

Meta-analysis

The first year of the COVID-19 pandemic in nursing homes: a meta-analysis study

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ABSTRACT

Severe impact of COVID-19 on nursing homes and the morbidity and mortality rates in nursing home residents can be higher than in the community during a pandemic. This study aimed to meta-analyse the COVID-19 attack, fatality and mortality rates among nursing home residents and to meta-analyse the risk ratio values by comparing these rates with those of the countries in which the nursing homes are located. The data was obtained from COVID-19 attack, mortality, and fatality rates of nursing home residents. Additional meta-analysis was performed using risk ratio calculated by dividing the data obtained from nursing homes by the expected numbers calculated using case, death, and population data from COVID-19. A total of 6,758,241 COVID-19 patients from 8 different countries and 19 studies were included during the meta-analysis study period. In nursing home residents compared to the general population, the risk ratio (95%CI) for COVID-19 attack rate was 148.19 (99.45 to 220.82), the mortality rate was 341.16 (211.94 to 549.15), and the fatality rate was 2.36 (1.90 to 2.93) (each $p < 0.001$). A meta-analysis of well-documented studies has shown that community morbidity and mortality rates can reach higher levels compared to community during a pandemic. Finding the exact causes can only be achieved after adjusting nursing home infection rates with regional rates. To ensure better community management of the COVID-19 pandemic and prevent future pandemics, preventive measures should be taken earlier.

Keywords: Nursing homes, COVID-19, Older adult, Meta-analysis, Mortality rate

INTRODUCTION

The increase in the older adult population in the world has brought the care problems of older persons to the agenda, and nursing homes have become one of the essential models for sustaining older individuals' lives. A study conducted in 10 developed countries with high life expectancy reported that 2-5% of older adults stayed in nursing homes. Nursing homes have also been more affected due to the global impact of COVID-19.^{1,2} The COVID-19 pandemic has focused attention on the health and social problems of older adults worldwide. One of the most highlighted issues during the COVID-19 pandemic has been the global increase in the older person population,

as well as the care, health, and social problems associated with older adults.^{3,4}

In the first period of the pandemic, many older people living in nursing homes lost their lives. By early 2021, almost all U. S. nursing homes had experienced at least one COVID-19 case, and most (more than 80%) had experienced at least one death.⁵ The mortality rate due to COVID-19 was 3.8% in Lombardy region with the first outbreak in Europe, but increased to 7.5% in nursing homes in Lombardy.⁶ It was reported as 0.5% in Germany and 6.2% in Spain, 2.5% in France, 3.3% in Sweden and 5.1% in the UK. In many countries, such as the United States, United Kingdom, France, Spain and Sweden,

nursing home residents are reported to be responsible for 30-50% of all COVID-19-related deaths.⁷

Since nursing homes are affected by the COVID-19 pandemic at different levels, efforts to control the pandemic have focused on the conditions in nursing homes where COVID-19 cases and deaths are higher. The study of Koshkouei et al provided details on how the infection spread in nursing homes during the beginning of the COVID-19 epidemic.³ Nursing home residents have become more vulnerable to COVID-19 due to reasons such as nursing home employees working in several centers, continuing to work despite being symptomatic, lack of awareness, lack of contact precautions, lack of personal protective equipment, the inadequacy of testing facilities, living in crowded and closed environments.^{8,9}

The number of COVID-19 cases in the state where the nursing home is located was found to be one of the important variables determining COVID-19 cases in nursing homes. The number of COVID-19 cases in nursing homes is approximately two times higher than the reported cases in the states (428.2 and 231.3 per 100,000 population, respectively).⁴ Similar findings were found in Gordes and Konetzka's research of 13,167 nursing homes, where per capita cases were found to be the county's best predictor of cases and outbreaks in nursing homes.² In a study to inform COVID-19 infection prevention measures by identifying and assessing risk and potential infection vectors in nursing homes using a machine learning approach, the infection rate of the region where the nursing home is located and the number of separate units in the nursing home were identified as strong predictors of COVID-19 infection.¹⁰ However, there are significant limitations in the data on the extent of the relationship.^{11,12}

Information derived from research with a high degree of evidence on the extent of the risk in future pandemics will guide the reorganization of older people's care centers. However, there is a need for information that adjustments should be made according to the infection rates in the region where the nursing home is located, which is a confounding factor in the investigation of these causes. It is necessary to provide health service providers and policymakers with information with a high level of evidence. The objectives of the study was to conduct a meta-analysis of the relative risk values derived from attack, fatality, and mortality rates estimated from publications including COVID-19 case and death data in patients residing in nursing homes during the first year of the pandemic, taking into consideration nation data over the study's time frame.

METHODS

Study permits

This study is a meta-analysis of COVID-19 nursing home attack, mortality and fatality rates and risk ratio calculated using case and mortality rates of COVID-19 nursing home

residents published in the literature from the onset of the pandemic to 03/01/2021 and country data during the study period. The study was approved by the Ministry of Health and the Ethics Committee of Eskişehir Osmangazi University. The study protocol was registered with PROSPERO under registration number CRD42021237306.¹³ The PRISMA 2020 checklist was used to prepare the study report.¹⁴

Literature search

Manuscripts to be included in the study were found by two researchers in the Pubmed, Web of Science, Google Scholar, Scopus, and Cochrane databases by searching for the keywords 'COVID -19', 'death', 'nursing home', 'rest home', 'home for aged', 'eventide home', and 'elderly care home'. A total of 408 studies were reviewed for eligibility for meta-analysis, including 377 studies based on database searches and 31 studies based on manual searches of relevant publications.

