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RESEARCH ARTICLES

The effectiveness of non-pharmaceutical interventions on outbreaks of COVID-19 in aged care and long-term care facilities: A meta-analysis

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Abstract

A review on the use of non-pharmaceutical interventions (NPI) was conducted in long-term care facilities. The use of personal protective equipment, isolation and re-testing of COVID-19 were protective against the infection. Facilities which implemented NPIs prior to the outbreak had fewer COVID-19 outbreaks, odds ratio=0.70. Re-testing of asymptomatic people during outbreaks is crucial.

Key words: COVID-19, PPE, aged care facilities, long-term care facilities

Research Letter

Globally, high mortality rates of COVID-19 have occurred in older people, and the disease has disproportionately affected the residents of long-term care facilities (LTCFs) (1, 2). In the United States in May 2020, on average, 43% of the total COVID-19 deaths were reported from the LTCFs across the 40 states, 26 states reported a higher number, and 50% or more LTCF deaths were due to COVID-19 (3). The World Health Organisation (WHO) Europe estimates that 50% of COVID-19 related deaths in Europe also occurred among LTCF residents (4).

A systematic review of COVID-19 outbreaks in LTCFs was conducted between January 1, 2020 and June 30, 2020, as per PRISMA guidelines, and registered with Prospero (CRD42020196764). A meta-analysis was performed to compare COVID-19 cases in LTCFs which had applied COVID-19 non-pharmaceutical interventions (NPIs) to those with no reported NPIs. The odds ratio (OR) and 95% confidence interval (CI) were calculated. A p-value of < 0.05 was considered statistically significant. Forest plots were generated using the random-effects model. Review Manager Software, version 5.4 was used in the analysis (5). Studies were grouped by type of interventions applied such as assessment and restriction of visitors, personal protective equipment (PPE) use, hand hygiene, re-testing of people who had initially negative test results, and isolation or cohorting of residents. PPE use was defined as the use of masks or other types, such as gowns, gloves and eye protection. An analysis was performed by type of NPI applied as well as application of combined interventions either before or after the outbreak. Facilities that applied NPIs before the outbreak were grouped into pre-outbreak interventions, which included the assessment of visitors and visitor restrictions (supplementary table S1, reference; 3, 6, 7, 12), assessment of residents for signs, and symptoms of COVID-19 (supplementary table S1, reference 1-3, 6), assessment of staff before the beginning of a shift (supplementary table S1, reference 3, 6, 7, 12, 1), mask use (supplementary table S1, reference 1, 2, 7, 12, 14), restriction on communal activities (supplementary table S1, reference 3, 14) and suspension of resident admissions in the facility (supplementary table S1, reference 6, 7).

A flow chart for study selection is shown in supplementary figure S1. We identified 542 published articles; 15 studies met the selection criteria (supplementary table S1) and 14 studies were included in the analyses. The mean age of the COVID-19 positive residents was 84.5 years, and 43.9 years for aged care workers (ACWs). The attack rate among residents in LTCFs are shown in the supplementary table S2. Of the 1,767 LTCF residents identified, the overall attack rate was 31.1% (550/1767) and the CFR was 24.9% (137/550). From studies that reported on asymptomatic infection (supplementary table S1, reference 1- 4, 6, 7, 9, 12- 14), of the 302 residents confirmed with COVID-19, over half (n=159) were asymptomatic. In addition, 44% (134/302) of the reported COVID-19 positive residents showed COVID-19 symptoms (Supplementary table S1, reference 1, 2, 3, 4, 6, 7, 12, 14, 13).

