.

Study	Facilities	Outcomes
Abrams et al. (2020)[17]	Facilities	Average number of cases was 19.8 (range 1 to 256). New Jersey (88.6%, OR 7.16) and Massachusetts (78.0%, OR 4.36) had a higher number of affected facilities. Probability of having a COVID-19 case: Facility size (relative to small): Large OR=6.52; Medium OR=2.63 Location (relative to rural): Urban OR=3.22 % African American residents (relative to low %): Greater % OR=2.05 Nursing home chain status (relative to non-chain status): Chain status OR=0.89 State were significantly related to the probability of having COVID case Outbreak size associations: Facility size (relative to small facility size): Large= -15.88; medium= -10.8 (percentage point change)

		For-profit status (relative to non-profit status) =1.88 State. Medicaid dependency, ownership, five-star rating, and prior infection violation were not significantly related to COVID-19 cases.
Brainard et al. (2020)[37]	Facilities	Risk of infection: Facility employee numbers (relative to <10 workers): 11-20 non-care workers HR = 6.502 (95%CI 2.614 -16.17); 21-30 non-care workers HR = 9.870 (95% CI 3.224 -30.22); >30 non-care workers HR = 18.927 (95% CI 2.358 -151.90). Predictors of spread and increase in cases per unit after 5th April risk increased 1.0347 (95% CI 1.02-1.05) p < 0.001, reduced availability of PPE for eye protection increased risk 1.6571 (95% CI 1.29-2.13) p < 0.001, PPE for facemasks 1.2602 (95% CI 1.09-1.46) p = 0.002, count of care workers employed 1.0379 (95% CI 1.02-1.05) p < 0.001 count of nurses employed (in bands of 0-10,11-20, 21-30 and 31+) 1.1814 (95% CI 1.13-1.24) p < 0.001.
Brown et al. (2020)[42]	Facilities	Incidence in high crowding index homes was 9.7% versus 4.5% in low crowding index homes (p<0.001), while COVID-19 mortality was 2.7% versus 1.3%. Likelihood of COVID-19 introduction did not differ (31.3% vs 30.2%, p=0.79). After adjustment for a regional nursing home, and resident covariates, the crowding index remained associated with increased risk of infection (RR=1.72, 95% CI: 1.11-2.65) and mortality (RR=1.72, 95% CI: 1.03-2.86). Simulations suggested that converting all 4-bed rooms to 2-bed rooms would have averted 988 (18.9%) infections of COVID-19 and 271 (18.7%) deaths.
Burton et al. (2020)[38]	Facilities	Significant associations between the presence of an outbreak and number of beds (OR per 20-bed increase 3.50), a history of multiple previous outbreaks (OR 3.76), and regulatory risk assessment score (OR high-risk vs low 2.19). However, in the adjusted analysis, only number of beds (OR per 20-bed increase 3.50, 95%CI 2.06 to 5.94 per 20-bed increase).
Dutey-Magni et al. (2020)[39]	Facilities	COVID-19 outbreak recorded in 121 of 179 facilities (67.6%). Large LTCF had greater rates of infection (aHR=1.8 [95% CI: 1.4-2.4] for LTCF with ≥70 beds versus <35 beds. The adjusted hazard ratio for confirmed infection was 2.5 times [95% CI: 1.9-3.3] greater in LTCF with 0·85-1 resident per room versus LTCF with 0.7-0.85 resident per room. A ten-percentage point increase in the bed to staff ratio was associated with a 23% increase in infection (aHR=1·23 [95% CI: 1.17-1.31]).
Fisman et al. (2020)[43]	Facilities	Covid-19 cases higher in for-profit operators 165/361 (45.7%) compared to charitable 18/57 (31.6%).
Hand et al. (2018)[24]	Facilities	Residents noted to share rooms, walk throughout the facility and spent time in shared areas (e.g., gym, dining rooms, and recreational rooms). Because all case-patients had visited the gym at the facility for recreation or physical therapy before becoming ill, environmental cleaning of this area was performed.
Heung et al. (2006)[47]	Facilities	67 of 90 residents participated. 26 of 32 staff participated. 2 residents and one staff member were positive during the outbreak. None of the remaining participants was positive for SARS-CoV antibodies. Residents were aged 65+ years, 79% were female, 93% were ambulant, 90% did activities with others, 79% went out. Review of residents who died: Resident A transferred from the hospital and was chair bound and dependent with care needs. Resident B was chair bound and had not left home or had visitors. She was brought to a shared sitting room during mealtimes. This was only time residents A and B were located near each other. One resident shared a room with patient B and tested positive. Staff C was a domestic worker, and contact was via clinical waste in resident A room. Low seroprevalence attributed to precautionary measures taken in the facility to reduce droplet and prevent contact transmission. Risks noted of SARS via fomites possible.

Ho et al. (2004)[48]	Facilities	3 residents positive for SARS. 1 employee positive for SARS. 3 visitors positive for SARS. The index case was a single resident who was infected during a hospital stay, returned to the LTCF, and the virus spread to another 6 people. Transmission of the virus occurred due to lack of isolation rooms in nursing homes, lack of restricted movement of other patients and relatives, lack of infection control precautions, lack of knowledge among staff.
Iritani et al. (2020)[52]	Facilities	Larger cluster sizes in long term care hospitals/facilities were significantly positively associated with higher morbidity ($\rho = 0.336$, $P = 0.006$) and higher mortality ($\rho = 0.317$, $P = 0.009$). Multivariate logistic regression showed larger cluster size (OR = 1.077, 95% CI: 1.017-1.145) and larger cluster number (OR = 2.019, 95% CI: 1.197-3.404) associated with mortality.
Kennelly et al. (2020)[51]	Facilities	Outbreak recorded in 75.0% (21/28) of facilities – four public and seventeen private. During the study period, 40.1% of residents in 21 nursing homes with outbreaks had a laboratory diagnosis of COVID-19. Correlation between the proportion of symptomatic staff and number of residents with confirmed/suspected COVID-19 (ρ=0.81). No significant correlation between the proportion of asymptomatic staff and number of residents with confirmed/suspected COVID-19 (ρ=0.18 p=0.61).
Kim (2020)[53]	Facilities	After the management of the outbreak, there were no more infected persons. All patients and employees tested negative 14 days from the start of quarantine.
McMichael et al. (2020) a[29]	Facilities	February 28, 2020, four cases COVID-19 identified in County. One person identified as index case from Facility A. Staff roles for confirmed cases reported: therapists, nurses, nurse assistants, health information manager, physician, and case manager. Paper reports that 30 facilities in County had confirmed cases and provides detail on first 9 (Facilities A to I). Facility A shared staff with another facility and two resident transfers from facility A. Surveillance reported inadequate PPE, training, infection control practices, lack of documentation signs and symptoms, working in unfamiliar facilities or sharing staff. On March 10, 2020, the governor of Washington implemented mandatory screening of health care workers and visitor restrictions for all licensed nursing homes and assisted living facilities including screening, testing, policies around visiting, excluding symptomatic staff, close monitoring of residents, testing, training and PPE. Monitoring of staff absences.
Office for National Statistics (2020)[40]	Facilities	For each additional member of infected staff working at the care home, the odds of resident infection increase by 11%, i.e. OR = 1.11 (95% CI: 1.1-1.11). Care homes using bank or agency nurses or carers most or every day more likely to have cases in residents (OR= 1.58, 95% CI: 1.5 - 1.65) compared to those who never use bank or agency staff. Residents in care homes outside of London had a lower chance of infection, except West Midlands (OR = 1.09, 95% CI: 1.0 - 1.17). Homes where staff receive sick pay are less likely to have resident cases (OR= 0.82 to 0.93, 95% CI: 7-18%), compared to homes where no sick leave. For each additional infected resident at a home, the odds of staff infection increase by 4% OR=1.04 (95% CI: 4 - 4%). Care homes using bank or agency staff most or every day OR=1.88 (95% CI: 1.77-2.0) compared to homes not using. Homes where staff regularly work elsewhere (most or every day) increase odds (OR=2.4, 95% CI: 1.92 - 3.0) compared to homes who never work elsewhere. Staff at homes outside London had higher odds of COVID-19 infection.
Patel et al. (2020)[30]	Facilities	First resident unwell March 9, female aged in her 60s with cough and fever. Hospitalized March 11 and tested positive COVID-19 March 13. 14 residents who were positive developed symptoms over 30 day follow up. 21% (n=7) confirmed cases lived in single occupancy rooms. 55% (n=18) were in a double room with another confirmed case, and 24% (n=8) were in a double room with a resident who was negative March 15. Screening visitors and staff for symptoms, restricting visiting hours from March 6. No visitor access from March 12. Universal masking of all staff and residents from March 14. 15th -19th March on-site team implemented assessment of symptoms, resident cohorting. Staff testing positive isolated and return 7 days or after 72 hours of symptoms resolving. Education and training to staff in facility A infection control, PPE, vital signs

