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Review Article

Risk Factors for Hospital Readmissions among Elderly Patients with Pneumonia: A Systematic Review and Meta-Analysis

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SUMMARY

Background: Several studies have explored the distinct reasons supporting the impact of various factors on hospital readmissions for elderly pneumonia patients. However, we could not find any review to identify the risk factor effect on this outcome. Thus, we did this study to assess the impact of various factors on the rate of hospital readmissions in elderly patients with pneumonia.
Methods: Systematic and comprehensive search was carried out in the following databases & search engines: EMBASE, Cochrane, MEDLINE, ScienceDirect & Google Scholar from 1954 until December 2021. Newcastle Ottawa (NO) scale was utilized to assess the risk of bias. Meta-analysis was carried out using random-effects model and pooled odds ratio (OR) along with 95% confidence interval (CI) was reported.
Results: We included 6 studies comprising of 617,960 participants. Most studies had low risk of bias (good to satisfactory quality). Male gender (pooled OR = 1.19; 95% CI: 1.11–1.28), cancer (pooled OR = 1.68; 95% CI: 1.48–1.91), heart failure (pooled OR = 1.31; 95% CI: 1.20–1.42), chronic respiratory disease (pooled OR = 1.57; 95% CI: 1.23–1.99), chronic kidney disease (pooled OR = 1.50; 95% CI: 1.21–1.85) and diabetes mellitus (pooled OR = 1.15; 95% CI: 1.07–1.24) had significant association with hospital readmission rate among elderly pneumonia patients.
Conclusion: Male gender and chronic comorbid conditions were significant risk factors for hospital readmission among elderly pneumonia patients. Hence, it is important for clinicians and policymakers to frame intervention strategies among the patients.

1. Introduction

The burden and incidence of acute infectious diseases including pneumonia that have traditionally led to hospital admissions are expected to rise over the next few decades, mainly due to the large amount of increase in the population aged above 80 years.[1,2] Hospital admissions for pneumonia patients are required frequently amongst the older adults.[3] The rehospitalization & mortality rate are also found to be higher amongst the older adults surviving initial admission.[3] Hence, majority of the older adults following initial discharge requires special attention from the healthcare providers to reduce short-term admission & mortality rates.

Previous studies have reported that 10% to 20% of the older adults are hospitalized within one month following initial admission for the pneumonia.[3–5] In addition, readmissions increases the chance of iatrogenic complication, challenge the health system with additional cost and increase the treatment burden.[6–8] This trend of having short hospital stays made it to transfer much more complex health task and issue present in such older patients to the primary health care setting following discharge.[9]

Factors that are associated with the short-term readmissions have been studied previously extensively. However, only very little evidence exists on the elderly patients who are at risk of having readmissions following discharge from pneumonia. The existing studies also have not produced any conclusive results because of their smaller sample sizes, differences in the definition of pneumonia, joint pooling of the in-hospital and post-discharge deaths and lower generalizability.[10–18] Such evidence is urgently required to make sure that the health care attention has been given to those patients with the highest level of needs. To the best of our knowledge there has been no effort to pool data on the risk factors for hospital readmissions in elderly patients with pneumonia. Thus, the purpose of the present study shall be to pool data from individual studies to find the risk factors for 30-day hospital readmissions in elderly patients for pneumonia.

2. Methods

2.1. Eligibility criteria

2.1.1. Study design

Any observational studies irrespective of study design (cross-sectional/cohort/case-control/) were included, given that they satisfy the inclusion criteria. Full-text articles were included while the conference abstracts/case series/case reports and grey literature were excluded.

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2.1.2. Study participants

Studies containing the elderly pneumonia patients aged ≥ 60 years were incorporated, while those including only specific diseased group were excluded.

2.1.3. Exposure

Studies evaluating any sociodemographic, comorbidity or behavioural risk factors with hospital readmissions. At least three studies should have reported the particular risk factor to be eligible for inclusion in the review.

2.1.4. Outcome

Rate of hospital readmission within 30 days' time interval for pneumonia across the different sociodemographic, behavioural and comorbidity factors were included.

