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Effectiveness of inpatient geriatric rehabilitation in those with cognitive impairment: a secondary analysis of meta-analysis data

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Abstract

Background Geriatric rehabilitation reduces mortality and long-term care home (LTCH) admission. However, cognitive impairment is often perceived to be a barrier for successful rehabilitation. Our objective was to determine the impact of cognitive impairment on rehabilitation outcomes using a systematic review of inpatient geriatric rehabilitation.

Methods We conducted a secondary analysis of a recent systematic review and meta-analysis of geriatric rehabilitation in the inpatient settings. We screened 29 randomized controlled trials (RCTs) included in the original systematic review for those that reported rehabilitation outcomes (e.g. mortality, LTCH admission) by cognitive status (high vs. low cognition as defined by score cutoff or dementia diagnosis). Results were analyzed by (i) a meta-analysis of outcomes in those with cognitive impairment and (ii) pooling the within study interaction by cognitive status.

Results Of 29 RCTs, 8 RCTs (1134 patients) reported outcomes by cognitive status. For the subgroup of patients with cognitive impairment, the risk ratio (RR) of mortality at the longest follow up was 0.75 (95% confidence interval [CI] 0.39 to 1.45, $I^2 = 61.0\%$) and the RR of LTCH admission was 0.89 (95% CI 0.62 to 1.28, $I^2 = 0$). There was no interaction between baseline cognitive status and mortality (pooled interaction of difference in logRR – 0.12, 95% CI -0.72 to 0.48) or LTCH admission (pooled interaction 0.17, 95% CI -0.34 to 0.68).

Conclusions There is no interaction between baseline cognitive status and the outcomes in this systematic review, suggesting that baseline cognitive impairment does not alter the mortality and institutionalization benefits of geriatric rehabilitation.

Review registration PROSPERO: CRD42022345078.

Keywords Geriatric rehabilitation, Function, Inpatient, Systematic review, Meta-analysis, Cognitive impairment, Dementia

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Background

Geriatric rehabilitation is a multidisciplinary intervention that aims to restore or optimize function in older adults who experience functional decline due to illness or injury [1]. A key part of the intervention is to progressively regain mobility and function, which is thought to require retention of information and motivation to participate [2]. Cognitive impairment is common in older adults requiring geriatric rehabilitation, affecting up to 80% of patients [3]. Cognitive impairment often affects a patient's ability to learn [4] and may impact motivation in those with apathy [5]. However, patients with cognitive impairment also have a higher risk of functional decline after hospitalization [6], highlighting the need to provide rehabilitation to these individuals to optimize their quality of life and independence.

Early observational studies determined that older adults with cognitive impairment do not benefit from rehabilitation [7, 8], particularly those with moderate to severe cognitive impairment [7]. Qualitative studies of health care providers revealed uncertainty around how to approach rehabilitation in older adults with cognitive impairment [9] and how worthwhile rehabilitation is in patients with dementia [10]. This perception of futility has real world consequences leading to lower odds of undergoing hospital-based rehabilitation in patients with dementia [11]. Even when rehabilitation is offered, an observational study found that patients with cognitive impairment received fewer therapy hours than those without cognitive impairment, which may have contributed to worse functional outcomes [12].

More recent observational studies found that older adults with cognitive impairment can benefit from geriatric [3, 13] and stroke rehabilitation [14]. Given the uncertainty in benefit of geriatric rehabilitation in those with cognitive impairment in observational studies, summary evidence from RCTs would be helpful. Furthermore, an exploration of the benefit of geriatric rehabilitation in those with cognitive impairment is particularly important as the prevalence of dementia is expected to rise from 57.4 million cases globally in 2019 to 152.8 million cases in 2050 [15].

We recently completed a systematic review and meta-analysis of geriatric rehabilitation in the inpatient and day hospital settings [16]. In the included 29 RCTs, we found that geriatric rehabilitation reduced mortality and long-term care home (LTCH) admissions. The intervention also improved functional status, cognition, and the number of individuals discharged or remaining at home. Some of the included trials reported the outcomes by cognitive status (i.e., patients with cognitive impairment or patients without cognitive impairment). The objective of this study was to determine whether cognitive impairment modifies the efficacy of geriatric rehabilitation.

Methods

The original systematic review was prospectively registered (PROSPERO: CRD42022345078). The review conduct was guided by the Cochrane Handbook for Systematic Reviews of Interventions [17] and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [18]. As the full review methodology was previously published [16], we briefly summarised the methods below.

Eligibility criteria

For the systematic review, we included RCTs of geriatric rehabilitation interventions compared with usual care. The population consisted of older adults (mean age ≥ 65 years) with any indication for rehabilitation. The geriatric rehabilitation intervention had to be designed for older adults and include a multidisciplinary component (at least occupational or physical therapy). For this current analysis, we only included trials that reported outcomes by cognitive status (i.e., with or without cognitive impairment). Although we included inpatient and day hospital settings in the original review, all of the trials that reported outcomes by cognitive status were done in the inpatient setting.