Quigley et al. (2020)[32]	Facilities	For-profit = 67.86%, non-profit = 26.79% and government-owned = 5.36%. 37.5% were part of a chain. 54% have COVID-19 plans. All had staff training for COVID-19 and 100% processes to restrict/ limit visitors. 29% conducted COVID-19 simulation training. Communication with local Public Health - 96%, and 68% linked to local hospital referral. 66% reported access to COVID-19 tests - available for all residents and 53% of staff. 72% reported inadequate PPE supplies. 83% expected staff shortages. Solutions for staff included staff volunteer for more shifts (55%), non-clinical staff used (45%). 19% reported they would use agency staff.
Sacco et al. (2020)[46]	Facilities	Restrictions on residents from March 16 - social distancing, remain in single rooms, no communal dining or group activities. No visitors since March 10, individual walks outside only in the presence of one staff member. Mail and packages stored 24 hours before being delivered to residents. Enhanced hygiene and cleaning. Staff had permanent face masks and additional hand hygiene
Sanchez et al. (2020)[34]	Facilities	Of the 12 facilities in the final survey, eight had implemented cohorting in a dedicated COVID-19 unit before 1st follow up. 4 remaining initiating cohorting after receiving results. 4 facilities did not assign dedicated personnel to care for residents with COVID-19 due to staff shortages. Final survey census 80 residents (range 36 to 147). 373 of 1063 (35%) had received positive results 1st follow up.
Stall (2020)[44]	Facilities	Adjusted modelling odds of COVID-19 outbreak associated with for-profit status aOR 1.01 (95% CI: 0.64-1.57), Municipal aOR 0.83 (95% CI: 0.45-1.54). Model 2 + Health Region aOR 2.02 (95% CI: 1.20-3.38) population <10,000 rural aOR 0.27 (95% CI: 0.13-0.58); and model 3 + home characteristics. Number of residents (unit of 50) aOR 1.38 (95% CI: 1.18-1.61), older design aOR 1.55 (95% CI: 1.01-2.38), chain ownership vs single home aOR 1.47 (95% CI: 0.86 to 2.51) and staff (full time equivalent/ bed ratio aOR 1.98 (95% CI: 0.39-9.97). The extent of a COVID-19 outbreak with profit aRR 1.83 (95% CI: 1.18-2.84) vs municipal aRR 0.60 (95% CI: 0.28 -1.30) compared with non-profit. Health Region aRR 1.65 (95% CI: 1.02- 2.67), older design standards aRR (95% CI: 1.27 -2.79), chain ownership aRR 1.84 (95% CI: 1.08-3.15) and staff/ bed ratio a RR 0.73 (95% CI: 0.10-5.35). Deaths accounted for 6.5% of all residents in for-profit homes vs 5.5 % in non-profit vs 1.7% municipal LTCF. For-profit associated with total COVID-19 deaths aRR 1.78, (95% CI: 1.03 - 2.07). Adjusted model increased risk of death with for-profit aRR 0.82, (95% CI: 0.44- 1.54), older design facilities aRR 2.08 (95% CI: 1.28-3.36) and chain ownership aRR 1.89, (95% CI: 1.00- 3.59). Number of active residents was protective aRR 0.81, (95% CI: 0.70 -0.95) / 50 beds.
Unruh et al. (2020)[36]	Facilities	184 nursing homes (15.8%) had 6 or more COVID-19 deaths. Deaths associated with Medicaid patients (quintile 5: 8.6 PP greater probability vs quintile 1). Patients with higher ADL scores (2.6 (95% CI: 1.4-3.8) PP, p<0.001), more total beds (0.1 (95% CI: 0.0 to 0.1) PP, p<0.001), higher occupancy (0.3 (95% CI: 0.1-0.5) PP, p<0.009), for-profit status (4.8 (95% CI: 0.8-8.8) PP, p=0.019). Comparing States: Higher mortality in those with Medicaid (quintile 5: 6.1 (95% CI: 0.0-12.1) PP, p=0.048). Not significant for other States. More direct care hours per patient day associated with lower COVID-19 deaths All States (-4.8 95% CI: -9.4 - -0.03) PP, p<0.04).

OR, odds ratio; HR, hazard ratio; PPE, personal protective equipment; CI, confidence interval; LTCF, long-term care facility; aHR, adjusted hazard ratio; aRR, adjusted relative risk; ADL, activities of daily living; PP, percentage points.

Morbidity and mortality

Morbidity and mortality results from included studies are presented for residents (Table 3a), staff (Table 3b), and visitors (Table 3c). Prevalence of COVID-19 infection was reported in 29 studies, including prevalence in residents (27 studies; [18-30 33-35 39 40 42 44 46-51 54]) and staff (22 studies; [18 20-23 25 27-31 33 35 39 40 45-49 51 54]), with 2 studies reporting absolute case numbers in visitors.[29 48] Prevalence rates ranged from 3.8% in a sample of 2074 LTCF[49] and 1.2% in the third point-prevalence survey at a single facility[21] to 85.4% in a single facility that implemented a telemedicine service to limit transmission.[25] Staff prevalence ranged from 0.6% in a point-prevalence survey in a single facility[21] to 62.6% in a group of nine LTCF.[22] One study reported 16 COVID-19 positive visitor cases,[29] while a study that examined SARS infection following an outbreak in a Hong Kong facility reported three positive visitor cases.[48]

The symptom status (symptomatic/presymptomatic/asymptomatic, typical/atypical symptoms) of participants was reported in 16 studies, with resident and staff symptom status reported in 15 [18-20 22 23 26-28 30 33 34 46 49 51 54] and 13 studies,[20-23 27 28 30 33 45 46 49 51 54] respectively. No studies reported symptom status of visitors. The proportion of COVID-19 positive residents presenting with symptoms ranged from 26.3%[20 27] to 59.8% (a sample of both residents and healthcare workers).[28] Asymptomatic cases in residents were reported in 13 studies,[18 20 22 23 26-28 30 33 46 49 51 54] with proportions of COVID-19 positive residents presenting with no symptoms varying from 2.4%[46] to 75.3%.[49] Among COVID-19 positive staff, the proportion of symptomatic cases ranged from 6.4%[27] to 100%,[33] and asymptomatic cases ranged from 23.6%[51] to 100%.[21 23]

Mortality results were reported in 22 studies, including information on mortality of residents (22 studies; [18-20 23-25 28-30 34 35 38-44 46 48 50 51]), staff (4 studies; [29 35 46 48]), and visitors (2 studies; [29 48]). Mortality rates in COVID-19 positive residents ranged from 5.3%[20] to 55.3%.[39] One study reported a 66.7% death rate in residents who tested positive for the SARS virus.[48] A study examining the mortality risk in Ontario LTCF reported a death rate of 0.1% across all residents.[43] Across the three studies which presented mortality results in COVID-19 positive staff, mortality rates were 0%.[29 35 46] One study presenting mortality rates in a nursing home following a SARS outbreak reported one death of a

member of staff.[48] Mortality rates reported in visitors in two studies was 0%[48] and 6.2%,[29] respectively.

Characteristics of LTCFs on COVID-19 transmission

Numerous facility-specific characteristics were linked with risk of COVID-19 cases (Table 2). These include size of LTCF;[17 38 39 52] staffing levels and/or use of agency care staff;[29 32 37 39 40 44 51] part of larger chain of organisations and/or for profit status;[17 32 36 43 44 51] and related staffing, crowding, or availability of single rooms.[24 30 40 42 44 46-48]

Table 3a. Resident-specific outcomes of strategies implemented in nursing homes

Study	Interventions	Prevalence	Mortality	Other outcomes
Arons et al. (2020)[18]	Mass testing (two point-prevalence surveys) PPE	48/76 (63%) across two surveys, 17/48 typical symptoms, 4/48 atypical symptoms, 3/48 asymptomatic, 24/48 presymptomatic 57/89 through point-prevalence, clinical evaluation, post-mortem	15/57 (26%)	Common symptoms: fever (71%), cough (54%), malaise (42%) Estimated doubling time: 3.4 days (95% CI: 2.5-5.3)
Blackman et al. (2020)[19]	PPE Symptom screening Visitor restrictions	12 positive cases, 2 awaiting results, 47 symptomatic residents	3 COVID-19 related deaths	
Borras-Bermejo et al (2020)[54]	Mass testing Visitor restrictions	768/3214 (23.9%), 486 (69.5% of those with symptom information) were asymptomatic		2624 of all residents reported symptoms in the previous 14 days
Brown et al. (2020)[42]	Facility characteristics	5218/78607 (6.6%)	1452/5218 (27.8%)	
Burton et al. (2020)[38]	Facility characteristics		403 deaths recorded in care homes	472 excess deaths in care homes with an outbreak (399 COVID-19 related)
Dora et al. (2020)[20]	Mass testing (three point-prevalence surveys) Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	19/96 (19.8%) across three surveys, 5/19 symptomatic, 8/19 presymptomatic, 6/19 asymptomatic	1/19 (5.3%)	Symptoms: fever (58%), myalgia (58%), cough (47%), dyspnoea (32%), nausea (32%) Oxygen therapy required for 4/8 presymptomatic, 4/5 symptomatic cases
Dutey-Magni et al. (2020)[39]	Mass testing	951/9339 (10.2%)	526/951 (55.3%)	2075/9339 (22.2%) experienced infection symptoms
Eckardt et al. (2020)[21]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Cohorting	Survey 1: 5/105 (4.8%) Survey 2: 4/86 (4.7%) Survey 3: 1/85 (1.2%)		
Feaster & Goh (2020)[22]	Mass testing	408/582 (49.5%), 202/408 (49.5%) symptomatic		