Inclusion and exclusion criteria

The inclusion criteria were as follows; the study must be conducted on nursing home residents, information could be retrieved on the number of residents diagnosed with COVID-19 with laboratory-based or epidemiologic confirmation, and the number of residents who died because of COVID-19. Studies must have a known time period and the entire publication or abstract must be in English. The exclusion criteria were that the study did not contain data appropriate for the purpose of this study, that the full text of the study was not available, and that the main text or abstract was not in English.

Definition of measurements

In the study, deaths in nursing homes or hospitals of persons with COVID-19 were accepted as deaths due to COVID-19 on the basis of laboratory results or a physician's decision. The number of COVID-19 cases and deaths in the country where the study was conducted during the study period was obtained from the ECDC dashboard COVID-19, and population figures for the country were obtained from Worldometer.^{15,16} The attack rate was calculated by dividing the number of nursing home residents diagnosed with COVID-19 by the number of nursing home residents during the study period. The mortality rate was calculated by dividing the number of individuals who died because of COVID-19 by the number of nursing home residents. The fatality rate was calculated by dividing the number of persons who died because of COVID-19 by the number of patients.

Data extraction

As a result of the literature review using the search design and inclusion criteria, 408 articles were identified. As a result of the evaluation of these articles, 96 duplicate articles were removed and a total of 312 articles were

obtained. After title and/or abstract screening, 267 records were eliminated. Full texts of the articles whose abstracts met the eligibility criteria were reviewed (n=45). Unreachable reports (n=24) were also excluded. We

excluded 2 articles considered as 'reviews' and finally included 19 studies selected for meta-analysis. The PRISMA flow diagram of the literature search and screen process is shown in Figure 1.

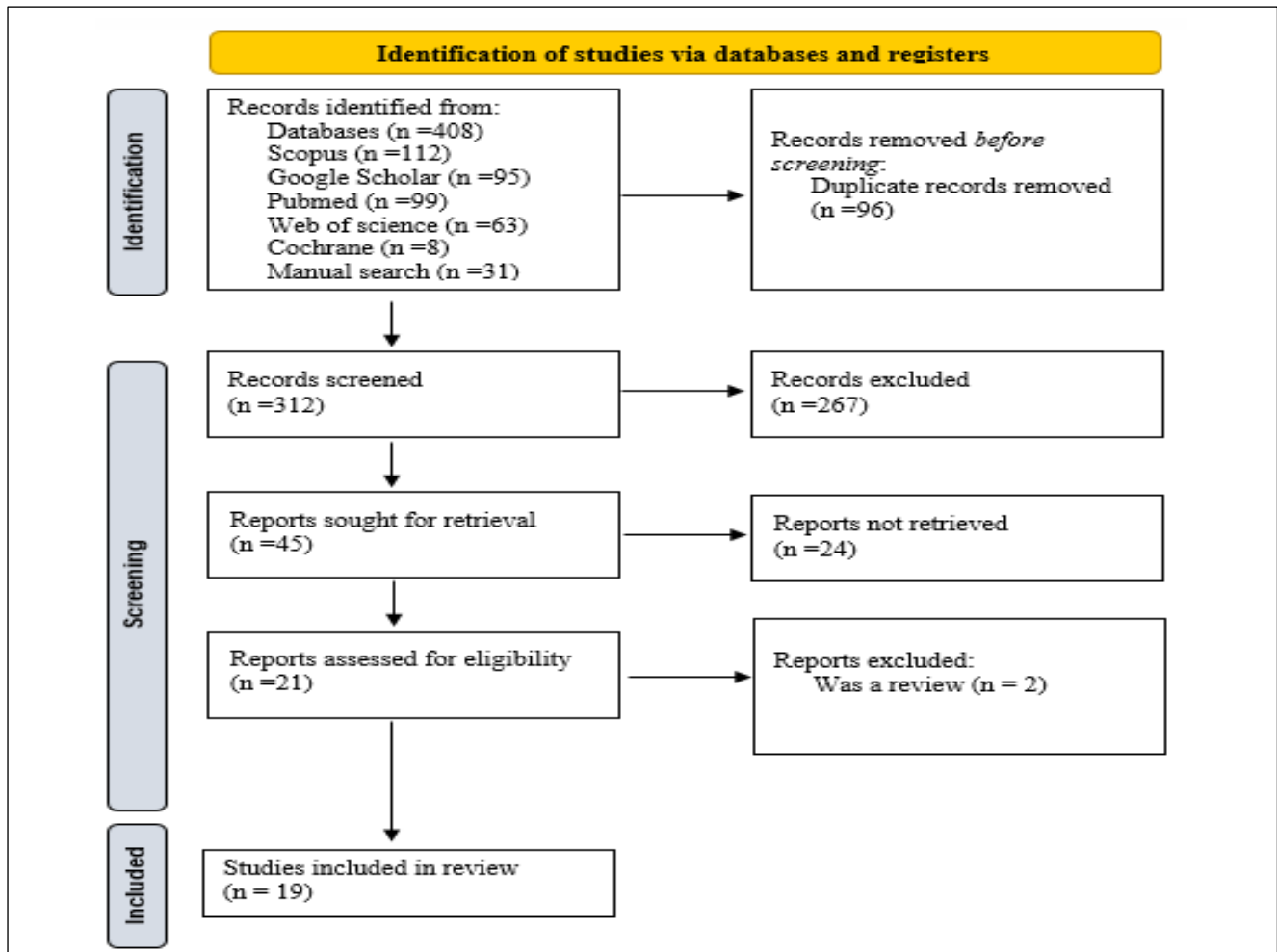


Figure 1: PRISMA flow diagram of literature search and screen process.