Information sources and search strategy

A comprehensive literature search was conducted by an experienced librarian (JM) using MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, PsycINFO, PEDro and EBSCO AgeLine (from inception to September 21, 2022). The search strategy was peer reviewed by a second librarian using the Peer Review of Electronic Search Strategies (PRESS) checklist [19]. The grey literature and conference proceedings were included, as well as references of included articles and related systematic reviews. The search strategy was previously published [16]. We did not update the search since September 2022 because the evidence for this field is not rapidly evolving [20].

Study selection and data collection process

Records were screened by two team members independently for level 1 (titles and abstract) and level 2 (full text). A calibration exercise was done prior to each screening stage using a sample of 50 records to ensure good agreement (≥ 80%). The data were abstracted by two team members independently after a pilot abstraction exercise was completed using three studies (agreement ≥ 80%). Discrepancies were resolved by a third reviewer.

Data items

We abstracted study characteristics (e.g., author, year of publication), participant characteristics (e.g., mean age, sex), intervention characteristics (e.g., setting, indication for rehabilitation, team members), and outcomes at the longest follow up. Patient characteristics associated with health equity were abstracted based on the PROGRESS-Plus framework (e.g. place of residence, race, ethnicity, culture, language, occupation, gender, sex, religion, education, socioeconomic status, social capital) [21, 22]. The primary outcomes of interest included mortality, LTCH admission, and functional status (continuous outcome by a functional score). Secondary outcomes included functional improvement (dichotomous outcome as defined by the study authors), remaining home (number of patients living at home), cognition (continuous outcome by cognitive score), mood (continuous outcome by mood/depression score), and quality of life (continuous outcome by quality of life score).

Risk of bias assessment

We assessed the risk of bias in each study using the Cochrane Risk of Bias 2 tool [23] completed by two team members independently (PH and EW).

Synthesis of included studies

The impact of cognitive impairment on primary outcomes was explored in two ways: (i) forest plots of the subset of patients with cognitive impairment (and those without cognitive impairment) and (ii) calculating the interaction of cognitive impairment and outcome.

We descriptively summarised study characteristics, patient characteristics and risk of bias assessments. Only outcomes with cognitive subgroup data were analysed. A pairwise meta-analysis was used to pool outcomes in patients with cognitive impairment. Some studies reported only one subgroup (e.g., only those with cognitive impairment), which was included in the cognitive subgroup meta-analysis. Outcomes that were reported in fewer than two studies could not be pooled. Risk ratios (RR) were used to pool binary outcomes (mortality, LTCH admission, functional improvement, remaining home). Standardised mean differences (SMD) were used to pool continuous outcomes with different units of measure (functional status [e.g., Barthel and Katz scales]) and mean differences (MD) were used to pool continuous outcomes reported using the same unit (length of stay and cognition). A random effects model [24] with 95% confidence intervals (95% CI) was used for the analysis. Meta-analysis was done using the "meta" and "metafor" packages [25] in R [26]. Between-study variance was estimated using the restricted maximum likelihood (REML) method with Hartung-Knapp/Sidik-Jonkman (HKSJ) adjustments due to the small number of studies [27]. Heterogeneity was quantified using the I^2 statistic [28].

Exploration of the interaction of cognitive impairment on outcomes was done using the method described by Fisher et al. [29] and Altman et al. [30]. Interaction calculations were only possible for studies that presented outcomes for both subgroups (i.e. cognitive impairment and no cognitive impairment). The within-study interaction was calculated by the difference in effect estimates of the two cognitive subgroups in each study (interaction = cognitive impairment subgroup – no cognitive impairment subgroup) [29]. For binary outcomes (mortality and LTCH admission), we used log-transformed RR (logRR) to calculate the mean difference between cognitive subgroups (Supplementary Appendix E for R code). A significant pooled interaction in logRR can be exponentiated as a ratio of RR for interpretation. For continuous outcomes (functional status and length of stay), we calculated the mean difference using the subgroup mean differences (length of stay) and standardised mean differences (functional status). For the interaction terms for mortality, LTCH admission and length of stay, a negative number favours the group with cognitive impairment. For the interaction term for functional status, a positive number favours the cognitive impairment subgroup. Variance was calculated using the square root of the sum of the standard errors of the cognitive subgroups, which assumes no correlation between the subgroup (conservative assumption). We then performed a standard meta-analysis on the interaction terms in each study to pool the interaction effect (REML method with HKSJ adjustment). The pooled interactions were plotted using the "ggplot2" package in R [26].

Due to the small number of trials, sensitivity and meta-regression analyses were not conducted, although planned. Heterogeneity was explored using subgroups of clinical (e.g., mean age, indication for rehabilitation) and methodological factors (e.g., study design, risk of bias), where possible. The subgroup for rehabilitation indication included hip fracture or general geriatric rehabilitation. Subgroup for population mean age was dichotomised into ≥ 80 or < 80 years. Publication bias was assessed by visual inspection of a funnel plot; Egger's regression was not feasible due to the small number of studies.