2.2. Search strategy

Literature search was executed in the databases like EMBASE, Cochrane library, MEDLINE and search engines like Google Scholar and ScienceDirect (Supplementary Appendix). We combined medical subject headings (MeSH) & free-text terms for running the search. We did the final search using the suitable Boolean operators ("AND" & "OR"). The following filters were applied during the search: time point (January 1954 to December 2021), language (English only) and design (observational study). References from the retrieved articles are also searched to find any missed out articles during the literature search.

2.3. Study selection process

The selection process has involved 3 stages:

(1) Two independent investigators (NZ and QC) did the screening of title and abstract during literature search. Full-text studies were retrieved after shortlisting based on the inclusion criteria.
(2) Retrieved full texts were then screened by the same set of investigators (NZ and QC) and assessed against inclusion criteria. Studies satisfying the criteria were finally included and for the excluded studies, reason for exclusion was noted down.
(3) Disagreements arising out of the study selection process were resolved and final consensus was reached with the assistance of another investigator (YJ).

"*Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement 2020*" was used for reporting this review.[19]

2.4. Data extraction process

Manual extraction of data was done using a pre-defined structured data extraction form. Data extracted using the form were as follows: authors, title of study, year of publication, study period, study design, setting, country/region, total sample size, outcome assessment details, average age, primary and secondary outcomes in each approach. Data entry was done by the first author (NZ) and the entry was checked again by the second author (QC) for the correctness of entry.

2.5. Risk of bias assessment

Two independent authors (NZ and QC) executed assessment of bias risk using Newcastle Ottawa (NO) scale for the observational studies. It includes following domains: Selection (four stars), Comparability (two stars) & Outcome (two stars). The final score ranges from zero to eight stars, with studies ranging from 7–8 stars indicates "good", 5–6 stars indicates "satisfactory", & 0–4 stars indicates "unsatisfactory" quality.[20]

2.6. Statistical analysis

Meta-analysis was carried out using STATA version 14.2 (StataCorp, CollegeStation, TX, USA). Since the outcomes were binary, number of events and sample size in each group was entered and the final estimate was interpreted in terms of pooled odds ratio (OR). Random effects model with inverse variance was performed to account for the methodological heterogeneity.

Heterogeneity was evaluated using chi square test & quantified the amount of inconsistency in terms of I^2 statistic. The interpretation of I^2 was as follows: I^2 < 25% = mild, 25–75% = moderate and > 75% = substantial heterogeneity.[21] Forest plot was used to visually depict the study specific estimate & pooled estimate. Sensitivity analysis was executed to evaluate the robustness of pooled estimate by removing each study one-by-one and checking for any variation in the magnitude or direction of the association. Meta-regression or assessment of publication bias could not be performed as the final number of included studies was less than 10 (6 studies).

3. Results

3.1. Study selection

In total, 2,421 records were identified through literature search and 110 of these studies were found to be relevant and full text was obtained. Four additional articles were retrieved by going through the references of the retrieved full texts during primary screening. After final screening against eligibility criteria, the final consensus was reached for including 6 studies containing 617,960 participants (Figure 1).[11,22–26]

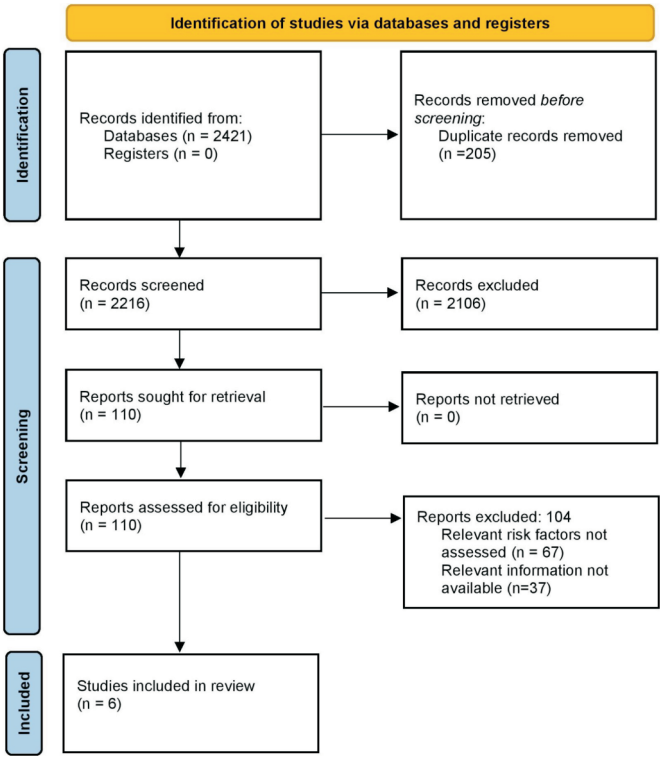

Figure 1. PRISMA flowchart.