A database was created in Microsoft Office excel from the information obtained from the articles read. The databases included the title of the article, the author, the year of publication, the total number of residents in the nursing home, the number of residents diagnosed with COVID-19, the number of residents who died because of COVID-19, the population of the country where the nursing home is located, the total number of COVID-19 cases and deaths in the country where the nursing home is located between the period of the study.

The Newcastle-Ottawa Quality Assessment Scale for Observational Studies, modified and used by Fung et al, was used to assess the methodological quality and risk of bias of 19 studies included in the meta-analysis after it was adapted to this study.^{17,18} Each study was scored between 0 and 16 using the prepared form. The risk of bias was assumed to decrease as the total score increased. Studies were classified as high (0-10 points), medium (11-13 points), and low (15-16 points) for risk of bias. Studies

were scored independently by two observers. The Cohen-Kappa coefficient was then calculated to determine the reliability of agreement between the two observers ($\kappa=0.855$; $p<0.0001$).¹⁹

Statistical analysis

Observed attack, mortality, and fatality rates were calculated from studies included in the meta-analysis, and expected values were calculated from countries' COVID-19 data. Risk ratio values were calculated by dividing the observed rates by the expected value. To assess statistical significance, the 95% confidence intervals (CI) of RR were calculated as follows: the standard error (SE) of the natural logarithm of the RR was approximated by inverting the square root of the observed number of cases. The 95% confidence limits of RR were calculated as the natural logarithm of RR (in RR), with the per cent standard error added and multiplied by 1.96. After exponentiation, the exact 95%CI indicated that the approximation was satisfactory.²⁰

The open meta-analyst demo program was used to create six different databases that contained the attack, mortality, and fatality rates of each study as well as the risk ratio values of these rates using information from the studies that were included in the coding form made in Microsoft Office Excel. Because the heterogeneity test yielded $p < 0.001$ and $I^2 > 75\%$, the random-effects model was used for the meta-analysis.

RESULTS

The sample size of the studies included in the meta-analysis ranged from 60 to 125,000. The number of residents was 227,834, COVID-19 cases were 20,862, and COVID-19 deaths were 5,094. Five studies involved nursing home residents in the United States of America, five in France, two in the Netherlands, two in Spain, two in Italy, one in Germany, one in United Kingdom, and one in Canada. The total number of COVID-19 cases and deaths in the countries at the time of the studies was 6,758,241 and 531,872, respectively. Table 1 shows the characteristics of the studies included in the analysis.

The COVID-19 attack rate ranged from 6.6% (95% CI: 6.5 to 6.8) to 65.0% (52.9 to 77.1), and the weighted percentage \pm SE value was calculated as 37.0% \pm 0.016 (34.0 to 40.1) ($p < 0.001$). Fatality rate ranged from 11.8% (0.9 to 22.6) to 43.4% (33.7 to 53.2), with a weighted percentage \pm SE of 25.6% \pm 0.019 (21.9 to 29.2) ($p < 0.001$). The COVID-19 mortality rate ranged from 1.4% (1.3 to 1.4) to 27.4% (20.4 to 34.4), and the weighted percentage \pm SE was 8.1% \pm 0.005 (7.1 to 9.0) ($p < 0.001$) (Figure 2-4). In a total of 19 studies from 8 different countries included in the meta-analysis, the number of people with COVID-19 was 6,758,241 during the study periods. The risk ratio of the attack rate of COVID-19 in nursing home residents compared with the general population was 148.19 (95% CI: 99.45 to 220.82) ($p < 0.001$). The lowest RR was 31.38 (30.70 to 32.08) and the highest was 863.68 (739.14 to 1009.20). The risk ratio of fatality was 2.36 (1.90 to 2.93), the lowest was 0.60 (0.24 to 1.51) and the highest was 10.68 (6.90 to 16.49). The risk ratio of mortality was 341.16 (211.94 to 549.15), the lowest was 48.60 (46.00 to 51.35) and the highest was 9219.46 (5807.68 to 14635.54) (Figure 5-7).

Table 1: Summary of study data included in the analysis and countries' COVID-19 data.