Results

Study selection, characteristics, and risk of bias

In the original systematic review, we screened 5304 database records and reviewed 445 full-text reports for eligibility [16]. Of the 29 studies (7999 patients) in the review, we included eight studies (1665 patients total; 1134 patients with cognitive subgroup data) that reported outcomes by cognitive status (Table 1). A cognitive score cutoff was used to define subgroups in six RCTs and a diagnosis of dementia was used to define subgroups in two RCTs (Supplementary Appendix A, Table S1). Seven RCTs (87.5%) included patients with any severity

Table 1 Characteristics of included studies

Study characteristic (*n* = 8)	**Number of studies, *n* (%)**
Year of publication	3 (37.5)
- 1980–1990	1 (12.5)
- 1991–2000	3 (37.5)
- 2001–2010	1 (12.5)
- 2011–2022	
Continent	1 (12.5)
- Asia	5 (62.5)
- Europe	2 (25.0)
- North America	
Funding source	5 (62.5)
- Government	1 (12.5)
- Non-profit	1 (12.5)
- Mixed (public/private)	1 (12.5)
- Not reported	
Single vs. multi-centre	8 (100)
- Single centre	
Indication for rehabilitation	1 (12.5)
- General geriatric rehabilitation	7 (87.5)
- Hip fracture	
Cognitive status in eligibility criteria	7 (87.5)
- Included patients with any dementia severity	1 (12.5)
- Included mild to moderate dementia	
Mean age	2 (25.0)
- < 80 years	6 (75.0)
- ≥ 80 years	
Proportion female, mean % (SD)	72 (30)
Proportion with dementia, mean % (SD)†	43 (13)
Place of residence, mean % (SD)*	78 (16)
- Home	13 (16)
- Long-term care home	
Team members	8 (100)
- Physiotherapist	7 (87.5)
- Occupational therapist	7 (87.5)
- Nurse	8 (100)
- Geriatrician	5 (62.5)
- Social worker	2 (25.0)
- Physician (non-geriatrician)	1 (12.5)
- Dietitian	3 (37.5)
- Psychiatrist	2 (25.0)
- Physiatrist	0 (0)
- SLP	0 (0)
- Pharmacist	1 (12.5)
- Audiologist	1 (12.5)
- Dentist	
Risk of bias	0 (0)
- High	6 (75.0)
- Some concerns	2 (25.0)
- Low	

† 4 studies reported proportion with dementia; 4 studies did not report this

*Not all studies reported full breakdown of place of residence

SD standard deviation, *SLP* speech language pathologist

of dementia and one RCT (12.5%) only included patients with mild to moderate dementia. All studies were done in the inpatient setting. Seven studies (87.5%) included patients with hip fractures [31–37] and one study (12.5%) included patients with general geriatric rehabilitation needs [38]. The mean age of participants across studies was 81.1 years and the mean proportion of females was 72% (standard deviation [SD] 30%). The mean proportion of patients with dementia was 43% (SD 13%), with four RCTs (50%) not reporting this characteristic. The mean proportion of patients admitted from home was 78% (SD 16%). All studies included a physiotherapist and a geriatrician. Seven studies (87.5%) included an occupational therapist. One study reported education level and one study reported race. No other equity characteristics were reported using the PROGRESS-Plus variables (Supplementary Appendix G). Six studies (75.0%) had some concerns in the risk of bias assessment and two studies (25.0%) had low risk of bias (Supplementary Appendix B, Figures S1 and S2 for risk of bias plots). A summary of outcome measures is shown in Table 2. A summary of outcomes definition and follow-up duration of each outcome is shown in Supplementary Appendix F.

Results of synthesis

Primary outcomes: mortality, LTCH admission, and functional status

Six studies reported mortality at longest follow up in those with baseline cognitive impairment (as defined by study authors, shown in Supplementary Appendix C, Figure S3), revealing a RR of 0.75 (95% CI 0.39 to 1.45, $I^2 = 61.0\%$) for mortality in the intervention group. Heterogeneity in the subgroup with cognitive impairment was explored by definition of cognitive impairment (Supplementary Appendix C, Figure S3), indication for rehabilitation (Supplementary Appendix C, Figure S3a), mean age of the participants (Supplementary Appendix C, Figure S3b), and risk of bias (Supplementary Appendix C, Figure S3c). When cognitive impairment was defined by a score cutoff, the RR was lower at 0.57 (95% CI 0.22 to 1.48) compared to studies using dementia to define cognitive impairment (RR 1.15, 95% CI 0.28 to 4.81), but the confidence intervals overlapped. Participants with mean age < 80 years (two studies) had a greater reduction in mortality (RR 0.29, 95% CI 0.26 to 0.33, $I^2 = 0\%$) compared with participants with mean age ≥ 80 years (RR 0.95, 95% CI 0.59 to 1.54, $I^2 = 34\%$, four studies). In the risk of bias subgroups (Supplementary Appendix C, Figure S3c), studies with some concerns (four studies) and with low risk (one study) had similar estimates for mortality in the subgroup with cognitive impairment (0.68 [95% CI 0.18 to 2.55] and 0.69 [95% CI 0.48 to 0.99], respectively). In the pooled subgroup without cognitive impairment (four studies, Supplementary Appendix C, Figure S3d), mortality was lower in the geriatric rehabilitation group (RR 0.85, 95% CI 0.63 to 1.15, $I^2 = 0\%$), but confidence intervals do not exclude the opposite effect. The interaction of cognitive impairment and mortality (Fig. 1) was calculated in studies reporting the outcome for participants with and without cognitive impairment (four studies). The pooled interaction by mean difference in logRR was − 0.12 (95% CI -0.72 to 0.48; exponentiated