		237/332 (71.4%) female residents positive, 121/237 (51.1%) asymptomatic 171/250 (68.4%) male residents positive, 81/171 (47.4%) asymptomatic		
Fisman et al. (2020)[43]	Facility characteristics		83/79498 (0.1%)	IRR (COVID-19 related death in LTCF residents) = 13.1 (95% CI: 9.9-17.3) compared with community-living adults older than 69 years
Graham et al (2020)[23]	Mass testing (two point-prevalence surveys) Cohorting	Survey 1: 126/313 (40%), 72/126 (57.1%) symptomatic, 50 typical symptoms, 22 atypical symptoms, 54/126 (42.9%) asymptomatic Survey 2: 5/176 (2.8%)	53/131 (40.4%)	Increased risk of death: men (48% of deaths vs. 34% in those who survived; whole group 38% male, p=0.02); the trend for median age to be greater among those who died (p = 0.058) Increased odds of COVID-19 positive: new onset anorexia (OR = 3.74, 95% CI: 1.5-9.8); cough and/or shortness of breath (OR = 3.72, 95% CI: 1.8-7.8); fever, altered mental state/behaviour, diarrhoea not associated with positive test
Hand et al. (2018)[24]	Symptom screening Hand hygiene, contact precautions	20/130 residents suspected cases, 13/20 tested 7/13 (54%) tested positive; 6/7 required hospitalization	3/7 (42.9%)	No new cases identified after November 18 2017
Harris et al. (2020)[25]	Facility characteristics	41/48 (85.4%) 18/48 residents hospitalised, 11/18 returned to facility from hospital	6/48 (12.5%)	13/48 (27.1%) of residents received telemedicine consultations
Heung et al. (2006)[47]	Hand hygiene, contact precautions	2 residents were positive during the outbreak, 0/67 residents positive for SARS-CoV antibodies upon screening		2/67 reported symptoms
Ho et al. (2004)[48]	PPE Cohorting	3 residents positive	2/3 (66.7%)	
Hoxha et al. (2020)[49]	Mass testing	5390/142100 (3.8%), 4059/5390 (75.3%) asymptomatic		Infection odds: Women compared to men OR = 1.2 (95% CI: 1.1-1.2); symptomatic compared to

				asymptomatic OR = 8.5 (95% CI: 8.0-9.0)
Kennelly et al. (2020)[51]	Mass testing Facility characteristics	710/1741 (40.1%), 54/1741 (3.1%) residents were suspected COVID-19, 193/710 (27.2%) asymptomatic, 396/710 (55.8%) had recovered by the completion of surveillance period	183/710 (25.8%)	Non-COVID-19 mortality rate similar between outbreak and non-outbreak NHS (5.1% vs. 4%, p=0.4)
Kimball et al. (2020)[32]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	23/76 (30.3%), 10/23 symptomatic (8/10 typical symptoms, 2/10 atypical symptoms), 3/23 asymptomatic, 10/23 presymptomatic		Symptoms: fever (61.5%), malaise (46.2%), cough (38.5), Presymptomatic mean interval from testing to symptom onset was 3 days
Klein et al. (2020)[50]	Mass testing PPE Visitor restrictions Cohorting	39/60 (65%)	8/39 (20.5%)	Symptoms: exhaustion, loss of appetite, dysphagia, fever, cough, colds, diarrhoea
Lennon et al. (2020)[27]	Mass testing	2654/16966 (15.5%), 1692/2654 (63.8%) asymptomatic, 699/2654 (26.3%) symptomatic, (263/2654 symptom data missing)		
Louie et al. (2020)[28]	Mass testing Symptom screening Visitor restrictions	214/431 (49.7%) residents and healthcare workers, 128/214 (59.8%) symptomatic (78/128 were residents), 86/214 (40.2%) asymptomatic Additional 156 asymptomatic residents subsequently tested: 63/156 COVID-19 positive	12/78 (15.4%) symptomatic residents died	22/78 (28.2%) symptomatic residents hospitalized
McMichael et al. (2020)a[29]	Mass testing PPE Cohorting	101/118 (58.6%)	34/101 (33.7%)	55/101 (54.5%) hospitalized; (37/101 no data on hospitalisation status)
Office for National Statistics (2020)[40]	Mass testing Facility characteristics	19.9% (95% CI: 18.5-21.3) in homes with a confirmed outbreak 10.7% (95% CI: 10.1-11.3) in all homes	15606 across all homes	Odds of resident infection: Each additional infected staff member at a home OR = 1.11 (95% CI: 1.0-1.17) Homes using bank or agency nurses most or all days OR = 1.58

				(95% CI: 1.5-1.65) compared with homes never using these staff Homes outside of London had lower infection chance, except West Midlands (OR = 1.09, 95% CI: 1.0-1.17) Homes where staff receive sick pay OR = 0.82-0.93 (95% CI: unknown)
Patel et al. (2020)[30]	Mass testing Symptom screening Visitor restrictions Cohorting	33/118 (28.0%), 19/33 (58%) symptomatic (8 typical symptoms, 4 atypical symptoms, 10 both typical and atypical symptoms); 1/33 (3%) presymptomatic, 13/33 (39%) asymptomatic	10/35 (28.6%) (5/10 symptomatic) 30-day survival = 71% (95% CI 52-83)	1/91 negative residents reported symptoms 35/90 negative asymptomatic residents developed symptoms during 30-day surveillance, 2/35 COVID-19 positive upon re-testing 13/35 COVID-19 residents hospitalized
Roxby et al. (2020)[33]	Mass testing Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	Survey 1: 3/80 (3.8%), 1/3 reported resolved cough and loose stool during the preceding 14 days Survey 2: 1/77 (1.3%)		All residents clinically stable 14 days after second test 21 days after the test, all cases continued their usual state of health
Sacco et al. (2020)[46]	Mass testing PPE Visitor restrictions Hand hygiene, contact precautions Cohorting	41/87 (47.1%) 3/41 asymptomatic	11/41 (27%) All-cause mortality: 13% (95% CI 7.2-21.2), compared to 3% for the same period during the previous 5 years	Incidence rate for residents = 1.54 per 100 person-days 14/87 (16.1%) residents hospitalized
Sanchez et al (2020)[34]	Mass testing (two point-prevalence surveys) Cohorting	Survey 1: 716/2218 (32.3%), 344/716 (48%) symptomatic Survey 2: 115/637 (18.1%), 5/115 (4%) symptomatic Total surveillance period: 1207/2773 (44%)	287/2773 (24%)	446/2773 (37%) hospitalised
Stall et al. (2020)[44]	Facility characteristics	5218/75676 (6.9%) 3599/5218 (69.0%) for-profit home residents	1452/5218 (27.8%)	

		1239/5218 (23.7%) non-profit home residents 380/5218 (7.3%) municipal home residents	989/3599 (27.5%) for-profit home 368/1239 (29.7%) non-profit home 95/380 (25.0%) municipal home	
Stow et al. (2020)[41]	Facility characteristics		1532 COVID-19 related deaths	Highest correlation of increased NEWS and deaths observed for a two-week lag (r=0.82, p<0.05) Above baseline measures of high respiratory rate (r=0.73, p<0.05 for a two-week lag) and low oxygen saturation (r=0.8, p<0.05 for a two-week lag) appear to follow the pattern of COVID-19 and non-COVID-19 deaths
Telford et al (2020)[35]	Mass testing (15 facilities in response to outbreak, 13 facilities as prevention)	821/2868 (28.6%) Response group: 804/1703 (47.2%) Preventive group: 17/1133 (1.5%), (p<0.0001)	Response group: 131/804 (16.3%) Preventive group: 3/17 (17.6%)	Response group: 171/804 (21.3%) residents hospitalised Preventive group: 5/17 (29.4%) residents hospitalised

PPE, personal protective equipment; CI, confidence interval; IRR, incidence risk ratio; LTCF, long-term care facility; OR, odds ratio; NEWS, national early warning score.

Table 3b. Staff-specific outcomes of strategies to reduce transmission

Study	Interventions	Prevalence	Mortality	Other outcomes
Arons et al. (2020)[18]	Mass testing PPE	26/51 (51.0%) 17/26 (65%) were nursing staff, 9/26 (35%) had roles that provided care/therapies across multiple units		0/26 hospitalized
Blackman et al. (2020)[19]	PPE Symptom screening Visitor restrictions			26 staff members absent from work due to sickness
Borras-Bermejo et al (2020)[54]	Mass testing Visitor restrictions	403/2655 (15.2%), 144/403 (35.7%) asymptomatic		1772/2665 (66.7%) staff reported fever or respiratory symptoms in the preceding 14 days

Dora et al. (2020)[20]	Mass testing (three point-prevalence surveys) Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	8/136 (6%) 4/8 (50%) asymptomatic 3/8 nursing staff 5/8 licensed vocational nurses		
Dutey-Magni et al. (2020)[39]	Mass testing	585/11604 (5.0%)		1892/11604 (16.3%) reported symptoms
Eckardt et al. (2020)[21]	Mass testing (three point-prevalence surveys) PPE Symptom screening Visitor restrictions Cohorting	Survey 1: 10/176 (5.7%), 10/10 (100%) asymptomatic Survey 2: 5/175 (2.9%), 5/5 (100%) asymptomatic Survey 3: 1/173 (0.6%), 1/1 (100%) asymptomatic		
Feaster & Goh (2020)[22]	Mass testing	223/356 (62.6%), 55/223 (24.7%) asymptomatic		Infection prevalence higher in staff with direct resident contact (150/219, 68.5%) compared with staff with no direct resident contact (25/52, 48.1%)
Fisman et al. (2020)[43]	Facility characteristics			Infection among LTCF staff was associated with death among residents with a 6-day lag (adjusted IRR for death per infected staff member, 1.17; 95% CI: 1.11-1.26) and a 2-day lag (relative increase in risk of death per staff member with infection, 1.20; 95% CI: 1.14-1.26)
Graham et al. (2020)[23]	Mass testing (two point-prevalence surveys) Cohorting	3/70 (4.3%) 3/3 (100%) asymptomatic		Staff absence due to sickness/self-isolation between March 1 and May 1 elevated relative to background level (215.9% increase, 95% CI: 80-352)
Guery et al. (2020)[45]	Mass testing	3/136 (2.2%) 1/3 (33.3%) asymptomatic		