Reference	Study dates (2020)	Country	Nursing home			Country		
			Resident number	COVID-19 case number	COVID-19 death number	Population	COVID-19 case number	COVID-19 death number
Graham et al ¹² (2020)	1 March to 1 May	UK	985	394	103	67886011	172562	26683
Bernabeu et al ²¹ (2020)	1 March to 30 April	Spain	457	272	61	46754778	215129	24543
Blain et al ²² (2020)	1 March to 30 April	France	79	38	12	65273511	128385	24085
Fischer et al ¹¹ (2020)	24 April to 2 June	USA	100	38	5	331002651	968648	58363
Strazzulla et al ²³ (2020)	17 March to 11 June	France	66	34	4	65273511	149713	29192
Echeverría et al ²⁴ (2020)	1 April to 30 April	Spain	10347	1293	383	46754778	110916	17203
Klein et al ²⁵ (2020)	1 April to 28 April	Germany	60	39	8	83783942	94424	5330
Sanchez et al ²⁶ (2020)	7 March to 8 May	USA	2773	1207	287	331002651	1256739	75658
Schols et al ²⁷ (2020)	28 Feb to 1 May	Holland	125000	9000	1700	17134872	39316	4795
Veronese et al ²⁸ (2020)	8 April 14 May	Italy	175	50	12	60461826	89557	14581
Brown et al ²⁹ (2021)	29 March to 20 May	Canada	78607	5218	1452	37742154	74426	5859
Rutten et al ³⁰ (2020)	18 March to 13 May	Holland	4007	1538	646	17134872	41571	5486
Dolveck et al ³¹ (2021)	26 March to 7 May	France	770	348	94	65273511	114848	24709
Patel et al ³² (2020)	15 March to 15 April	USA	126	35	10	331002651	607342	26010
Tang et al ³³ (2020)	1 March to 12 June	USA	1970	752	155	331002651	2023281	113820
Tarteret et al ³⁴ (2021)	18 March to 12 April	France	375	224	57	65273511	87157	13684
Arons et al ³⁵ (2020)	3 March to 3 April	USA	89	57	15	331002651	245451	6051

Continued.

Reference	Study dates (2020)	Country	Nursing home			Country		
			Resident number	COVID-19 case number	COVID-19 death number	Population	COVID-19 case number	COVID-19 death number
Cangiano et al ³⁶ (2020)	1 March to 30 April	Italy	157	99	43	60461826	202703	27661
Ly et al ³⁷ (2020)	24 March to 2 June	France	1691	226	47	65273511	136073	28159

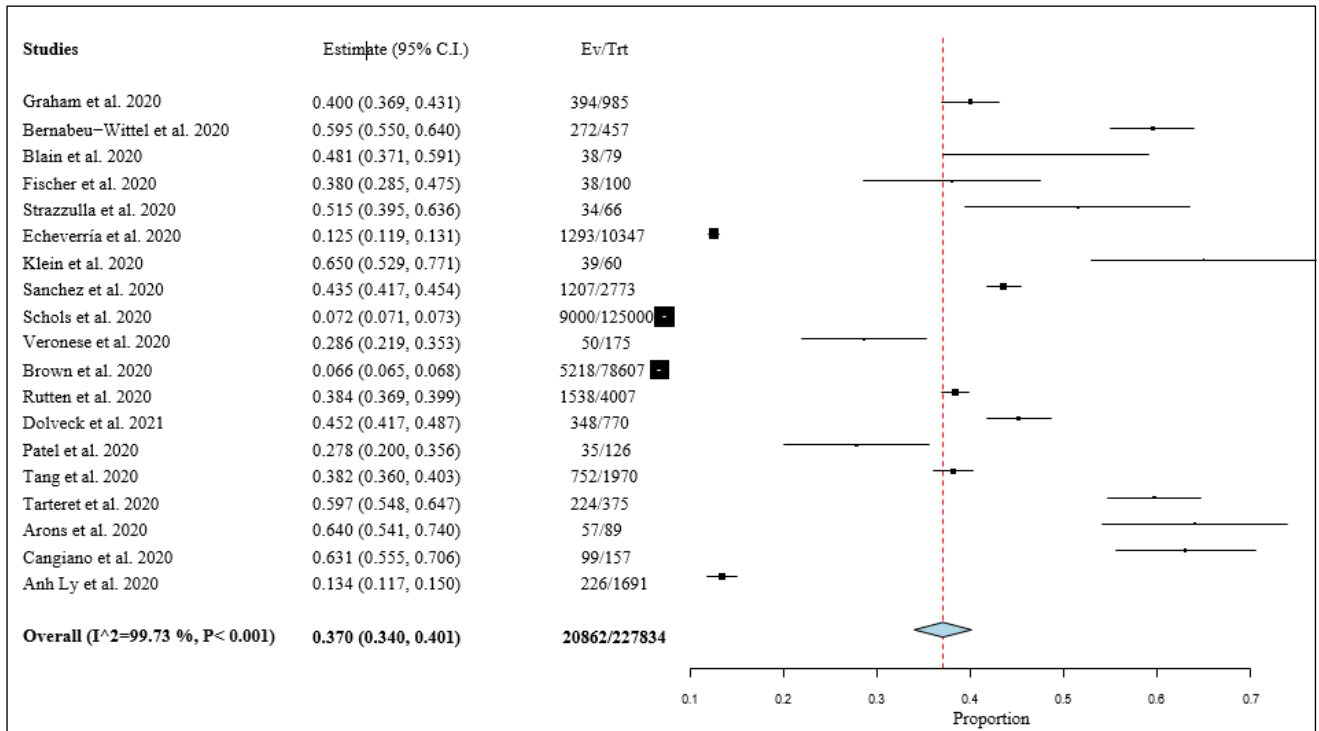


Figure 2: Forest plot of COVID-19 attack rates in nursing homes.