Table 2 Summary of outcome estimates and meta-analysis of the within-study interaction of cognitive subgroups

Outcome	No. of studies‡	No. of patients	Effect estimate¶ (95% CI)	I^2 (%)	Interaction† (95% CI)
Mortality	4	381	RR 0.85 (0.63 to 1.15)	0	-0.12 (-0.72 to 0.48)
• No cognitive impairment	6	546	RR 0.75 (0.39 to 1.45)	61	
• Cognitive impairment					
LTCH admission	3	312	RR 0.94 (0.22 to 4.10)	0	0.17 (-0.34 to 0.68)
• No cognitive impairment	4	418	RR 0.89 (0.62 to 1.28)	0	
• Cognitive impairment					
Functional status	2	215	SMD 0.26 (-1.33 to 1.84)	0	-0.33 (-6.08 to 5.54)
• No cognitive impairment	3	277	SMD − 0.07 (-0.90 to 0.75)	57	
• Cognitive impairment					
Length of stay	4	359	MD -10.51 (-29.56 to 8.55)	97	-4.79 (-27.45 to 17.87)
• No cognitive impairment	4	418	MD -6.94 (-26.53 to 12.65)	74	
• Cognitive impairment					
Functional improvement	1	109	RR 1.42 (0.97 to 2.07)	*	*
• No cognitive impairment	2	115	RR 2.27 (0.99 to 5.20)	0	
• Cognitive impairment					
Remaining home	1	97	RR 0.99 (0.83 to 1.18)	*	*
• No cognitive impairment	1	141	RR 1.01 (0.78 to 1.31)	*	
• Cognitive impairment					
Cognition	1	106	MD 1.00 (-0.22 to 2.22)	*	*
• No cognitive impairment	1	162	MD -1.00 (-5.21 to 3.21)	*	
• Cognitive impairment					

RR = risk ratio, 95% CI = 95% confidence interval, I2 = measure of heterogeneity, SMD = standardised mean difference, MD = mean difference

¶ Effect estimate include RR for dichotomous outcomes, SMD for continuous outcomes where multiple measurement units are used and MD for continuous outcomes with the same units

* Only one RCT available, so pooling and meta-analysis not possible

† Interaction term is calculated by the difference of the effect estimates between subgroups (with and without cognitive impairment). For binary outcomes (mortality/LTCH admission), the interaction term is provided in difference in logRR. For continuous outcomes (functional status and length of stay), the interaction term is provided in difference in SMD and MD, respectively

‡ Showing all studies reporting results by any cognitive subgroup. Only RCTs reporting both subgroups (cognitive impairment and no cognitive impairment) were included in the meta-analysis.