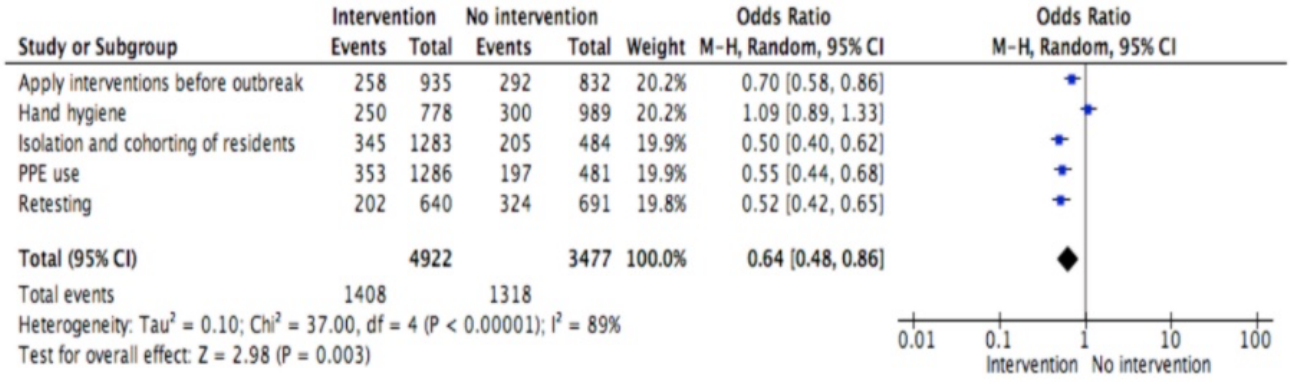
More than half (60%) of the facilities had applied NPIs before the emergence of COVID-19 cases in the facility (supplementary table S1, reference 1, 2, 3, 6, 7, 9, 12, 13). The probability of COVID-19 infection was reduced by 45% when ACWs used PPE. All other NPIs, except hand hygiene, were also protective (Figure 1). The odds of

contracting COVID-19 in facilities that implemented intervention before the onset of outbreak (relative to facilities that applied interventions after the outbreak) was 0.70 (95% CI: 0.58-0.86) (Figure 1).

The majority of the studies used Reverse Transcription Polymerase Chain Reaction (RT-PCR) testing of residents (supplementary table S1, reference 1, 4-8, 10-15) and staff (supplementary table S1, reference 2, 6, 7, 13, 14) after the occurrence of an outbreak. In 36.2% (640/1767) of the outbreaks, retesting of all residents or negative residents/staff was conducted (supplementary table S1, reference 1, 4, 6, 7, 13, 10). Some LTCFs instituted either isolation of residents and cohorting of positive cases, or isolation of all residents and exposed ACWs (supplementary table S1, reference 2, 6, 7, 8, 10,11-13, 15). In the aftermath of an outbreak, most LTCFs recommended RT-PCR testing to identify all infected staff and residents for early isolation (supplementary table S1, reference 1, 3, 4, 6, 9, 11, 12 14, 15). Six of these facilities also advocated for repeated testing of all residents, irrespective of symptoms (supplementary table S1, reference 1, 4, 6, 7, 10, 13).

We found that asymptomatic cases plausibly contribute the widespread transmission of COVID-19 in the facilities, and therefore re-testing of undiagnosed cases is essential during outbreaks. Overall, findings from our review support the use of PPE, isolation and re-testing in aged care settings during outbreaks, as well as routine use of NPIs prior to outbreaks occurring.

Figure 1. Forest plot of overall interventions used in LTCFs.



LTCFs, long-term care facilities; PPE, Personal protective equipment.

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Competing interest
None declared.

Supplementary Materials

Table S1. Geographic distribution and demographic characteristics of LTCF residents and staff from 15 studies.