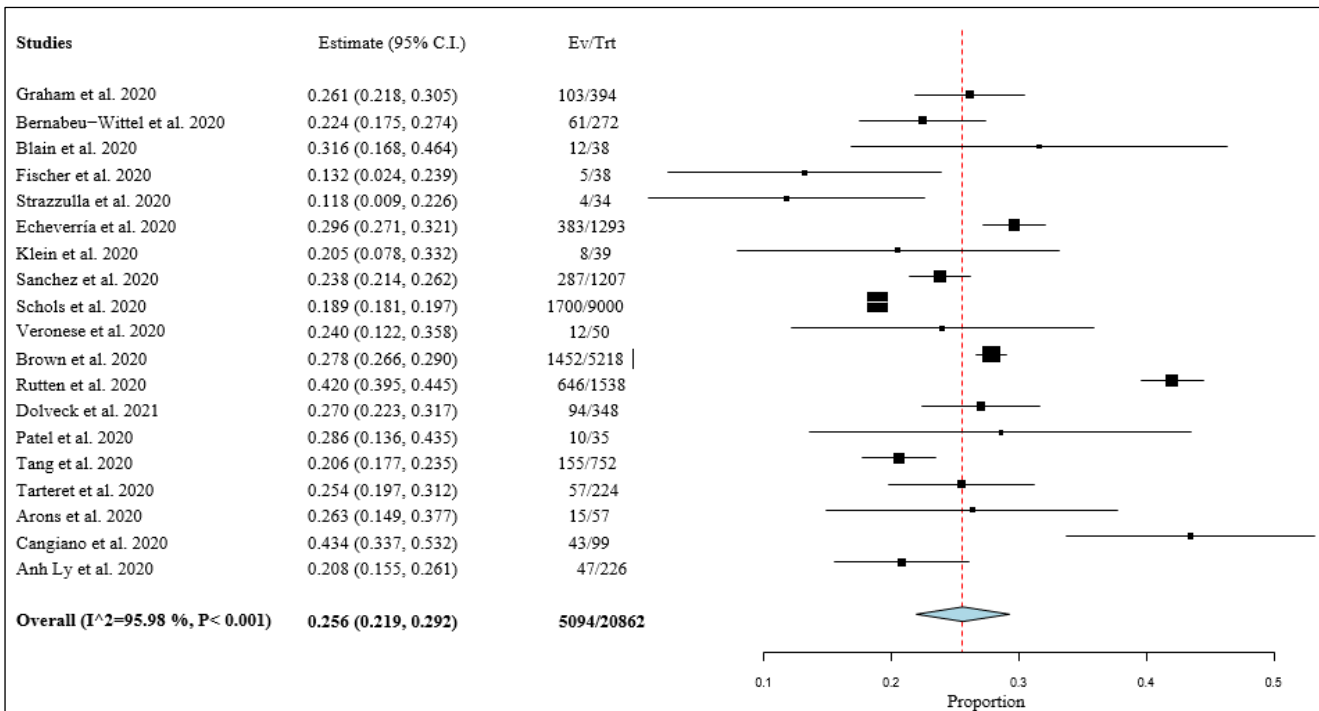


Figure 3: Forest plot of COVID-19 fatality rates in nursing homes.