		1/3 (33.3%) presymptomatic 1/3 (33.3%) symptomatic		
Harris et al. (2020)[26]	Facility characteristics	7 staff COVID-19 positive prior to intervention 0 further staff positive after intervention implemented		
Heung et al. (2006)[47]	Hand hygiene, contact precautions	1 staff member SARS-CoV positive during outbreak (a domestic worker) 0/26 staff positive for SARS-CoV antibodies		
Ho et al. (2004)[48]	PPE Cohorting	1 staff member SARS positive	1/1 (100%)	
Hoxha et al. (2020)[49]	Mass testing	2953/138327 (2.1%) 2185/2953 (74.0%) asymptomatic		
Kennelly et al. (2020)[51]	Mass testing Facility characteristics	675 staff COVID-19 positive 159/675 (23.6%) asymptomatic		Proportion of symptomatic staff correlated with number of residents with confirmed/suspected COVID-19, $\rho = 0.81$ ($p<0.001$)
Lennon et al. (2020)[27]	Mass testing	624/15514 (4.1%) 487/624 (78.0%) asymptomatic 40/624 (6.4%) symptomatic		
Louie et al. (2020)[28]	Mass testing Symptom screening Visitor restrictions	214/431 (49.7%) residents and staff COVID-19 positive 86/214 asymptomatic 128/214 symptomatic (50/128 were health care workers) Additional asymptomatic staff testing: 23/147 (15.6%) staff COVID-19 positive		0/50 symptomatic health care workers hospitalized
McMichael et al. (2020)a[29]	Mass testing PPE Cohorting	50 staff COVID-19 positive	0/50 (0%)	3/50 (6%) hospitalised Staff roles for confirmed cases: therapists, nurses, nurse assistants, health information manager, physician, case manager
Office for National Statistics (2020)[40]	Mass testing Facility characteristics	Estimated 6.9% (95% CI 5.9-7.9%) staff COVID-19 positive across homes that reported an outbreak		Odds of staff infection: for each additional infected resident, staff infection OR = 1.04 (95% CI: 1.04-1.04) Care homes using bank or agency staff most or every day OR = 1.88

				(95% CI: 1.77-2.0) compared to homes not using these staff Homes where staff work in other homes most or every day OR = 2.4 (95% CI: 1.92-3.0) compared to homes where staff never work elsewhere Staff at homes outside London had higher odds of COVID-19 infection
Patel et al. (2020)[30]	Mass testing Symptom screening Visitor restrictions Cohorting	19/42 (45.2%) 11/19 symptomatic (57.9%) 8/19 (42.1%) asymptomatic		
Quicke et al. (2020)[31]	Mass testing (five point-prevalence surveys)	Site A: all staff uninfected Site B: low prevalence in week 1, weeks 2-5 no infections detected, week 6 increase in cases Site C: initial infection prevalence was lower (6.9%), and the incidence declined to zero by week 3 Site D: 22.5% of workers at site D had prevalent infections at the start of the study and incidence was high initially (12.2 per 100 workers per week), declining over time Site E: low prevalence in week 1 saw an increase in cases in subsequent weeks		
Roxby et al. (2020)[33]	Mass testing Symptom screening Visitor restrictions Hand hygiene, contact precautions Cohorting	2/62 (3.2%) (1 worked in dining facilities, 1 was a health aide) 2/2 (100%) symptomatic		
Sacco et al (2020)[46]	Mass testing PPE Visitor restrictions Hand hygiene, contact precautions Cohorting	22 staff COVID-19 positive 9/22 (40.1%) asymptomatic	0/22 (0%)	Staff incidence: Care givers = 0.48/100 person-days Non-care givers with resident contact = 0.36/100 person-days Non-care givers with no resident contact = 0.04/100 person-days

Stall (2020)[44]	Facility characteristics			Outbreak involving staff and residents' for-profit homes 59/360 and staff only 44/360 Non-profit homes staff only 18/ 162. Municipal homes = outbreak staff only 16/101
Telford et al (2020)[35]	Mass testing (15 facilities in response to outbreak, 13 facilities as prevention)	264/2803 (9.4%) Response group: 249/264 (94.3%) Preventive group: 15/264 (5.7%) (d) Prevalence: Response group 12.8% vs Preventive group 1.7%, p<0.0001	1/264 (0.4%) Response group: 0/249 (0%) Preventive group: 1/15 (6.7%)	16/264 (6.1%) hospitalised Response group: 15/249 (6.0%) hospitalised Preventive group: 1/15 (6.7%) hospitalised15/249

LTCF, long-term care facility; IRR, incidence risk ratio; CI, confidence interval.

Table 3c. Visitor-specific outcomes following the implementation of strategies

Study	Interventions	Prevalence	Mortality	Other outcomes
Ho et al. (2004)[48]	PPE Cohorting	3 visitors SARS positive	0/3 (0%)	
McMichael et al (2020)a[29]	Mass testing PPE Cohorting	16 visitors COVID-19 positive	1/16 (6.2%)	8/16 (50%) hospitalized Underlying conditions: hypertension (2/8, 12.5%); cardiac disease (3/8, 18.8%); renal disease (2/8, 12.5%); obesity (3/8, 18.8%), pulmonary disease (2/8, 12.5%)

PPE, personal protective equipment

Quality review

The quality ratings of included studies are presented in Supplementary Table 2. Overall quality of evidence in this review is considered low based on MMAT assessment criteria.

Discussion

Evidence in this review indicates the impact of COVID-19 on LTCF, demonstrating the vulnerability of this setting in 11 countries. A novel outcome highlights the characteristics of LTCF associated with COVID-19 outbreaks, in addition to reporting the prevalence rates of COVID-19 and associated mortality and morbidity for residents, staff, and visitors. A variety of measures were implemented in LTCF, of which many were instigated locally by facility managers, and others through agile public health policy. Due to the rapid nature of introducing public health measures though, the evidence base does not facilitate an evaluation of the effects of these measures individually. Mass testing of residents with or without staff testing was the primary measure used to reduce transmission of COVID-19. This provides objective evidence of infection rates in facilities, and enables application of subsequent measures, including isolation of residents who are infected with re-designation of specific staff to care for them. Repeated point-prevalence testing allows facilities to grasp the spread of the virus along with the impact of their mitigation strategies.

Further measures implemented in facilities echoed public health recommendations to the broader community to limit the spread of the virus. These included guidance on hand hygiene, contact and droplet precautions, and restricting staff, including agency workers, to working in only one facility.[55] Restricting visitor access to facilities was implemented generally to reduce the likelihood of introducing COVID-19 into LTCF, assessing body temperature and symptom screening of staff and visitors on entry.

The prevalence of COVID-19 infection varied throughout included studies, with no distinct pattern emerging between prevention strategies and infection prevalence. Similarly, the mortality rate varied widely among studies and prevention measures. However, patterns emerged regarding associations between facility characteristics and the risk of a COVID-19 outbreak and spread. Sepulveda (2020)

reports the disproportionately higher risk of contracting COVID-19 for residents of LTCF, calculating a 12-country average mortality rate of 2772 per 100, 000 LTCF residents compared to 122 per 100, 000 for community dwelling older persons.[56] This represented an average 24.2 fold higher rate of death (range 14.2 (Germany) to 73.7 (Canada)). Higher LTCF mortality rates in Canada (78.4% compared to the OECD 12 country average of 43.7%) are explained by poorer services in care facilities and includes limited staffing and funding.[56]

Evidence identified the facility size/number of beds was significantly associated with the probability of having a COVID-19 case, and the resulting size of an outbreak. For example, in a sample of 30 US nursing homes, the probability of having a COVID -19 case was increased in medium and large facilities compared with small facilities,[17] while in 121 UK homes reporting an outbreak, facilities with ≥70 beds had 80% greater infection rates than facilities with <35 beds.[39] A sample of 623 Canadian nursing homes demonstrated facilities with a high crowding index had more infections and deaths than those with a low crowding index. Simulations conducted suggested nearly 20% of infections and deaths may have been averted by converting all 4-bed rooms into 2-bed rooms.[42] Similarly, facilities with a greater number of employees, staff who work in multiple facilities, and an increased number of infected staff, were also more likely to experience a COVID -19 outbreak.[37 40 51] However, facilities where staff receive sick leave were shown to be less likely to have positive cases.[40] Reduced availability of PPE predicted the spread and increase in case number in facilities,[37] while for-profit status of facilities was commonly identified as increasing the odds of case outbreaks relative to non-profit status.[17 32 36 43 44]

Rapid development of COVID-19 vaccines was recognised in early March 2020.[57] Lurie et al. (2020) note previous success in the development of H1N1 vaccination, and similarly the challenges for SARS, Ebola, and Zika vaccines.[57] The speed of developments is acknowledged, and Public Health England (2021) report that at the end of February 2021 up to 5900 deaths were averted in people aged 80 years and older, with over 200 deaths prevented in those aged 7- to 79 years.[58] Montano (2021) advises that an accelerated pace of vaccine developments may not lead to total eradication of the virus, citing smallpox as the only virus that has been eliminated worldwide.[59] Given this, the

transmission reduction measures highlighted in the present review are of crucial importance for the continued management of COVID-19 in LTCF.

Quality review

The quality of evidence in this review is technically low, primarily reported from observational studies, expert opinion, reporting of outbreaks and describing the process and management (Supplementary Table 2). Factors associated with lower quality of evidence include the reliance on self-reporting of symptoms, recall bias, use of datasets which may be incomplete, and use of convenience sampling. However, confirmation of COVID-19 in the majority of studies was via laboratory testing. We did not remove any study following our review of quality and the evidence is consistent with real-time reporting of data to learn from outbreaks. Papers included from MEDRXIV pre publishing repository are acknowledged; however, as papers were subsequently published in peer review journals we reviewed accordingly. The Institute of Medicine (2004)[60] advocates for early detection of epidemics, effective communication to the public, and promotion of research and development for strategic planning.

Limitations in the review process

A key strength of this review is that it addresses a knowledge gap and has collated evidence from a broad methodological base to report the measures to reduce transmission of COVID-19 in LTFC and reports characteristics of facilities.

Due to the heterogeneity of included studies, meta-analysis was not performed, while the descriptive nature of studies prevents identification of a causative relationship between measures and outcomes. We acknowledge that while a summary of facility characteristics and COVID-19 outcomes are presented, insufficient evidence is available to statistically evaluate and summarise the relationship between individual measures to prevent COVID-19 transmission and thus further research studies are required to elucidate this. Despite this, the systematic approach to this review has identified the scope of interventions implemented in LTFC to reduce COVID -19 transmission.