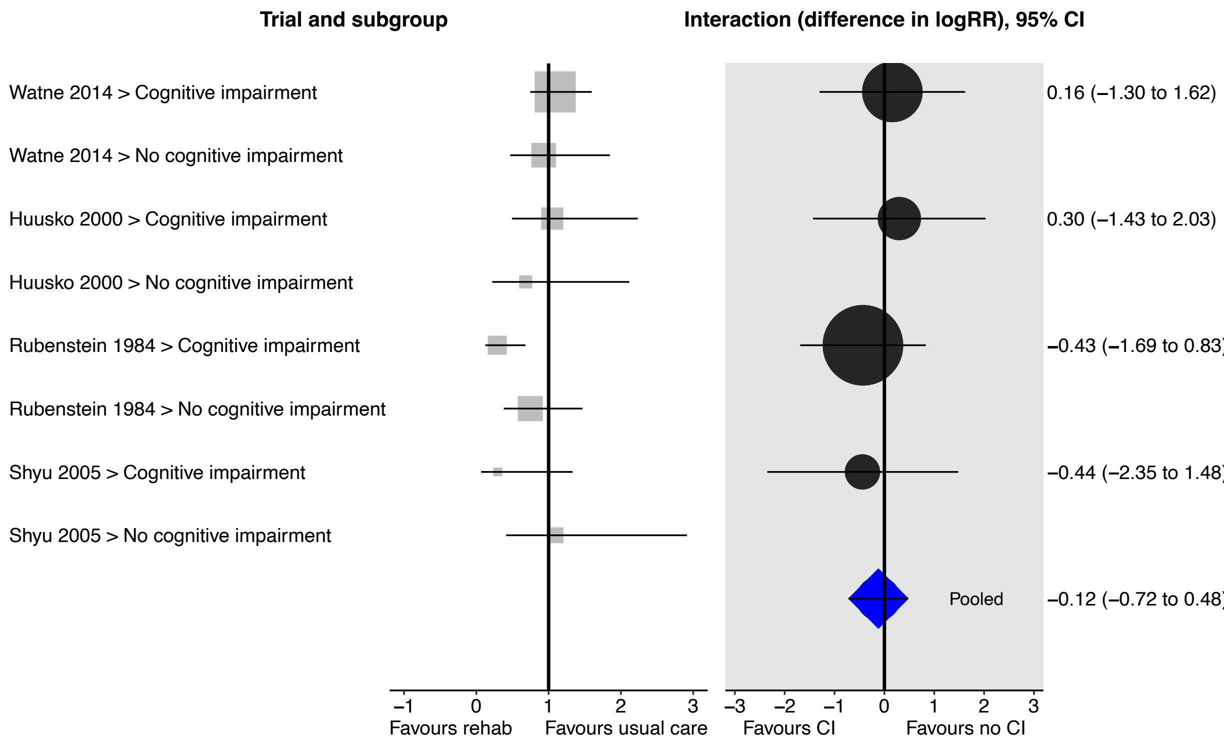

Fig. 1 Mortality at longest follow up in studies reporting outcome by cognitive status; showing interaction of cognitive impairment and mortality in each study and the pooled interaction

The forest plot on the left (square) shows the effect estimates for each study reporting mortality at longest follow up by cognitive status of patients. The forest plot on the right (circle) shows the interaction of cognitive status in each study. The blue diamond shows the pooled interaction by difference in log of the risk ratios (logRR). CI = cognitive impairment, 95% CI = 95% confidence interval

ratio of RR 0.89, 95% CI 0.49 to 1.62), indicating that cognitive impairment did not impact the effectiveness of the intervention in reducing overall mortality.

Four studies reported LTCH admission at longest follow up in the subgroup with cognitive impairment and three studies reported the outcome in the subgroup without cognitive impairment (Supplementary Appendix C, Figures S4 and S4a). There were fewer LTCH admissions in the intervention group for the subgroup with cognitive impairment (RR 0.89, 95% CI 0.62 to 1.28, $I^2 = 0\%$) and the subgroup without cognitive impairment (RR 0.94, 95% CI 0.22 to 4.10, $I^2 = 0\%$), but the confidence intervals could not exclude an increase in LTCH admission. When cognitive impairment was defined by a diagnosis of dementia, the RR for LTCH admission in those with cognitive impairment was lower at 0.82 (95% CI 0.36 to 1.83) compared to studies defining cognitive impairing using a score cutoff (RR 1.37, 95% CI 0.29 to 6.33), but the confidence intervals overlapped. In the interaction calculations of three studies reporting LTCH admission for both cognitive impairment and no cognitive impairment, the pooled interaction was 0.17 (95% CI -0.34 to 0.68; exponentiated ratio of RR 1.19, 95% CI 0.71 to 1.97), suggesting no impact of cognitive impairment on the effect of the intervention on LTCH admissions (Fig. 2).

Three studies reported functional status at longest follow up in the subgroup with patients with cognitive impairment and two studies reported the outcome in the subgroup without cognitive impairment (Supplementary Appendix C, Figures S5 and S5a). In the subgroup with cognitive impairment, there was no difference between intervention and usual care for this outcome (SMD –0.07, 95% CI -0.90 to 0.75, I^2 = 56.6%). A positive SMD indicates better functional performance in the intervention group. There were not enough studies to generate subgroup pooled estimates by the definition of cognitive impairment. Of the studies reporting functional status, only one study (Stenvall 2007 [36]) used direct observation to assess for functional performance, while the other two studies relied on patient or caregiver report [35, 37]. In the subgroup without cognitive impairment, functional status improved in the intervention group (SMD 0.26, 95% CI -1.33 to 1.84, I^2 = 0%), but confidence intervals suggested uncertainty with this result. The pooled interaction for two studies (Fig. 3) reporting functional status in both cognitive impairment and no cognitive impairment subgroups showed no significant influence of cognitive status on this outcome (pooled interaction –0.33, 95% CI -6.08 to 5.54). A positive interaction term