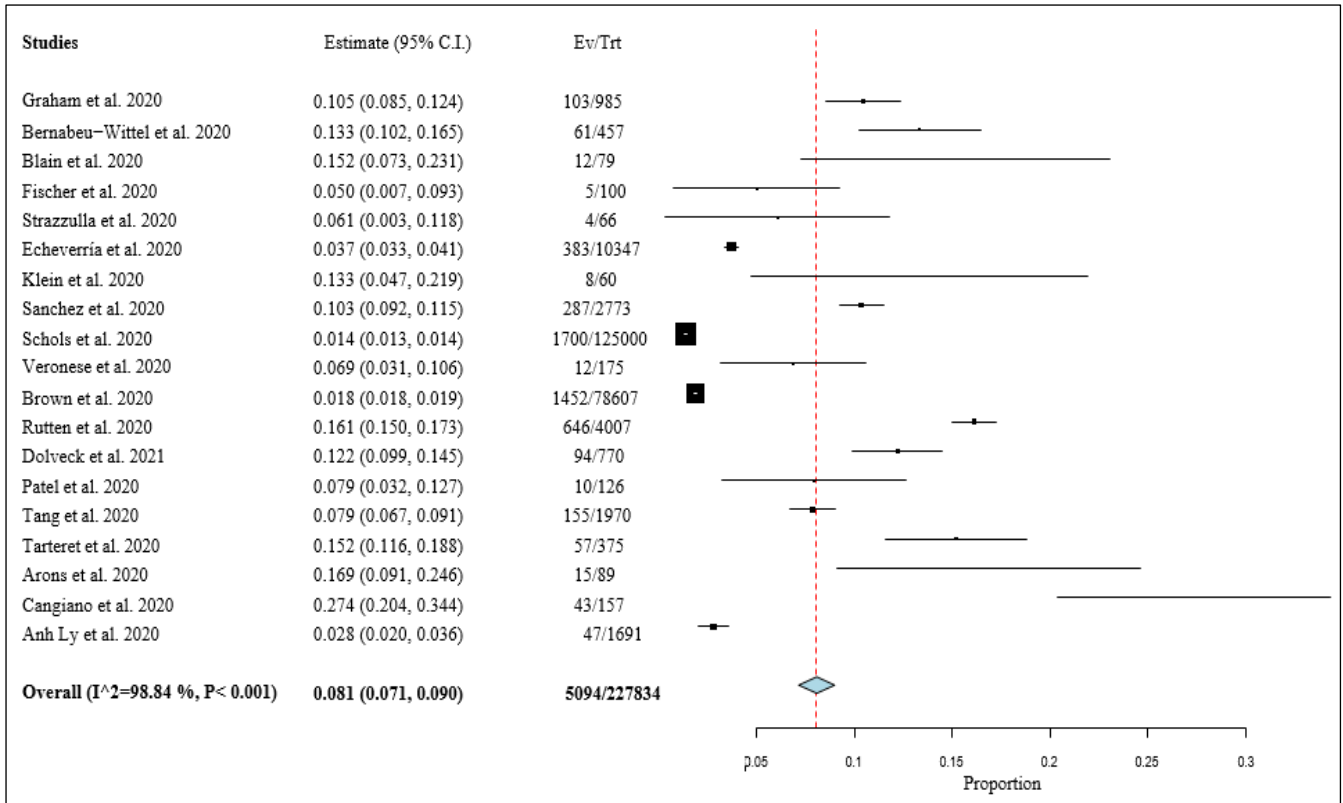


Figure 4: Forest plot of COVID-19 mortality rates in nursing homes.

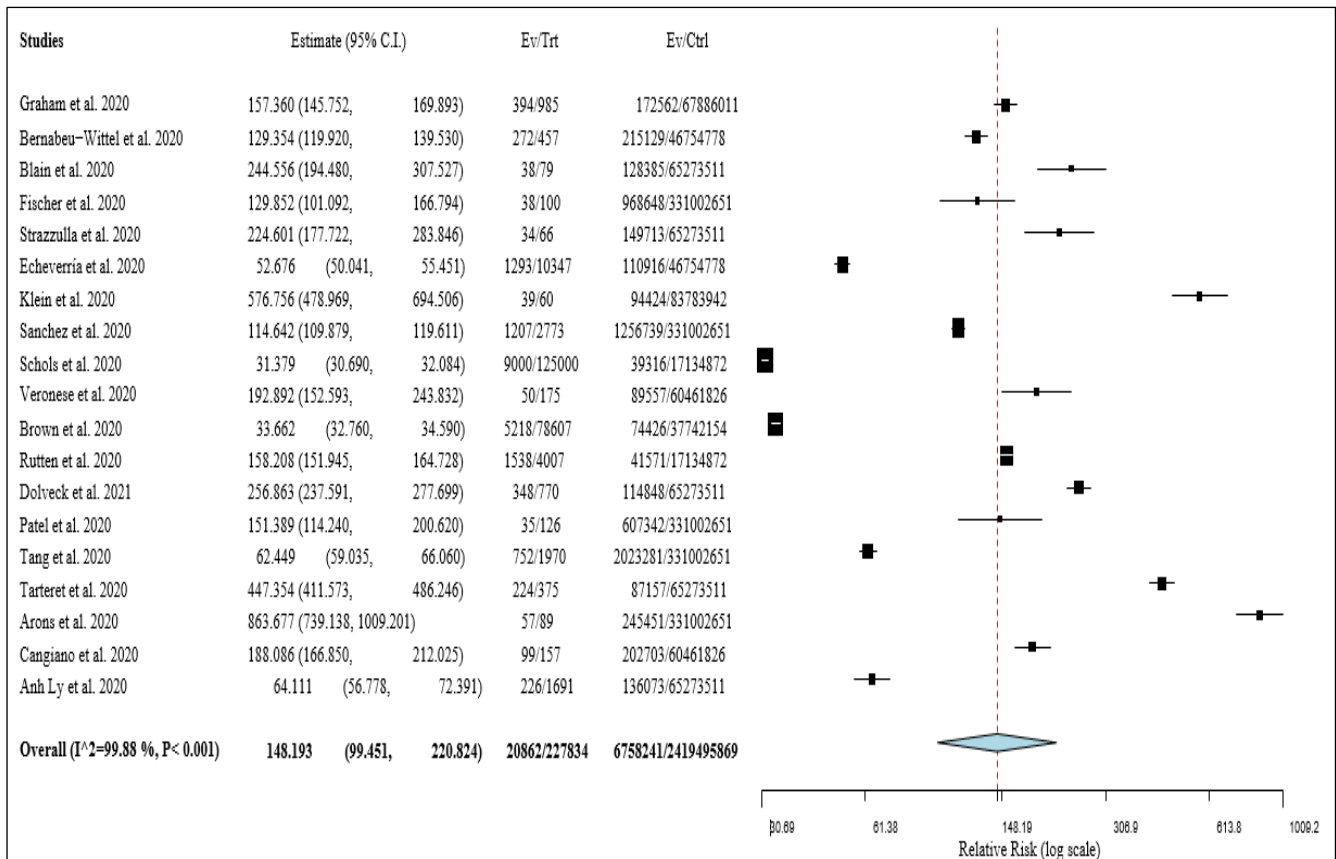


Figure 5: The risk ratio for COVID-19 attack rates in nursing home residents compared with the general population.