Publication bias was minimized with inclusion of pre-published evidence, follow up contacts with authors for early reporting, and through the inclusion of observational study designs. Most studies reported are in English, we translated papers from German and Spanish as part of the assessment and review. Outbreak reports include convenience samples or smaller cohorts of residents in LTCF with limited data reported in brief reports and letters. However, real-time reporting of outbreaks provides immediate evidence and shared understanding advocated by the Institute of Medicine.[60]

Evidence in this review builds on publications from Salcher-Konrad, et al. [61], a report from WHO,[62] and an Irish Expert Panel review,[55] furthermore, data on the role of facilities in the transmission of COVID-19 are presented.

Conclusion

This novel, rapid review summarises the evidence base to date identifying specific factors for consideration as part of preparedness plans to reduce transmission of COVID-19 outbreaks in LTCF. Future research should incorporate methodologically robust study designs with longer follow up to assess the impact on reducing transmission.

Funding

Authors declare no funds were provided for the production of this review.

Author Contributions

CK, KF, and LM designed the study; KF and DS developed the search strategy; DS conducted the literature search; KF and LM screened titles and full texts to select studies, and extracted data; LM, EL, KF, and CK conducted quality ratings; KF, LM, DS, EL, EC, CK interpreted and synthesised data; KF, LM, DS, EL, EC, CK were involved in writing. All authors have approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest. CK was a member of an expert panel investigating COVID-19 in nursing homes in Ireland.

Data availability

No additional data available.

Ethics statement

No ethical approval was required for this study.

References

1. European Centre for Disease Prevention and Control (ECDC). Timeline of ECDC's response to COVID-19 2020 [cited 2020 4th October]. Available from: https://www.ecdc.europa.eu/en/covid-19/timeline-ecdc-response accessed 4th October 2020.
2. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report – 94, 2020.
3. Nussbaumer-Streit B, Mayr V, Dobrescu AI, et al. Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. *The Cochrane database of systematic reviews* 2020;4(4):Cd013574. doi: 10.1002/14651858.cd013574 [published Online First: 2020/04/09]
4. European Centre for Disease Prevention and Control (ECDC). Risk assessment: Outbreak of acute respiratory syndrome associated with a novel coronavirus, Wuhan, China. Stockholm: ECDC; 2020 [updated 22 January 2020 Available from: https://www.ecdc.europa.eu/en/publications-data/rapid-risk-assessment-cluster-pneumonia-cases-caused-novel-coronavirus-wuhan2020.
5. World Health Organization. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). Geneva: WHO; 2020 [Available from: https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov).
6. Meng X, Deng Y, Dai Z, et al. COVID-19 and anosmia: A review based on up-to-date knowledge. *Am J Otolaryngol* 2020;41(5):102581-81. doi: 10.1016/j.amjoto.2020.102581 [published Online First: 06/02]
7. European Centre for Disease Prevention and Control (ECDC). COVID-19 situation update worldwide, as of week 12, updated 1 April 2021 2021 [Available from:

https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases accessed 8th April 2021.

8. European Centre for Disease Prevention and Control (ECDC). Surveillance of COVID-19 at longterm care facilities in the EU/EEA. Technical Report, 2020.

9. ECDC Public Health Emergency Team, Danis K, Fonteneau L, et al. High impact of COVID-19 in long-term care facilities, suggestion for monitoring in the EU/EEA, May 2020. *Euro Surveill* 2020;25(22):2000956. doi: 10.2807/1560-7917.ES.2020.25.22.2000956

10. Mueller AL, McNamara MS, Sinclair DA. Why does COVID-19 disproportionately affect older people? *Aging* 2020;12(10):9959-81. doi: 10.18632/aging.103344 [published Online First: 2020/05/30]

11. United Nations. Policy Brief: The Impact of COVID-19 on older persons, 2020.

12. World Health Organization. Policy Brief: The Impact of COVID-19 on older persons, 2020.

13. Frazer K, Mitchell L, Stokes D, et al. Systematic review of measures to protect older people in long term care facilities from COVID 19. *PROSPERO: International prospective register of systematic reviews* 2020;CRD42020191569

14. Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Medicine* 2009;6(7):e1000097. doi: 10.1371/journal.pmed.1000097

15. Hong QN, Fàbregues S, Bartlett G, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information* 2018;34:285-91. doi: 10.3233/EFI-180221

16. Campbell M, McKenzie JE, Sowden A, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. *BMJ* 2020;368:l6890. doi: 10.1136/bmj.l6890

17. Abrams HR, Loomer L, Gandhi A, et al. Characteristics of U.S. Nursing Homes with COVID-19 Cases. *Journal of the American Geriatrics Society* 2020 doi: 10.1111/jgs.16661

18. Arons MM, Hatfield KM, Reddy SC, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. *New England Journal of Medicine* 2020;382(22):2081-90. doi: 10.1056/NEJMoa2008457

19. Blackman C, Farber S, Feifer RA, et al. An Illustration of SARS-CoV-2 Dissemination Within a Skilled Nursing Facility Using Heat Maps. *Journal of the American Geriatrics Society* 2020;68(10):2174-78. doi: 10.1111/jgs.16642

20. Dora AV, Winnett A, Jatt LP, et al. Universal and Serial Laboratory Testing for SARS-CoV-2 at a Long-Term Care Skilled Nursing Facility for Veterans - Los Angeles, California, 2020. *MMWR Morbidity and mortality weekly report* 2020;69(21):651-55. doi: 10.15585/mmwr.mm6921e1

21. Eckardt P, Guran R, Hennemyre J, et al. Hospital affiliated long term care facility COVID-19 containment strategy by using prevalence testing and infection control best practices. *American Journal of Infection Control* 2020 doi: https://doi.org/10.1016/j.ajic.2020.06.215

22. Feaster M, Goh Y-Y. High Proportion of Asymptomatic SARS-CoV-2 Infections in 9 Long-Term Care Facilities, Pasadena, California, USA, April 2020. *Emerging Infectious Disease journal* 2020;26(10):2416. doi: 10.3201/eid2610.202694

23. Graham N, Junghans C, Downes R, et al. SARS-CoV-2 infection, clinical features and outcome of COVID-19 in United Kingdom nursing homes. *J Infect* 2020 doi: 10.1016/j.jinf.2020.05.073 [published Online First: 2020/06/07]

24. Hand J, Rose EB, Salinas A, et al. Severe Respiratory Illness Outbreak Associated with Human Coronavirus NL63 in a Long-Term Care Facility. *Emerg Infect Dis* 2018;24(10):1964-66. doi: 10.3201/eid2410.180862 [published Online First: 2018/09/19]

25. Harris DA, Archbald-Pannone L, Kaur J, et al. Rapid Telehealth-Centered Response to COVID-19 Outbreaks in Postacute and Long-Term Care Facilities. *Telemedicine and e-Health* 2020;0(0):null. doi: 10.1089/tmj.2020.0236

26. Kimball A, Hatfield KM, Arons M, et al. Asymptomatic and Presymptomatic SARS-CoV-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility - King County, Washington, March 2020. *MMWR Morbidity and mortality weekly report* 2020;69(13):377-81. doi: 10.15585/mmwr.mm6913e1

27. Lennon NJ, Bhattacharyya RP, Mina MJ, et al. Comparison of viral levels in individuals with or without symptoms at time of COVID-19 testing among 32,480 residents and staff of nursing homes and assisted living facilities in Massachusetts. *medRxiv* 2020:2020.07.20.20157792. doi: 10.1101/2020.07.20.20157792

28. Louie JK, Scott HM, DuBois A, et al. Lessons from Mass-Testing for COVID-19 in Long Term Care Facilities for the Elderly in San Francisco. *Clinical Infectious Diseases* 2020 doi: 10.1093/cid/ciaa1020

29. McMichael TM, Currie DW, Clark S, et al. Epidemiology of covid-19 in a long-term care facility in King County, Washington. *New England Journal of Medicine* 2020;382(21):2008-11. doi: 10.1056/NEJMoa2005412

30. Patel MC, Chaisson LH, Borgetti S, et al. Asymptomatic SARS-CoV-2 Infection and COVID-19 Mortality During an Outbreak Investigation in a Skilled Nursing Facility. *Clinical Infectious Diseases* 2020 doi: 10.1093/cid/ciaa763

31. Quicke K, Gallichote E, Sexton N, et al. Longitudinal Surveillance for SARS-CoV-2 RNA Among Asymptomatic Staff in Five Colorado Skilled Nursing Facilities: Epidemiologic, Virologic and Sequence Analysis. *medRxiv* 2020:2020.06.08.20125989. doi: 10.1101/2020.06.08.20125989

32. Quigley DD, Dick A, Agarwal M, et al. COVID-19 Preparedness in Nursing Homes in the Midst of the Pandemic. *Journal of the American Geriatrics Society* 2020;68(6):1164-66. doi: 10.1111/jgs.16520

33. Roxby AC, Greninger AL, Hatfield KM, et al. Outbreak Investigation of COVID-19 among Residents and Staff of an Independent and Assisted Living Community for Older Adults in Seattle, Washington. *JAMA Internal Medicine* 2020 doi: 10.1001/jamainternmed.2020.2233

34. Sanchez GV, Biedron C, Fink LR, et al. Initial and Repeated Point Prevalence Surveys to Inform SARS-CoV-2 Infection Prevention in 26 Skilled Nursing Facilities — Detroit, Michigan, March–May 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:882-86. doi: http://dx.doi.org/10.15585/mmwr.mm6927e1external

35. Telford CT, Onwubiko U, Holland D, et al. Mass Screening for SARS-CoV-2 Infection among Residents and Staff in Twenty-eight Long-term Care Facilities in Fulton County, Georgia. *medRxiv* 2020:2020.07.01.20144162. doi: 10.1101/2020.07.01.20144162

36. Unruh MA, Yun H, Zhang Y, et al. Nursing Home Characteristics Associated With COVID-19 Deaths in Connecticut, New Jersey, and New York. *Journal of the American Medical Directors Association* 2020;21(7):1001-03. doi: https://doi.org/10.1016/j.jamda.2020.06.019

37. Brainard JS, Rushton S, Winters T, et al. Introduction to and spread of COVID-19 in care homes in Norfolk, UK. *Journal of Public Health* 2020;fdaa218 doi: 10.1093/pubmed/fdaa218

38. Burton JK, Bayne G, Evans C, et al. Evolution and impact of COVID-19 outbreaks in care homes: population analysis in 189 care homes in one geographic region of the UK. *Lancet Healthy Longevity* 2020;1(1):e21-31. doi: 10.1016/S2666-7568(20)30012-X

39. Dutey-Magni PF, Williams H, Jhass A, et al. Covid-19 infection and attributable mortality in UK Long Term Care Facilities: Cohort study using active surveillance and electronic records (March-June 2020). *Age and Ageing* 2021;afab060 doi: 10.1093/ageing/afab060

40. Office for National Statistics. Impact of coronavirus in care homes in England: 26 May to 19 June 2020. They Vivaldi study., 2020.