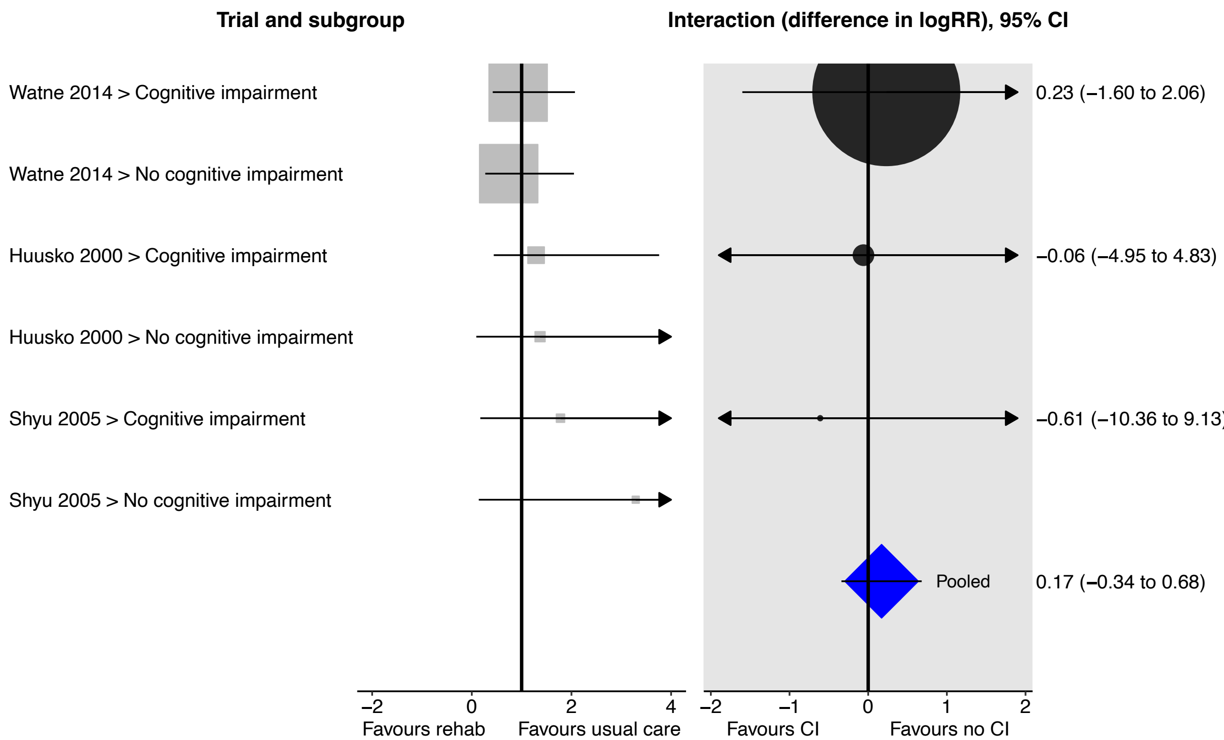

Fig. 2 LTCH admission at longest follow up in studies reporting outcome by cognitive status; showing interaction of cognitive impairment and LTCH admission in each study and the pooled interaction
The forest plot on the left (square) shows the effect estimates for each study reporting LTCH admission at longest follow up by cognitive status of patients. The forest plot on the right (circle) shows the interaction of cognitive status in each study. The blue diamond shows the pooled interaction by difference in log of the risk ratios (logRR). CI = cognitive impairment, 95% CI = 95% confidence interval

indicates better functional performance in the subgroup with cognitive impairment.

Secondary outcomes: length of stay, functional improvement, remaining home and cognition

For length of stay, four studies reported the outcome in the subgroup with cognitive impairment and four studies reported the outcome in the subgroup with no cognitive impairment (only three studies reported both subgroups; two studies reported only one of the subgroups). Both subgroups had lower length of stay in the intervention arm (Supplementary Appendix C, Figures S6 and S6a), but confidence intervals were wide and could not exclude the opposite effect. The MD in length of stay was − 6.94 days (95% CI -26.53 to 12.65, $I^2 = 74\%$) in the subgroup with cognitive impairment and − 10.51 days (95% CI -29.56 to 8.55, $I^2 = 97\%$) in the subgroup without cognitive impairment. The heterogeneity could not be explained by factors related to participant characteristics, intervention or risk of bias. When looking at subgroups by the definition of cognitive impairment, studies using a score cutoff had greater reduction in length of stay (MD -21.33, 95% CI -53.27 to 10.62) than studies using dementia diagnosis (MD -2.85, 95% CI -105.07 to 99.38), but their confidence intervals overlapped. In the three studies that reported outcomes for both subgroups (cognitive impairment and no cognitive impairment), the pooled within-study interaction (Supplementary Appendix C, Figure S6b) between cognitive status and length of stay was − 4.79 (95% CI -27.45 to 17.87). Overall, there was no difference in length of stay between the two cognitive subgroups.