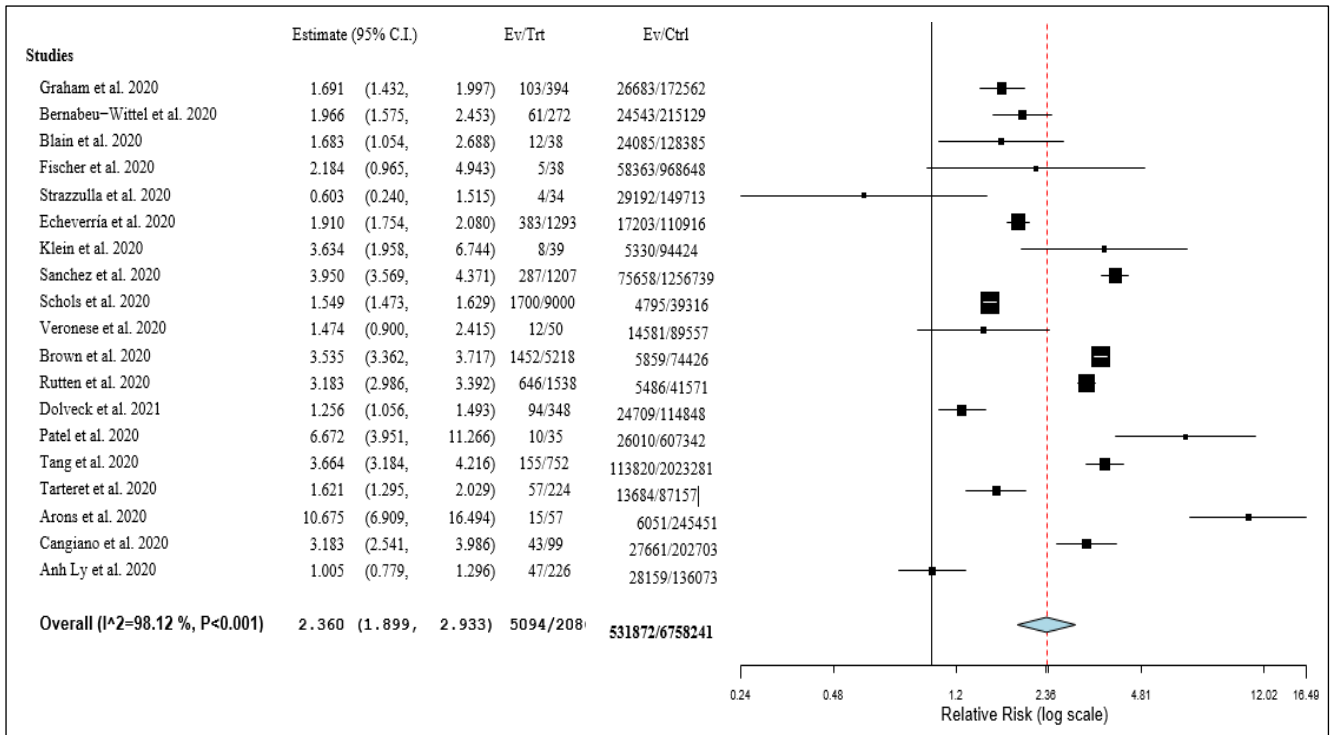


Figure 6: The risk ratio for COVID-19 fatality rates in nursing home residents compared with the general population.