41. Stow D, Barker RO, Matthews FE, et al. National Early Warning Scores (NEWS / NEWS2) and COVID-19 deaths in care homes: a longitudinal ecological study. *medRxiv* 2020:2020.06.15.20131516. doi: 10.1101/2020.06.15.20131516

42. Brown KA, Jones A, Daneman N, et al. Association Between Nursing Home Crowding and COVID-19 Infection and Mortality in Ontario, Canada. *JAMA Internal Medicine* 2021;181(2):229-36. doi: 10.1001/jamainternmed.2020.6466

43. Fisman DN, Bogoch I, Lapointe-Shaw L, et al. Risk Factors Associated With Mortality Among Residents With Coronavirus Disease 2019 (COVID-19) in Long-term Care Facilities in Ontario, Canada. *JAMA Network Open* 2020;3(7):e2015957-e57. doi: 10.1001/jamanetworkopen.2020.15957

44. Stall NM, Jones A, Brown KA, et al. For-profit long-term care homes and the risk of COVID-19 outbreaks and resident deaths. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne* 2020;192(33):E946-e55. doi: 10.1503/cmaj.201197 [published Online First: 2020/07/24]

45. Guery R, Delaye C, Brule N, et al. Limited effectiveness of systematic screening by nasopharyngeal RT-PCR of medicalized nursing home staff after a first case of COVID-19 in a resident. *Médecine et Maladies Infectieuses* 2020 doi: https://doi.org/10.1016/j.medmal.2020.04.020

46. Sacco G, Foucault G, Briere O, et al. COVID-19 in seniors: Findings and lessons from mass screening in a nursing home. *Maturitas* 2020;141:46-52. doi: https://doi.org/10.1016/j.maturitas.2020.06.023

47. Heung LC, Li T, Mak SK, et al. Prevalence of subclinical infection and transmission of severe acute respiratory syndrome (SARS) in a residential care home for the elderly. *Hong Kong Med J* 2006;12(3):201-7. [published Online First: 2006/06/09]

48. Ho WW, Hui E, Kwok TC, et al. An outbreak of severe acute respiratory syndrome in a nursing home. *J Am Geriatr Soc* 2003;51(10):1504-5. doi: 10.1046/j.1532-5415.2003.514841.x [published Online First: 2003/09/27]

49. Hoxha A, Wyndham-Thomas C, Klamer S, et al. Asymptomatic SARS-CoV-2 infection in Belgian long-term care facilities. *The Lancet Infectious Diseases* 2020 doi: https://doi.org/10.1016/S1473-3099(20)30560-0

50. Klein A, Edler C, Fitzek A, et al. Der erste COVID-19-Hotspot in einer Hamburger Senioreneinrichtung. *Rechtsmedizin* 2020;30(5):325-31. doi: 10.1007/s00194-020-00404-1

51. Kennelly SP, Dyer AH, Noonan C, et al. Asymptomatic carriage rates and case-fatality of SARS-CoV-2 infection in residents and staff in Irish nursing homes. *Age and Ageing* 2021;50(1):49-54. doi: 10.1093/ageing/afaa220

52. Iritani O, Okuno T, Hama D, et al. Clusters of COVID-19 in long-term care hospitals and facilities in Japan from 16 January to 9 May 2020. *Geriatrics & Gerontology International* 2020;20(7):715-19. doi: 10.1111/ggi.13973

53. Kim T. Improving Preparedness for and Response to Coronavirus Disease 19 (COVID-19) in Long-Term Care Hospitals in the Korea. *Infect Chemother* 2020 [published Online First: 2020/05/15]

54. Borras-Bermejo B, Martínez-Gómez X, San Miguel MG, et al. Asymptomatic SARS-CoV-2 Infection in Nursing Homes, Barcelona, Spain, April 2020. *Emerging Infectious Disease journal* 2020;26(9):2281. doi: 10.3201/eid2609.202603

55. Kelleher CC, Doherty B, Donnelly P, et al. COVID-19 Nursing Homes Expert Panel. Examination of Measures to 2021. Report to the Minister for Health, 2020.

56. Sepulveda ER, Stall NM, Sinha SK. A Comparison of COVID-19 Mortality Rates Among Long-Term Care Residents in 12 OECD Countries. *Journal of the American Medical Directors Association* 2020;21(11):1572-74.e3. doi: 10.1016/j.jamda.2020.08.039 [published Online First: 09/12]

57. Lurie N, Saville M, Hatchett R, et al. Developing Covid-19 Vaccines at Pandemic Speed. *New England Journal of Medicine* 2020;382(21):1969-73. doi: 10.1056/NEJMp2005630

58. Public Health England. Impact of COVID-19 vaccines on mortality in England December 2020 to February 2021. London, 2021.

59. Montano M. Pressing Questions and Challenges in the HIV-1 and SARS-CoV-2 Syndemic. *AIDS Research and Human Retroviruses* 2021;Ahead of Print doi: 10.1089/aid.2021.0005

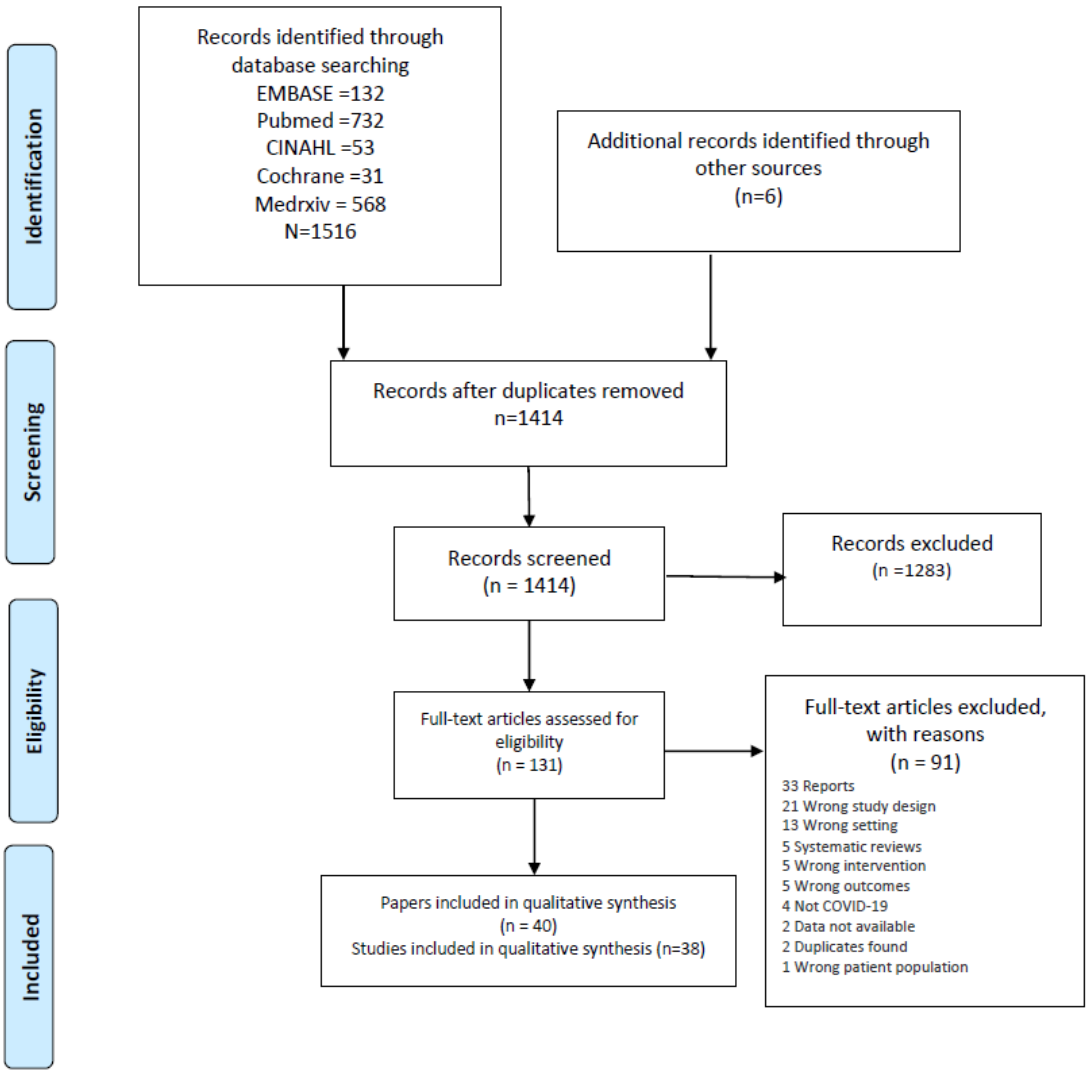
60. Institute of Medicine (IOM). Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. In: Knobler S, Mahmoud A, Lemon S, et al., eds. Learning from SARS: Preparing for the Next Disease Outbreak: Workshop Summary. Washington (DC): National Academies Press (US), Copyright © 2004, National Academy of Sciences. 2004.

61. 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. *medRxiv* 2020:2020.06.09.20125237. doi: 10.1101/2020.06.09.20125237

62. World Health Organization. Preventing and managing COVID-19 across long-term care services: policy brief. Geneva, 2020.