3.2. Characteristics of the included studies

Almost all the studies (5 out of 6 studies) were retrospective in nature. Most included studies (4 out of 6) were conducted in European countries such as Denmark, United Kingdom, and Spain. The sample sizes ranged from 956 to 298,872. About 5 studies each have reported on the outcomes such as gender, cancer, heart failure, dementia, and chronic respiratory disease, 4 studies each have reported on chronic kidney disease and diabetes mellitus, and 3 studies have reported on age more than 85 years (Table 1). All the included studies had good to satisfactory quality (Table 2).

3.3. Predictors of hospital readmissions among elderly pneumonia patients

3.3.1. Gender and hospital readmissions

Five studies have described on the risk of readmissions between male & female elderly pneumonia patients. The pooled OR was 1.19 (95% CI: 1.11–1.28; I^2 = 53%), indicating that the males have 1.19 times higher odds of having hospital readmissions when compared to female elderly pneumonia patients and this association was significant ($p < 0.001$) (Figure 3).

3.3.2. Dementia and hospital readmissions

Five studies have reported on the risk of readmissions between dementia and non-dementia elderly pneumonia patients. The pooled OR was 0.96 (95% CI: 0.83–1.12; I^2 = 97%), indicating that there is no significant association between dementia and hospital readmissions among elderly pneumonia patients (Figure 4).

3.3.3. Diabetes mellitus and hospital readmissions

Four studies have reported on the risk of readmissions between diabetes and non-diabetes elderly pneumonia patients. The pooled OR was 1.15 (95% CI: 1.07–1.24; I^2 = 33%), indicating that the diabetes patients have 1.15 times higher odds of having hospital readmissions when compared to non-diabetes elderly pneumonia patients and this association was significant ($p < 0.001$) (Figure 5).

3.3.4. Chronic respiratory disease and hospital readmissions

Five studies have reported on the risk of readmissions between patients with and without chronic respiratory disease. The pooled OR was 1.57 (95% CI: 1.23–1.99; I^2 = 96%), indicating that the patients with chronic respiratory disease have 1.57 times higher odds of having hospital readmissions when compared to patients without chronic respiratory disease and this association was significant ($p < 0.001$) (Figure 6).

3.3.5. Chronic kidney disease and hospital readmissions

Four studies have reported on the risk of readmissions between patients with and without chronic kidney disease. The pooled OR was 1.50 (95% CI: 1.21–1.85; I^2 = 59%), indicating that the patients with chronic kidney disease have 1.50 times higher odds of having hospital readmissions when compared to patients without chronic kidney disease and this association was significant ($p < 0.001$) (Figure 7).

3.3.6. Heart failure and hospital readmissions

Five studies have reported on the risk of readmissions between patients with and without heart failure. The pooled OR was 1.31 (95% CI: 1.20–1.42; I^2 = 39%), indicating that the patients with heart failure have 1.31 times higher odds of having hospital readmissions when compared to patients without heart failure and this association was significant ($p < 0.001$) (Figure 8).

3.3.7. Cancer and hospital readmissions

Five studies have reported on the risk of readmissions between patients with and without cancer. The pooled OR was 1.68 (95% CI: 1.48–1.91; I^2 = 76%), indicating that the patients with cancer have 1.31 times higher odds of having hospital readmissions when compared to patients without cancer and this association was significant ($p < 0.001$) (Figure 9).

3.4. Additional analysis

Sensitivity analysis has revealed no significant variation in the effect size (in terms of magnitude and direction). This indicates a lack of single study effect on the overall estimate for any of the outcomes. Funnel plot for publication bias and meta-regression for exploring the heterogeneity cannot be done due to limited number of studies.