Two studies reported functional improvement (dichotomous outcome as defined by study authors) in the subgroup with cognitive impairment (Supplementary Appendix C, Figure S7) and one study reported this in the subgroup without cognitive impairment (Supplementary Appendix C, Figure S7a, not pooled). In the subgroup with cognitive impairment, participants were more likely to have functional improvement (RR 2.27, 95% CI 0.99 to 5.20, $I^2 = 0\%$). There were not enough studies to provide a subgroup pooled estimate based on the definition of cognitive impairment. Interaction term was not calculated due to the small number of studies. Remaining home at longest follow up for both cognitive subgroups was reported by one study (Supplementary Appendix C, Figures S8 and S8a), which did not reveal an effect with the intervention (RR 1.01, 95% CI 0.78 to 1.31). Similarly, cognition (in mini-mental status examination score [MMSE]) at longest follow up was reported by one study (Supplementary Appendix C, Figures S9 and S9a), which

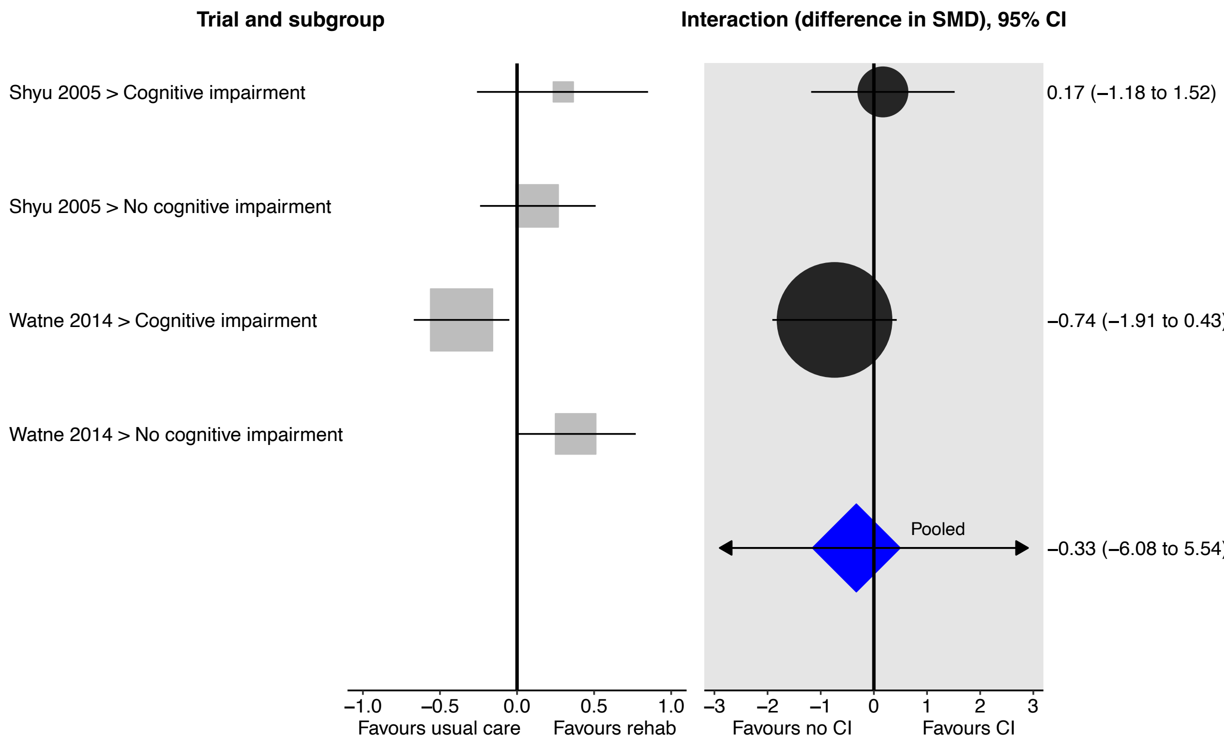

Fig. 3 Functional status at longest follow up in studies reporting outcome by cognitive status; showing interaction of cognitive impairment and functional status in each study and the pooled interaction
The forest plot on the left (square) shows the effect estimates for each study reporting functional status at longest follow up by cognitive status of patients. A positive SMD estimate indicates better functional performance in the rehabilitation intervention group. The forest plot on the right (circle) shows the interaction of cognitive status in each study. The blue diamond shows the pooled interaction by difference in standardised mean differences (SMD). A positive interaction term indicates better functional performance in the subgroup with cognitive impairment. CI = cognitive impairment, 95% CI = 95% confidence interval

revealed an improvement in cognitive scores in the subgroup without cognitive impairment only (MD 1.00 point, 95% CI -0.22 to 2.22). Interaction terms were not calculated for remaining home and cognition outcomes due to the small number of studies.

Publication bias

The funnel plot for mortality did not reveal significant asymmetry on visual inspection (Supplementary Appendix D, Figure S10).

Discussion

In this secondary analysis of a systematic review, we explored outcomes by baseline cognitive status of participants in RCTs of rehabilitation. Using a pooled within-study interaction approach [29], we determined that cognitive impairment at baseline did not alter the mortality, LTCH admission and functional benefits of geriatric rehabilitation.

Since a small number of studies reported outcomes by baseline cognitive status, the meta-analysis of outcomes by cognitive subgroup had limited precision for effect estimates. In this secondary analysis (six studies, 546 patients), the RR of mortality in those with cognitive impairment was 0.75 (0.39 to 1.45), while the estimate in the original review for all of the RCTs (26 studies, 7619 patients) was RR 0.84 (0.76 to 0.93) [16]. Similarly, in this secondary analysis (four studies, 418 patients), the RR of LTCH admission in those with cognitive impairment was 0.89 (0.62 to 1.28), while the estimate in the original review for all of the RCTs (22 RCTs, 6891 patients) was 0.86 (0.75 to 0.98) [16]. Since the effect estimates were similar with only wider confidence intervals in the cognitive impairment subgroup, it is likely that the benefits of geriatric rehabilitation are similar in those with cognitive impairment versus no cognitive impairment.