Figure legends

Figure 1. PRISMA flowchart


Identification
Screening
Eligibility
Included
Records identified through database searching
EMBASE =132
Pubmed =732
CINAHL =53
Cochrane =31
Medrxiv = 568
N=1516
Additional records identified through other sources
(n=6)
Records after duplicates removed
n=1414
Records screened
(n = 1414)
Records excluded
(n =1283)
Full-text articles assessed for eligibility
(n = 131)
Full-text articles excluded, with reasons
(n = 91)
33 Reports
21 Wrong study design
13 Wrong setting
5 Systematic reviews
5 Wrong intervention
5 Wrong outcomes
4 Not COVID-19
2 Data not available
2 Duplicates found
1 Wrong patient population
Papers included in qualitative synthesis
(n = 40)
Studies included in qualitative synthesis (n=38)

Pubmed

Search #1

“Residential facilit*” OR “Residential aged care” OR Convalescent home* OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR Home* for the aged OR “Old Age Home*” OR “long-term care” OR "Nursing Homes"[Mesh] OR “long-term care”[MeSH] OR "Residential Facilities"[Mesh] OR "Housing for the Elderly"[Mesh]

213,035 Results

Intervention

Search #2

(“Infection control” OR Infection prevention and control* OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “Health care Delivery” OR transmission OR body substance isolation* OR physical barrier* OR physical intervention* OR physical protection* OR personal protection* OR person protection* OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR non-pharm intervention* OR non-pharmaceutical intervention* OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing or separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face mask* OR face-mask* OR "Delivery of Health Care" OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR “Personal Protective Equipment” OR mask* OR virucide* OR antivirus agent* OR Handwashing OR “Hand washing” OR “Hand Disinfection” OR “hand hygiene” OR distancing OR distances OR aerosol-generating procedure* OR patient isolation* OR patient isolator* OR person isolator* OR “individual isolation” OR individual isolator* OR filtering face piece* OR face protection* OR face shield* OR face protective device* OR face protective gear* OR eye protection* OR eye shield* OR eye protective device* OR eye protective gear* OR Eye mask* OR airborne precaution* OR droplet precaution* OR safety supply OR safety supplies* OR safety device* OR safety equipment* OR safety measure* OR safety gear* OR protective supply* OR protective supplies* OR protective device* OR protective equipment* OR protective measure* OR protective gear* OR “personal isolation” OR respirator* OR respiratory protection* OR respiratory protective device* OR “respiratory protective supply” OR “respiratory protective supplies” OR “respiratory protective equipment” OR “respiratory protective gear” OR “safely equipped” OR meter OR metre OR foot OR feet OR meters OR metres OR head cover* OR face cover* OR eye cover* OR goggle* OR protective clothing* OR "Infection Control"[Mesh] OR "Personal Protective Equipment"[Mesh] OR "Hand Disinfection"[Mesh] OR "Communicable Disease Control"[Mesh:NoExp] OR "Disease Transmission, Infectious"[Mesh] OR "Primary Prevention"[Mesh] OR "Delivery of Health Care"[Mesh:NoExp] OR "Fomites"[Mesh] OR "Ventilators, Mechanical"[Mesh] OR "Communicable Disease Control"[Mesh] OR "Primary Prevention"[Mesh] OR "Delivery of Health Care"[Mesh] OR "Patient Isolation"[Mesh] OR "Patient Safety"[Mesh] OR "Patient Harm"[Mesh])

5,741,706 results

And

Search #3

(Coronavirus* OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR coronaviridae OR "corona virus" OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR "COVID-19" [Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2" [Supplementary Concept] OR "Coronavirus Infections"[Mesh] OR "Coronavirus"[Mesh] OR "Middle East Respiratory Syndrome Coronavirus"[Mesh] OR "Coronavirus Infections"[Mesh] OR "SARS Virus"[Mesh] OR "Betacoronavirus"[Mesh])

595,661 results

Search #4 = #2 AND #3 116,217 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “infection risk” OR "Mortality"[Mesh:NoExp] OR "Morbidity"[Mesh]

3,204,107 results

Search #6 = #1 AND #4 AND #5

EMBASE

Search #1

“Residential facilit*” OR “Residential aged care” OR “Convalescent home*” OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR “Home* for the aged” OR “Old Age Home*” OR

"long-term care" OR 'residential home'/exp OR 'nursing home'/exp OR 'home for the aged'/exp OR 'skilled nursing facility'/exp OR 'long term care'/de

212,416 results

Intervention

Search #2

("Infection control" OR "Infection prevention and control*" OR "Patient Safety" OR "Patient harm" OR "Patient risk" OR "body substance isolation*" OR "physical barrier*" OR "physical intervention*" OR "physical protection*" OR "personal protection*" OR "person protection*" OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR "non-pharm intervention*" OR "non-pharmaceutical intervention*" OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing OR separation OR "Communicable Disease Control" OR "Primary Prevention" OR facemask* OR face-mask* OR "face mask*" OR "Delivery of Health Care" OR "Health Care Delivery" OR "Disease transmission" OR "Infectious Disease Transmission" OR PPE OR "Personal Protective Equipment" OR mask* OR virucide* OR antivirus agent* OR Handwashing OR "Hand washing" OR "Hand Disinfection" OR "hand hygiene" OR distancing OR distances OR "aerosol-generating procedure*" OR "patient isolation*" OR "patient isolator*" OR "person isolator*" OR "individual isolation" OR "individual isolator*" OR "filtering face piece*" OR "face protection*" OR "face shield*" OR "face protective device*" OR "face protective gear*" OR "eye protection*" OR "eye shield*" OR "eye protective device*" OR "eye protective gear*" OR "Eye mask*" OR "airborne precaution*" OR "droplet precaution*" OR "safety supply" OR "safety supplies*" OR "safety device*" OR "safety equipment*" OR "safety measure*" OR "safety gear*" OR "protective supply*" OR "protective supplies*" OR "protective device*" OR "protective equipment*" OR "protective measure*" OR "protective gear*" OR "personal isolation" OR respirator* OR "respiratory protection*" OR "respiratory protective device*" OR "respiratory protective supply" OR "respiratory protective supplies" OR "respiratory protective equipment" OR "respiratory protective gear" OR "safely equipped" OR meter OR metre OR foot OR feet OR meters OR metres OR "head cover*" OR "face cover*" OR "eye cover*" OR goggle* OR "protective clothing*" OR 'infection control'/exp OR 'patient safety'/exp OR 'disease transmission'/exp OR 'contamination'/exp OR 'shedding'/exp OR 'fomite'/exp OR 'shield'/exp OR 'ventilator'/exp OR 'space'/exp OR 'separation'/exp OR 'communicable disease control'/exp OR 'primary prevention'/exp OR 'face mask'/exp OR 'health care delivery'/exp OR 'protective equipment'/exp OR 'mask'/exp OR 'antivirus agent'/exp OR 'hand washing'/exp OR 'patient isolation'/exp OR 'face shield'/exp OR 'eye protective device'/exp OR 'ventilator'/exp OR 'respiratory protection'/exp OR 'goggle'/exp OR 'protective clothing'/exp)

6,030,646 results

And

Search #3

(Coronavirus* OR "Corona virus" OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR

coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR 'Coronavirinae'/exp OR 'Betacoronavirus'/exp OR 'severe acute respiratory syndrome'/exp OR 'covid 19'/exp OR 'Coronavirus infection'/exp)

45,801 results

Search #4 = #2 AND #3 27,921 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “Infection risk” OR 'mortality'/exp OR 'mortality rate'/exp OR 'morbidity'/exp OR 'infection risk'/exp

1,862,861results

Search #6 = #1 AND #4 AND #5

CINAHL

Search #1

“Residential facilit*” OR “Residential aged care” OR “Convalescent home*” OR “Nursing Home*” OR “Homes for the aged” OR “Housing for the elderly” OR “Skilled nursing facilit*” OR “long term care” OR “Longterm care” OR “Home* for the aged” OR “Old Age Home*” OR “long-term care” OR (MH "Residential Facilities") OR (MH "Nursing Homes+") OR (MH "Housing for the Elderly") OR (MH "Long Term Care")

83,231 results

Intervention

Search #2

(“Infection control” OR “Infection prevention and control*” OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “body substance isolation*” OR “physical barrier*” OR “physical intervention*” OR “physical protection*” OR “personal protection*” OR “person protection*” OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR “non-pharm intervention*” OR “non-pharmaceutical intervention*” OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing OR separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face-mask* OR “face mask*” OR "Delivery of Health Care" OR “Health Care Delivery” OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR “Personal Protective Equipment” OR mask* OR virucide* OR antivirus agent* OR Handwashing OR “Hand washing” OR “Hand Disinfection” OR “hand hygiene” OR distancing OR distances OR “aerosol-generating procedure*” OR “patient isolation*” OR “patient isolator*” OR “person isolator*” OR “individual isolation” OR “individual isolator*” OR “filtering face piece*” OR “face protection*” OR “face shield*” OR “face protective device*” OR “face protective gear*” OR “eye protection*” OR “eye shield*” OR “eye protective device*” OR “eye protective gear*” OR “Eye mask*” OR “airborne precaution*” OR “droplet precaution*” OR “safety supply” OR “safety supplies*” OR “safety device*” OR “safety equipment*” OR “safety measure*” OR “safety gear*” OR “protective supply*” OR “protective supplies*” OR “protective device*” OR “protective equipment*” OR “protective measure*” OR “protective gear*” OR “personal isolation” OR respirator* OR “respiratory protection*” OR “respiratory protective device*” OR “respiratory protective supply” OR “respiratory protective supplies” OR “respiratory protective equipment” OR “respiratory protective gear” OR “safely equipped” OR meter OR metre OR foot OR feet OR meters OR metres OR “head cover*” OR “face cover*” OR “eye cover*” OR goggle* OR “protective clothing*” OR (MH "Infection Control") OR (MH "Handwashing") OR (MH "Patient Safety") OR (MH "Disease Transmission+") OR (MH "Microbial Contamination") OR (MH "Ventilators, Mechanical") OR (MH "Masks") OR (MH "Health Care Delivery+") OR (MH "Protective Devices+") OR (MH "Patient Isolation+")