4. Discussion

Almost one in five pneumonia patients have hospital readmissions, and it varies depending on the study setting and region.[27] Such readmissions to the hospital following an episode of pneumonia are becoming a relatively frequent event, specifically among the older adults and patients with various co-morbidities.[28] Hence, it is important to identify the patients at high-risk of getting admitted again in the hospital as early as possible and prevent future complications. Despite its importance, it has been unclear about the role of various risk factors on hospital readmission rate among elderly pneumonia patients. Hence, we did this systematic review to study the risk of various factors on hospital readmission rate among elderly pneumonia patients.

In total, we have found 6 studies fulfilling the eligibility criteria. Most of these studies were conducted in European region. Though, most studies followed retrospective design, all of them were of good to satisfactory quality. We found that males had significantly higher odds of having hospital readmissions when compared to female pneumonia patients. Co-morbidities such as diabetes mellitus, cancer, heart failure, chronic respiratory disease and chronic kidney disease were also significantly associated with the risk of readmissions among elderly pneumonia patients. Sensitivity analysis revealed no significant single-study effect on the magnitude or direction of association.

Although, there was no previous reviews to compare our study findings, the possible impact of such association has been explored using the previous literature. Several pneumonia readmissions among elderly are unavoidable as one in six patients might fail to resolve completely in spite of appropriate treatment.[29] Such patients might end up developing serious complications that requires hospital readmissions.[29] Several host factors like gender, immunocompromising conditions (cancer, diabetes mellitus), heart failure, and chronic respiratory and kidney disease might increase the number of pneumonia cases that fail to resolve completely and increase the risk of readmission as found in our study. In other words, such significant proportion of readmissions due to the pneumonia-related causes can be unavoidable.

However, these findings are relevant as the most frequent reason for the 30-day hospital readmission amongst pneumonia cases has not been pneumonia but the decompensation of the associated comorbid conditions.[30] Previous evidences have also shown that majority of the pneumonia readmissions are due to the unstable

Table 1
Characteristics of the studies included (N = 6).

S.N.	Author and year	Country	Study design	Sample size	Mean age (in years)	Study participants	Risk factors reported
1.	Chakrabarti et al. 2021[22]	United Kingdom	Retrospective analysis of data	10,366	73	All community acquired pneumonia cases submitted by the nine participating hospitals in the AQ Pneumonia Programme between 1 January 2017 and 31 March 2019.	Gender, Dementia, Heart failure, Cancer, CRD, CKD, DM
2.	Graversen et al. 2020[23]	Denmark	Retrospective analysis of data	298,564	NR	All Danish residents aged 65–99 years, who had been discharged after a pneumonia-related hospital admission, referred to as index admission, during our study period.	Age, Gender, Dementia, Heart failure, Cancer, CRD, DM
3.	Graversen et al. 2021[24]	Denmark	Retrospective analysis of data	298,872	NR	All Danish citizens aged 65–99 years, who were discharged after a hospital admission (index admission) with a primary or secondary diagnosis of pneumonia as defined by the allocation of diagnostic codes (ICD-10: J12-J18, A709, or A481).	Dementia
4.	Lee et al. 2017[25]	Republic of Korea	Retrospective cohort	7,446	NR	Patients older than 65 years who were hospitalized with pneumonia between 2003 and 2013.	Age, Gender, Dementia, Heart failure, Cancer, CRD, CKD
5.	Mather et al. 2013[11]	United States of America	Retrospective cohort	956	NR	Adult patients admitted to Hartford Hospital from January 2009 to March 2012 with principal diagnosis of pneumonia (International Classification of Diseases, 9th Revision, Clinical Modification codes 480.XX, 481, 482.XX, 483.X, 485, 486, and 487.0) as potential index pneumonia admission.	Gender, Dementia, Heart failure, Cancer, CRD, CKD, DM
6.	Toledo et al. 2018[26]	Spain	Cross-sectional	1,756	NR	Patients included were aged ≥ 65 years admitted through the emergency department to any of the participating hospitals for ≥ 24 hours with a chest X ray showing pulmonary infiltrate compatible with pneumonia and ≥ 1 of the following symptoms or signs of acute lower respiratory tract infection: cough, pleural chest pain, dyspnoea, fever > 38 °C, hypothermia < 35 °C and abnormal auscultator respiratory sounds unexplained by other causes.	Age, Gender, Heart failure, Cancer, CRD, CKD, DM

CKD, chronic kidney disease; CRD, chronic respiratory diseases; DM, diabetes mellitus; NR, not reported.