Although our original systematic review included geriatric rehabilitation in inpatient and day hospital settings, all of the studies reporting outcomes by baseline cognitive subgroups were in the inpatient setting. This inpatient setting allows for an intensive, collaborative environment where multiple team members can closely attend to each patient's needs. In particular, all studies in this analysis included a geriatrician as part of the intervention, which is not always the case in other geriatric rehabilitation studies [39]. This team composition may provide additional benefit to older patients who may experience increased complications in the rehabilitation setting. Comprehensive geriatric care [40] may have contributed to the mortality and LTCH admission benefits of the intervention in those with cognitive impairment. Future studies should explore how patients with cognitive impairment benefit from geriatric rehabilitation and which intervention components can best optimise their outcomes.

Although the functional status pooled interaction term did not reveal a difference in effect for those with and without cognitive impairment due to wide confidence intervals (difference in SMD – 0.33, 95% CI -6.08 to 5.54), the direction of benefit favoured those without cognitive impairment. The pooled estimate in the subgroup with cognitive impairment showed no change in functional status after the geriatric rehabilitation intervention (SMD – 0.07, 95% CI -0.90 to 0.75). However, when pooling the binary outcome functional improvement as defined by study authors, those with cognitive impairment had a positive effect (RR 2.27, 95% CI 0.99 to 5.20). The discordance in finding between change in functional status and author-defined functional improvement may be related to the tool used to measure function. Both RCTs [35, 37] reporting functional status used the Barthel index [41], which is a common tool to assess activities of daily function. Although the tool has been validated in older adults, its accuracy may be affected when used in patients with cognitive impairment [42]. The accuracy is higher when patients are assessed directly for functional performance, but both included RCTs relied on family report for assessment of functional status [35, 37]. Related to this measure, we did not discuss the minimal clinically important difference in functional and cognitive scores in this paper due to a lack of statistically significant findings, but we provided a more detailed discussion in the primary systematic review [16]. Future studies should explore functional measures that have better accuracy when used in patients with cognitive impairment.

We analysed the within-study interaction of baseline cognition and each outcome to conduct this meta-analysis. Methodologically, this is the preferred method to reduce ecological bias, which occurs when all individuals within a group are assumed to have the same characteristics [43]. The alternative but more frequently used approach pools all the effect estimates in each subgroup across trials, and subsequently calculates the interaction between the pooled effect estimates ("deluded" approach described in [29]). This alternative approach introduces ecological bias by allowing across-trial interactions to mask or bias the within-trial interaction, the latter of which was what we wanted to know. Aside from an individual participant data meta-analysis, the within-trial interaction approach that we used is best able to estimate the effect of cognition on outcomes [30].

Our study had several strengths including a comprehensive search of six databases and the grey literature for eligible studies. The included studies all had a multidisciplinary rehabilitation intervention designed for older adults, which reflects best practices in geriatric rehabilitation [44]. We screened, abstracted, and appraised studies with two independent reviewers. Our review conforms to the PRISMA 2020 statement and we collected equity characteristics using the PROGRESS-Plus criteria. We also used the aforementioned within-trial interaction approach to determine the relationship between cognitive status and outcomes.

Our study was limited by the small number of RCTs reporting the outcome by cognitive subgroups, which reduces precision in effect estimates. We also did not complete an economic analysis of rehabilitation for patients with cognitive impairment, which could be completed in future. We pooled the subgroup with cognitive impairment to include definitions by score cutoffs and a dementia diagnosis, which limits interpretation of this relationship for different severities of cognitive impairment. We did not conduct a risk of bias assessment on each outcome and did not conduct GRADE assessments, but GRADE assessments are available on these outcomes in the original systematic review [16]. We did not abstract the individual components of the interventions using a tool like the Template for Intervention Description and Replication (TIDieR) [45]. Finally, we did not update the search since September 2022. Although the evidence for this field is not rapidly evolving [20], we acknowledge the limitation that newer studies may be available since the search.

Conclusions

Baseline cognitive impairment does not appear to alter the mortality and institutionalization benefits of geriatric rehabilitation. Future studies should explore how to best implement this intervention in older adults with cognitive impairment.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-026-07504-9.

Supplementary Material 1.

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Authors' contributions

Conception or design: EKCW, ACT, WI, JEMS, DMJN, SESAcquisition, analysis or interpretation of data: EKCW, PH, AK, SG, YQH, JCL, SMW, RD, JM, KA, ACT, SESDrafted the manuscript or substantively revised it: EKCW, PH, AK, SG, YQH, JCL, SMW, RD, JM, KA, ACT, WI, JEMS, DMJN, SES.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

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Competing interests
The authors declare no competing interests.

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