917,391 results

And

Search #3

(Coronavirus* OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona* OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR 2019-nCoV OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" OR (MH "Coronavirus+") OR (MH "Coronaviridae Infections+"))

141,416 results

Search #4 = #2 AND #3 15,251 results

Outcomes

Search #5

Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “Infection risk” OR (MH "Mortality+") OR (MH "Morbidity+")

501,502 results

Search #6 = #1 AND #4 AND #5

Cochrane library

#1 MeSH descriptor: [Coronavirus Infections] explode all trees 179

#2 MeSH descriptor: [Coronavirus] explode all trees 18

#3 Coronavirus OR “Corona virus” OR Betacoronavirus or Beta-coronavirus OR Corona OR coronaviral OR coronavirdae OR coronavirida OR coronaviridae OR coronaviridea OR coronaviridiae OR coronavirinae OR coronavirion OR coronavirions OR coronaviroses OR coronavirous OR coronavirues OR coronaviruscpe OR coronaviruse OR coronaviruses OR coronaviruslike OR coronaviser OR coronaviurs OR coronaviuses OR coronavrius OR coronavvirus OR COVIDOR SARS OR SARS-CoV OR “Middle East respiratory syndrome” OR MERS OR MERS-CoV OR “Severe Acute Respiratory Syndrome” OR “severe acute respiratory pneumonia outbreak” OR nCoV OR COVID-2019 OR “COVID 2019” OR cov2 OR Covid19 OR COVID-19 OR COVID 19 OR SARS-CoV* OR coronaviridae OR "corona virus" OR "SARS-CoV-2" OR "sars cov2" OR "SARS-CoV-19" OR 2019nCoV OR "SARS-CoV" OR SARSCOV2 OR "2019 coronavirus" OR "SARS2" OR "2019 corona virus" OR covid19 OR "novel corona virus" OR "new corona virus" OR "novel coronavirus" OR "new coronavirus" OR “coronavirus infection” OR "nouveau coronavirus" 1173

#4 #1 OR #2 OR #3 1173

#5 “Infection control” OR Infection prevention and control* OR “Patient Safety” OR “Patient harm” OR “Patient risk” OR “Health care Delivery” OR transmission OR body substance isolation* OR physical barrier* OR physical intervention* OR physical protection* OR personal protection* OR person protection* OR BSI OR IPC OR N95 OR ffp1 OR ffp3 OR ffp2 OR transmission* OR contamination* OR shedding OR fomite* OR gap* OR non-pharm intervention* OR non-pharmaceutical intervention* OR Shield OR N99 OR N97 OR Ventilator* OR Space OR spacing or separation OR “Communicable Disease Control” OR "Primary Prevention" OR facemask* OR face mask* OR face-mask* OR "Delivery of Health Care" OR “Disease transmission” OR “Infectious Disease Transmission” OR PPE OR

"Personal Protective Equipment" OR mask* OR virucide* OR antivirus agent* OR Handwashing OR "Hand washing" OR "Hand Disinfection" OR "hand hygiene" OR distancing OR distances OR aerosol-generating procedure* OR patient isolation* OR patient isolator* OR person isolator* OR "individual isolation" OR individual isolator* OR filtering face piece* OR face protection* OR face shield* OR face protective device* OR face protective gear* OR eye protection* OR eye shield* OR eye protective device* OR eye protective gear* OR Eye mask* OR airborne precaution* OR droplet precaution* OR safety supply OR safety supplies* OR safety device* OR safety equipment* OR safety measure* OR safety gear* OR protective supply* OR protective supplies* OR protective device* OR protective equipment* OR protective measure* OR protective gear* OR "personal isolation" OR respirator* OR respiratory protection* OR respiratory protective device* OR "respiratory protective supply" OR "respiratory protective supplies" OR "respiratory protective equipment" OR "respiratory protective gear" OR "safely equipped" OR meter OR metre OR foot OR feet OR meters OR metres OR head cover* OR face cover* OR eye cover* OR goggle* OR protective clothing* 300480

#6 MeSH descriptor: [Infection Control] explode all trees 1147

#7 MeSH descriptor: [Personal Protective Equipment] explode all trees 2284

#8 MeSH descriptor: [Hand Disinfection] explode all trees 378

#9 MeSH descriptor: [Communicable Disease Control] explode all trees 4791

#10 MeSH descriptor: [Disease Transmission, Infectious] explode all trees 856

#11 MeSH descriptor: [Primary Prevention] explode all trees 4005

#12 MeSH descriptor: [Delivery of Health Care] explode all trees 44666

#13 MeSH descriptor: [Fomites] explode all trees 9

#14 MeSH descriptor: [Ventilators, Mechanical] explode all trees 264

#15 MeSH descriptor: [Patient Isolation] explode all trees 51

#16 MeSH descriptor: [Patient Safety] explode all trees 580

#17 MeSH descriptor: [Patient Harm] explode all trees 3

#18 #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 336372

#19 #18 AND #4 651

#20 residential facilit* OR residential aged care OR Convalescent home OR Nursing home* OR Homes for the aged OR Housing for the elderly OR Skilled nursing facilit* OR Long term care OR Longterm care OR Home* for the aged OR old age home OR Long-term care 121379

#21 MeSH descriptor: [Long-Term Care] explode all trees 1112

#22 MeSH descriptor: [Nursing Homes] explode all trees 1314

#23 MeSH descriptor: [Residential Facilities] explode all trees 1711

#24 MeSH descriptor: [Housing for the Elderly] explode all trees 39

#25 #20 OR #21 OR #22 OR #23 OR #24 121450

#26 Mortality OR “Death rate*” OR “Mortality Rate*” OR Morbidity OR “Risk of Infection” OR “infection risk” 111129

#27 MeSH descriptor: [Mortality] explode all trees 12838

#28 MeSH descriptor: [Morbidity] explode all trees 14392

#29 #26 OR #27 OR #28 124060

#30 #19 AND #25 AND #29

Medrxiv

"((COVID-19 OR SARS-CoV-2) And ("Infection control")) AND (Mortality) AND ("nursing homes")"

Supplemental Table 2. Quality Review

		S1	*S2*	*3.1*	*3.2*	*3.3*	*3.4*	*3.5*	*4.1*	*4.2*	*4.3*	*4.4*	*4.5*	*Comments*
Abrams (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	CT	Y	
Arons (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y	
Blackman 2020	Quantitative descriptive	Y	Y						Y	N	Y	CT	Y*	*Data very limited to descriptive statistics (counts)
Borras-Bermejo 2020	Quantitative descriptive	Y	Y						Y	CT	Y	N	Y*	*Data minimal descriptive statistics. Reported as a brief letter.
Brainard (2020)	Non-randomised	Y	Y	CT	Y	Y	CT	Y						
Brown (2021)	Non-randomised	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	
Burton (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Dora (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data reporting descriptive data from an outbreak (counts and percentages)
Dutey-Magni (2021)	Non-randomised	Y	Y	Y	Y	Y	N	Y						
Eckhardt (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Limited descriptive data (point prevalence data, counts &percentages)
Feaster (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Fisman (2020b)	Non-randomised	Y	Y	Y	Y	Y	N	Y						
Graham (2020)	Quantitative descriptive	Y	Y						Y	N	Y	Y	Y	
Guery (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Limited descriptive data reported. Outbreak reported as a published letter.
Hand (2018)	Quantitative descriptive	Y	CT											Research letter reporting minimal data.
Harris (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics
Heung (2006)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y*	*Limited descriptive data
Ho (2003)	Quantitative descriptive	Y	CT											Report of conference symposium. Limited details
Hoxha 2020	Quantitative descriptive	Y	Y						Y	Y	Y	CT	Y	
Iritani 2020	Non-randomised	Y	Y	N	CT	Y	Y	CT						
Kennelly (2021)	Quantitative descriptive	Y	Y						CT	Y	Y	N	Y	
Kim (2020)	Quantitative descriptive	Y	CT						N	N	N	N	N	
Kimball (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics (counts/ percentages) brief report

Klein (2020)	Quantitative descriptive	N	N											Autopsy reporting
Lennon (2020) +	Quantitative descriptive	Y	Y						Y	CT	Y	Y	Y	
Louie (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Data limited to descriptive statistics presented in a brief report
McMichael (2020b)	Quantitative descriptive	Y	Y						Y	Y	Y	N	Y*	*Data limited to descriptive statistics
Office for National Statistics (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	CT	Y	
Patel (2020)	Longitudinal, Descriptive quantitative	Y	Y						Y	Y	Y	Y	Y	
Quicke (2020) +	Quantitative descriptive	Y	Y						CT	CT	CT	CT	Y	Limited data reported and virologic assay.
Quigley (2020)	Quantitative descriptive	Y	Y						Y	N	Y	N	Y*	*Limited descriptive data reported in a research letter
Roxby (2020) JAMA	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y*	*Descriptive data reported
Sacco (2020)	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Sanchez (2020)	Quantitative descriptive	Y	Y						CT	CT	Y	CT	Y*	*Descriptive data reported on prevalence (counts/ percentages)
Stall (2020) (CMAJ)	Non-randomised	Y	Y	CT	Y	Y	CT	Y						
Stow (2020) +	Quantitative descriptive	Y	Y						Y	Y	Y	Y	Y	
Telford (2020) +	Non-randomised	Y	Y	CT	Y	Y	N	Y						
Unruh (2020)	Quantitative descriptive	Y	Y						Y	CT	Y	Y	Y	

Y = Yes, N= No, CT= Can't tell

+ pre published manuscript available

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary material
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5, 6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6, figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Supplementary table 2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	17-33
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Supplementary table 2
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	33-35
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	35
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	35
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	35

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097