Author/ year	Country	Settings	Total number of residents (N)	Index Case	Mean age of all residents (year)	Total number of residents tested for COVID-19 (n)	Laboratory-confirmed COVID-19 cases (Residents, n)	Male COVID-19 Residents (%)	Female COVID-19 Residents (%)	Total number of staff (N)	Mean age of all staff (year)	Total number of staff tested for COVID-19 (n)	Laboratory-confirmed COVID-19 cases (Staff, n)
Arons et al. 2020 (1)	USA	SNF	89	ACW	NR	76	57	NR	NR	138	NR	57	26
Balestrini et al. 2020 (2)	UK	LTCF	286	ACW	NR	98 (CCE) NR (STE) 0 (TM)	13	89 (CCE)	11 (CCE)	275 (CCE) 215 (STE) 250 (TM)	NR	150 (CCE) 105 (STE) 26 (TM)	1 (CCE) 15 (STE) 2 (TM)
Blackman et al. 2020 (3)	NR	SNF	150 bed	ACW	NR	11	11	NR	NR	NR	NR	NR	26
Blain et al. 2020 (4)	NR	NH	79	NR	NR	79	38	NR	NR	34	NR	34	8
Bouza et al. 2020 (5)	Spain	NH	79	NR	NR	62	58	NR	NR	44	NR	44	6
Dora et al. 2020 (6)	USA	LTSNF	99	R	NR	NR	19	100	0	136	NR	NR	8
Goldberg et al. 2020 (7)	USA	SNF	97	ACW	NR	97	82	NR	NR	146	45	97	36
Kim 2020 (8)	South Korea	LTCH	142	ACW	NR	NR	0	NR	NR	85	NR	NR	1
Kimball et al. 2020 (9)	USA	LTSNF	82	ACW	NR	76	23	31	70	NR	NR	NR	NR

Lee, et al. 2020 (10)	South Korea	LTCH	193	ACW	82	0	0	NR	NR	123	66	NR	2
McMichael et al. 2020 (11)	USA	SNF	130	R	NR	118	101	31.7	68	170	NR	NR	50
Patel et al. 2020 (12)	USA	SNF	127	R	NR	126	35	31	69	120	NR	42	19
Roxby et al. 2020 (13)	USA	IALF	83	R	86	80	6	NR	NR	62	40	62	2
Sacco et al. 2020 (14)	France	NH	87	R	87	87	41	NR	NR	92	NR	70	22
Stall et al. 2020 (15)	Canada	NH	126 bed	NR	NR	NR	89	NR	NR	NR	NR	NR	47

USA-United States of America, UK- United Kingdom.
SNF-Skilled Nursing Facility, NH- Nursing Homes, LTSNF- Long term Skilled Nursing Facility, LTCF- Long term Care Facility, LTCH- Long Term Care Hospital, IALF - Independent and Assisted Living Facility.
R- residents, ACW- aged care workers, CCE- Chalfont Centre for Epilepsy, STE- St. Elisabeth, TM- The Meath Epilepsy Facility, NR -not reported.

Table S2. Attack rate and case fatality rate among ACF residents

Author/year	Resident population (N)	COVID-19 cases (n)	COVID-19 deaths (n)	Attack rate (%)	Case fatality rate (%)
Arons et al. 2020 (1)	89	57	15	64	26.3
Balestrini et al. 2020 (2)	286	13	2	4.5	15.3
Blackman et al. 2020 (3)	150	11	4	7.3	36.4
Blain et al. 2020 (4)	79	38	12	48	31.5
Bouza et al. 2020 (5)	79	58	12	73.4	20.6
Dora et al. 2020 (6)	99	19	1	19	5.3
Goldberg et al. 2020 (7)	97	82	24	84.5	29.2
Kim, 2020 (8)	142	0	0	0	0
Lee et al. 2020 (10)	193	0	0	0	0
McMichael et al. 2020 (11)	130	101	34	77.6	33.6
Patel et al. 2020 (12)	127	35	10	27.5	28.5
Roxby et al. 2020 (13)	83	6	0	7.2	0
Sacco et al. 2020 (14)	87	41	11	47.2	26.8
Stall et al. 2020 (15)	126	89	12	70.6	13.4
All studies	**1767**	**550**	**137**	**31.1**	**24.9**

References of included studies (Tables S1 and S2)