Table 2
Quality assessment of the included studies (N = 6).

S.N.	Author and year	Representativeness	Sample size justification	Non-response	Ascertainment of exposure	Control for confounding	Assessment of outcome	Statistical tests	Overall quality
1.	Chakrabarti et al. 2021[22]	*	0 star	0 star	*	**	*	*	Satisfactory
2.	Graversen et al. 2020[23]	*	*	*	*	**	*	*	Good
3.	Graversen et al. 2021[24]	*	0 star	*	*	**	*	*	Good
4.	Lee et al. 2017[25]	*	*	0 star	*	**	*	*	Good
5.	Mather et al. 2013[11]	0 star	0 star	0 star	*	**	*	*	Satisfactory
6.	Toledo et al. 2018[26]	*	0 star	0 star	*	**	*	*	Satisfactory

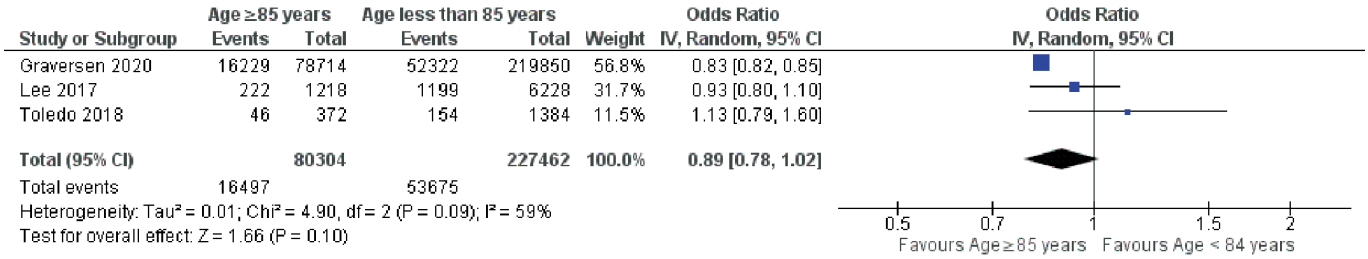

Figure 2. Forest plot showing the association between age and hospital readmission rate among elderly pneumonia patients.

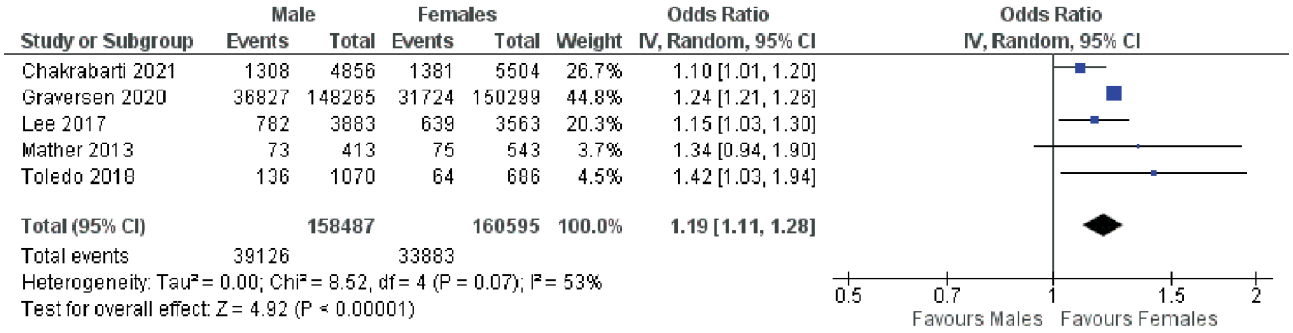

Figure 3. Forest plot showing the association between gender and hospital readmission rate among elderly pneumonia patients.