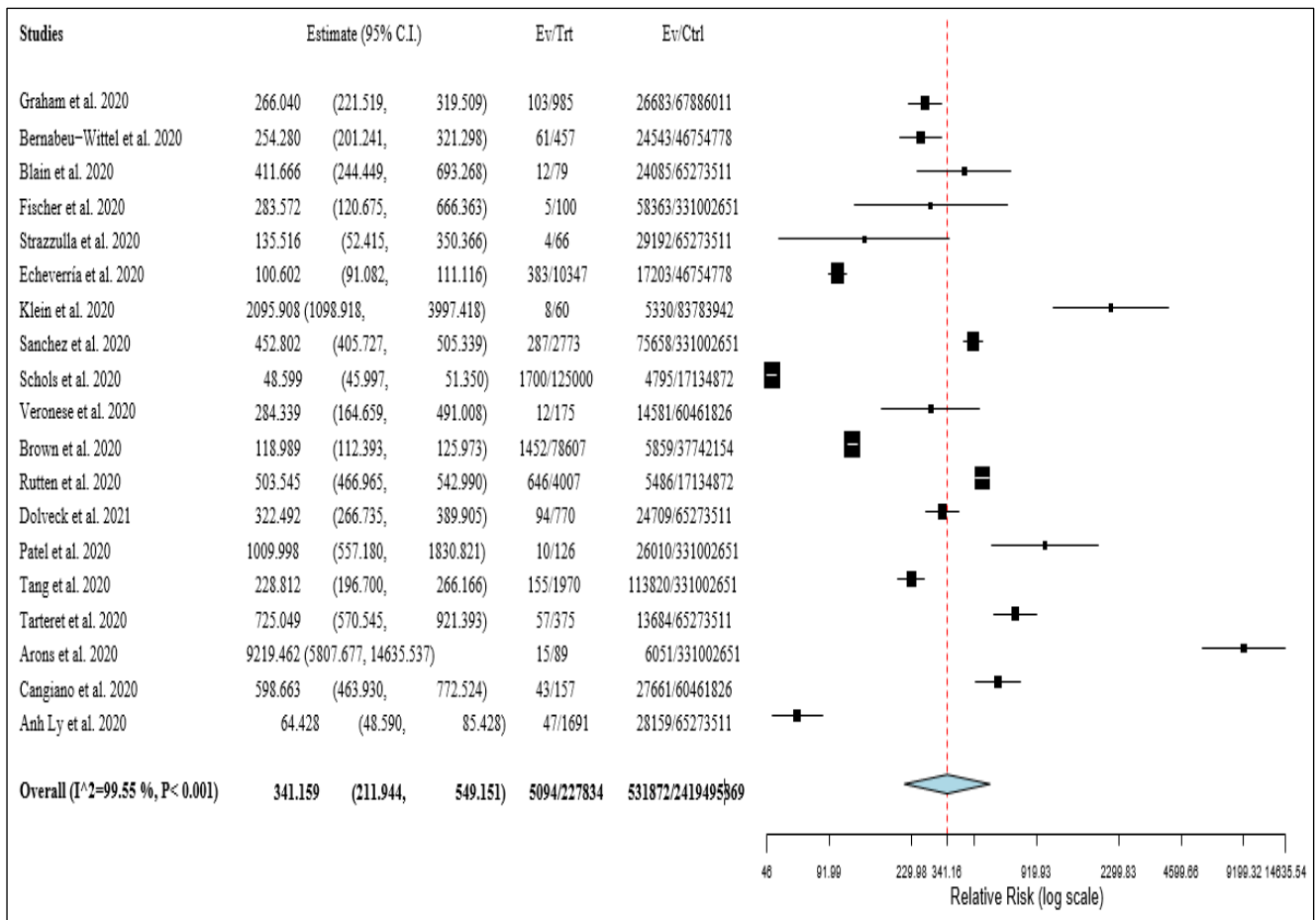


Figure 7: The risk ratio for COVID-19 mortality rates in nursing home residents compared with the general population.

DISCUSSION

Demographic changes have led to an increase in the older adult population and raised the issue of elder care. Nursing homes for the older adult take in older people who do not need to be hospitalized but whose relatives do not care for them, who cannot care for themselves and who are usually alone. In nursing homes for the older adults, the daily needs of patients are met, and medical care is provided.³⁸ Since the beginning of the pandemic, nursing homes have been at the center of the outbreak and played a role in the spread of infection. The study found that attack and mortality rates of COVID-19 in nursing homes were high. The COVID-19 attack rate was calculated to be 37%, the mortality rate was calculated to be 8.1%, and fatality rate was calculated to be 25.6%. Although studies are quite diverse, values indicating high COVID-19 attack rates and mortality rates in nursing homes have been reported from European countries and around the world. In contrast, reports of low COVID-19 rates among nursing home residents, particularly from Asian countries, are noteworthy. In May 2020, a study from Hong Kong reported no COVID-19 deaths in nursing homes.^{7,9,39}

All studies included in the meta-analysis were from European countries and the United States. Between screening dates, relevant studies from other countries were either not found in databases or the studies that were found did not meet the inclusion criteria. As noted by Comas et al, there are significant methodologic problems in comparing nursing home data from different countries.⁷

Studies have been conducted to assess the relative magnitude of COVID-19 attacks and mortality rates in older adults living in nursing homes compared with older adults living in the community. In one such study using this method, individuals living in Canadian nursing homes were found to be five times more likely to die from COVID-19 than older adults living in the community.⁴⁰ Another method is to compare mortality rates among nursing home residents with the pre-pandemic period. In a study from Italy, a comparison with mortality in the previous year showed a 6.7 fold increase in mortality associated with the COVID-19 pandemic.³⁶

Unlike other studies, this study presented the results of the meta-analysis with the values of the risk ratio obtained by comparing the values related to the attack and mortality rates of COVID-19 in nursing homes with the pandemic data in the country at the time covered by the studies. One of the factors affecting the number of COVID-19 cases in nursing homes is the extent of infection in the community. As the pandemic progresses over time, it is expected that a decrease in the number of cases in the population will reduce the number of cases in nursing homes according to the principle of 'flattening the curve'.²⁷ Based on this principle, the study aimed to calculate the impact on the risk of contracting and dying from COVID-19 among nursing home residents in different countries and at different time points. Although the risk ratio of the attack

rate was 148 and the risk ratio of fatality was 341, the risk ratio of mortality rate was calculated to be 2.4. Nursing homes are places where individuals are at risk for infections. The course of infection in the community is important, but the risk may become exaggerated in infectious diseases that prioritize the older adults, such as COVID-19. The most important limitation of the study is that although there are many studies on the prevalence of COVID-19 in nursing home residents, calculations of attack and mortality rates could not be made due to the absence of the number of residents in most studies. Other limitations include the lack of data because permission was not granted in most countries to conduct studies of nursing home residents during the pandemic period and the fact that studies with very small samples of nursing homes or studies that included results from more than one nursing home were included in the meta-analysis.

Age adjustment could not be performed because age-specific rates were not reported in the studies included in the meta-analysis or the corresponding country data. The lack of data on the COVID-19 outbreak in nursing home residents is widely recognised in the literature.^{26,27,35} There are data gaps in the studies due to differences in the principles of performing diagnostic tests, such as testing or not testing asymptomatic individuals or inadequacies in test performance.

Limitations

Despite all limitations, a meta-analysis of well-documented studies has shown that morbidity and mortality rates may be higher in nursing home residents than in the community during a pandemic.

CONCLUSION

This meta-analysis indicated that morbidity and mortality rates may be higher in nursing home residents than in the community during a pandemic. Future studies should explore the effects of the Pandemic crisis and provide strong evidence to policymakers to develop different types of services and coping strategies. There is a need to revise infection rates in the nursing home area while presenting this evidence. Infection rates in the region where the nursing home is located should be considered as a confounding factor and reported after adjusting for potential causal factors. It is critical to assess the pandemic in all community healthcare settings to be prepared for future pandemics. Preventive measures should be taken in facilities with vulnerable groups, such as nursing homes, to ensure better control of COVID-19 and future outbreaks in the community.

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