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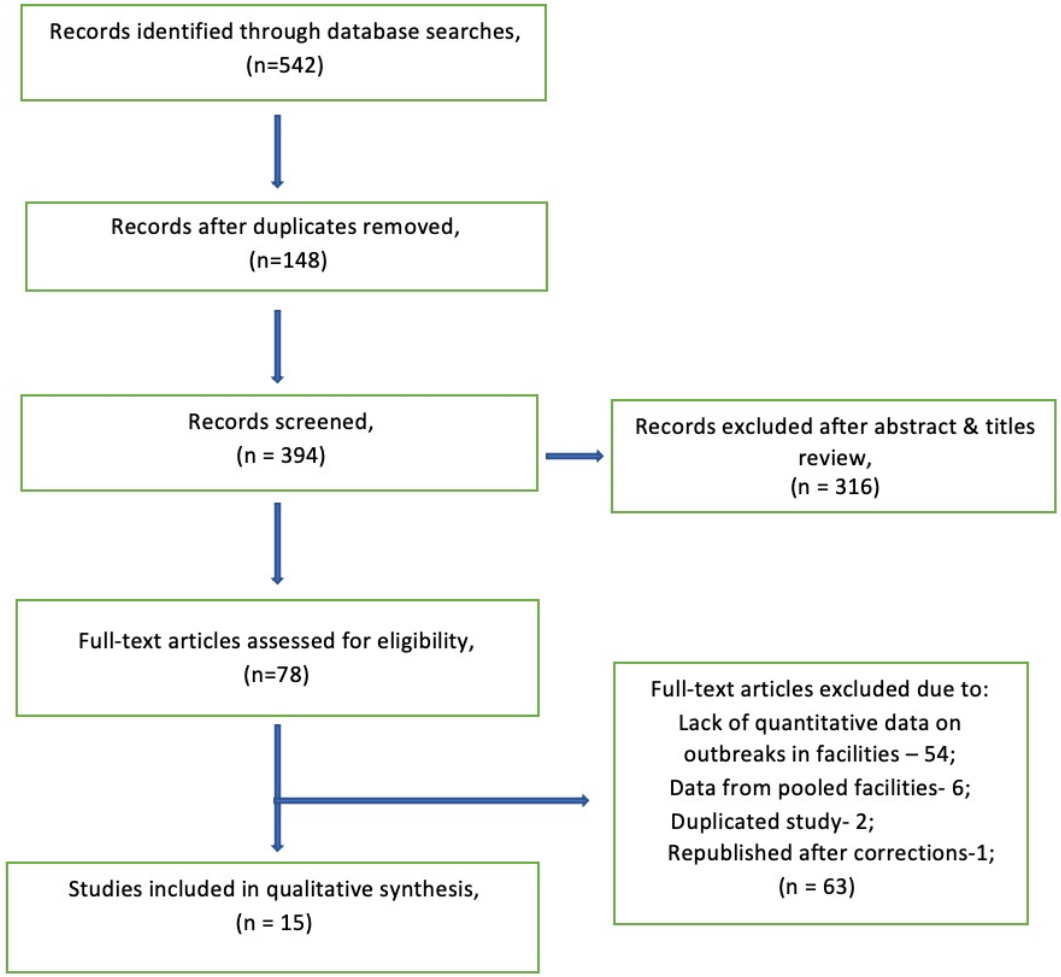
Table S3. List of abbreviations

Term	**Abbreviation**
ACF	Aged care facility
ACW	Aged care worker
CCE	Chalfont Centre for Epilepsy
CFR	Case fatality rate
COVID-19	Corona Virus Disease-2019
IALF	Independent and Assisted Living Facility
HH	Hand hygiene
MERS	Middle East Respiratory Syndrome
LTCF	Long Term Care Facility
LTCH	Long Term Care Hospital
LTSNF	Long Term Skilled Nursing Facility
NR	Not reported
NH	Nursing Homes
PPE	Personal protective equipment
PR	COVID-19 positive residents
R	Residents
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SARS-COV-2	Severe Acute Respiratory Syndrome-Corona Virus-2
SNF	Skilled Nursing Facility
STE	St. Elisabeth
TM	The Meath Epilepsy Facility

Figure S1. Flow chart for database search and study selection.



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