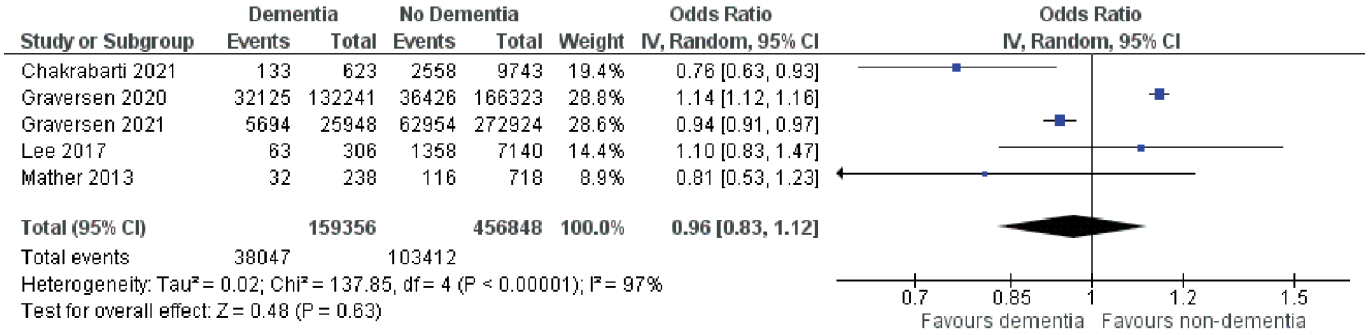

Figure 4. Forest plot showing the association between dementia and hospital readmission rate among elderly pneumonia patients.

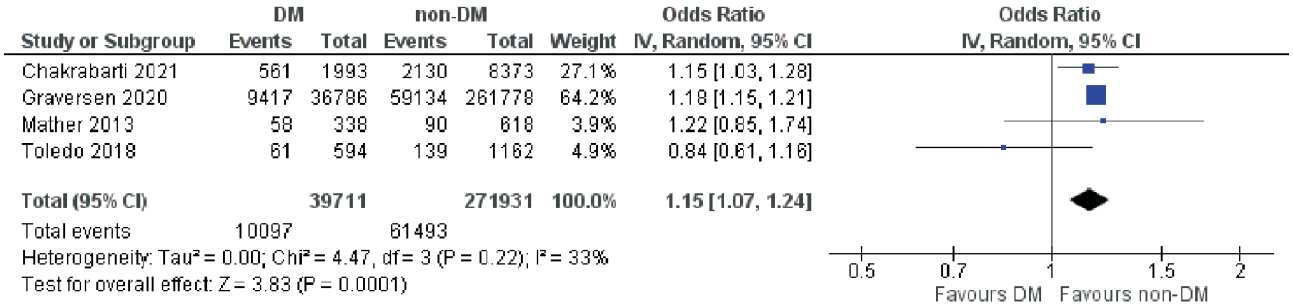

Figure 5. Forest plot showing the association between diabetes mellitus and hospital readmission rate among elderly pneumonia patients.

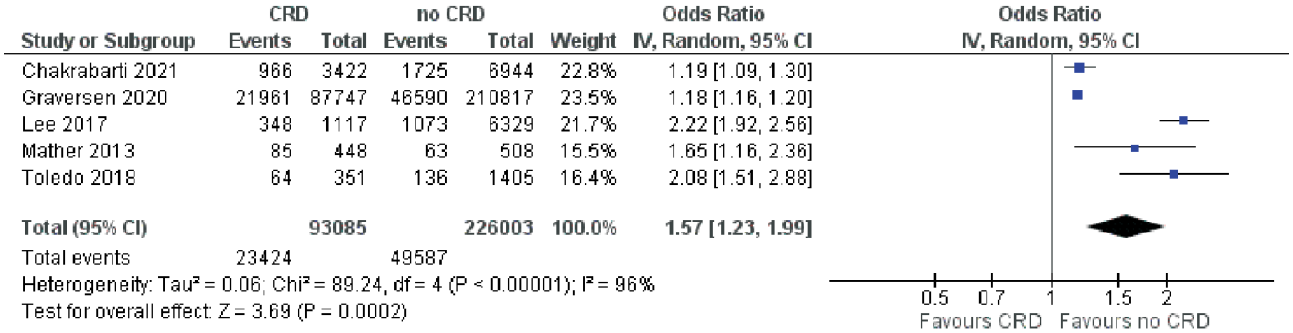

Figure 6. Forest plot showing the association between chronic respiratory disease and hospital readmission rate among elderly pneumonia patients.

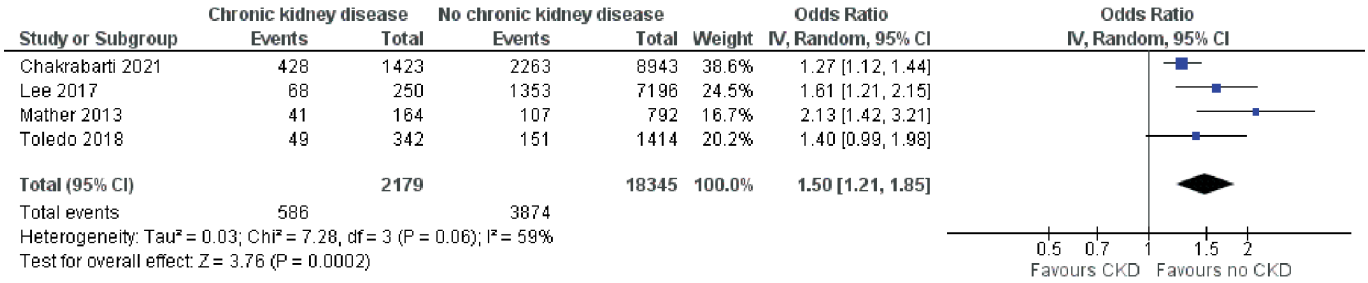

Figure 7. Forest plot showing the association between chronic kidney disease and hospital readmission rate among elderly pneumonia patients.

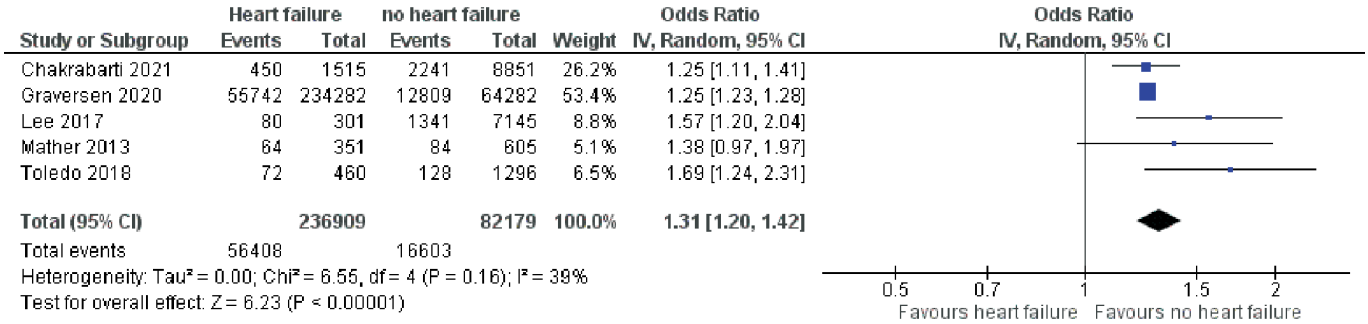

Figure 8. Forest plot showing the association between heart failure and hospital readmission rate among elderly pneumonia patients.

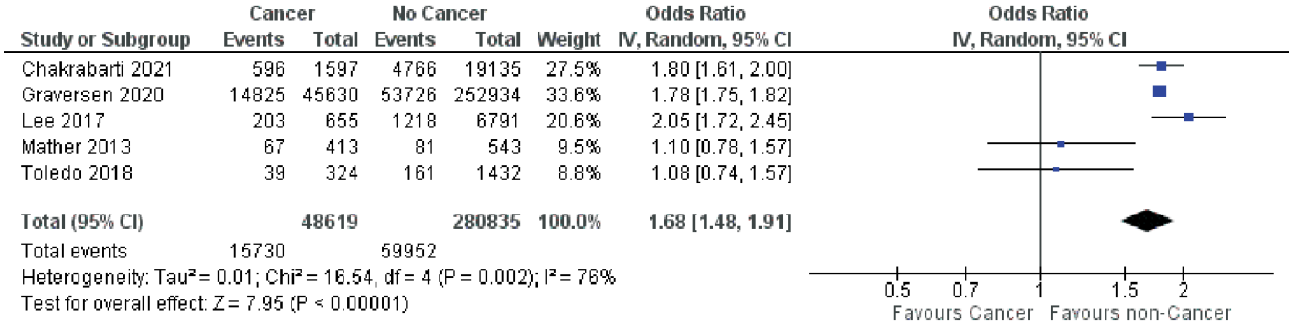

Figure 9. Forest plot showing the association between cancer and hospital readmission rate among elderly pneumonia patients.

comorbidities.[31] Hence, it is important to develop interventions that are aimed at reducing the all-cause readmission rates as it would in turn have a significant impact on the pneumonia readmission rate. Almost all the top five diagnoses of the potentially avoidable readmission for each of the comorbidities were either possible direct or an indirect complication of that particular comorbidity. For example, patients with diabetes mellitus, atrial fibrillation, heart failure, ischemic heart disease, or chronic kidney disease, the most common cause and diagnosis of the potentially avoidable hospital readmission was the acute heart failure. Hence, ensuring stability of the comorbidities at the time of discharge amongst patients at high risk of having potentially avoidable readmissions, like patients with heart failure, kidney failure and cancer, would impact the all-cause readmission rate and the pneumonia readmission rate. Further research is required to explore the potential intervention to evaluate and ensure the clinical stability at the level of discharge, particularly amongst patients with the multiple and interrelated comorbidities.

In many other cases, the pneumonia readmissions may be not related to the initial pneumonia episode or the comorbidity decompensation but related to certain other causes like hospital acquired infections, acute conditions, or trauma. With enhanced care, these numbers of readmission because of the hospital-acquired infections might decrease; however, a significant portion of these cases may remain as potentially unavoidable readmissions. Despite all this evidence, there is a need to study in detail about how these factors of an individual modifies the readmission rate among pneumonia patients.

The major strength of this review was the rigorous methodology in the systematic review process. In addition, this review adds to the limited evidence available on the association between sociodemographic and comorbid risk factors and hospital readmissions among elderly pneumonia patients. We found that almost all studies included were of higher quality and had a standard-criteria for defining hospital readmission (30-day hospital readmission). This enhances the credibility of the evidence and external validity (generalisability) of the findings. No significant change in magnitude or direction of association was found in sensitivity analysis.

However, there are some limitations in this study. Substantial between-study variability was found for majority of the outcomes. Exploration of such high heterogeneity cannot be done with the meta-regression due to the limited number of studies. In addition, we could not assess the possibility of publication bias with any of the outcomes, due to similar reasons. Almost all the studies followed retrospective design, making it difficult to establish the causal association. Hence, longitudinal evidences are required for the identification of reliable effect size and help in making evidence-based recommendations for developing interventions at the hospital setting. Finally, we did not search the non-English databases which might limit the number of studies included in the review.

Despite these limitations, our study has certain important im-

plications for the clinicians and researchers. We have provided important baseline information on the risk factors of hospital readmissions among elderly pneumonia patients. This knowledge will help the clinicians to identify the elderly pneumonia patients at risk of readmission during the initial visit itself and provide targeted therapies to avoid such readmissions in the future. However, the researchers have further role to develop more high-quality longitudinal studies to identify the risk factors and develop a model scoring system that can be applied during the time of first pneumonia admission among elderly patients.

5. Conclusion

Male gender and chronic comorbid conditions such as diabetes mellitus, heart failure, chronic respiratory disease, chronic kidney disease, and cancer were significant risk factors for hospital readmission among elderly pneumonia patients. It is important for the clinicians and policymakers to identify these target group patients and frame appropriate intervention strategies to prevent the readmission for elderly pneumonia.

Declaration of any potential financial and non-financial conflicts of interest

None.

Supplementary materials

Supplementary materials for this article can be found at http://www.sgecm.org.tw/ijge/journal/view.asp?id=24.

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