Assessment tools and incidence of hospital-associated disability in older adults: a rapid systematic review (#83733)

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- Methods described with sufficient detail & information to replicate.

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Assessment tools and incidence of hospital-associated disability in older adults: a rapid systematic review

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Background

During hospitalization older adults have a high risk of developing functional impairments unrelated to the reasons for their admission. This is termed hospital-associated disability. This systematic review aimed to assess the incidence of hospital-associated disability among older patients admitted to acute care, to identify the tools used to assess activities of daily living in these patients, and to evaluate which functional task is most sensitive for detecting changes in disability among older hospitalized patients.

Methods

A rapid systematic review was performed according to the recommendations of the Cochrane Rapid Reviews Methods Group and the PRISMA statement. A literature search was performed in Medline (via Ovid), EMBASE, and Cochrane Central Register of Controlled Trials databases on 26 August 2021. Inclusion criteria: older adults (≥ 65 years), assessment of activities of daily living at baseline and discharge. Exclusion criterion: diseases affecting functional decline. The protocol was registered on OSF registries (https://osf.io/9jez4/) identifier: DOI 10.17605/OSF.IO/9JEZ4.

Results

Eleven studies were included in the final review. Incidence of hospital-associated disability (overall score) was 37% (95% CI 0.31–0.42). Insufficient data prevented meta-analysis of the individual items. The review identified five assessment tools, two sets of tasks, and individual items assessing activities of daily living. The most sensitive measure for detecting changes in disability was the overall score of assessment of activities of daily living.

Conclusions

Incidence of hospital-associated disability in older patients might be overestimated, due to the combination of disease-related disability and hospital-associated disability. The tools used to assess these patients presented some limitations. These results should be interpreted with caution, as a limited number of studies reported adequate information to assess the incidence of hospital-associated disability. Risk of bias in the included studies raised some concerns.

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Abstract

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Keywords

Functional decline, hospitalization; activities of daily living; older patients

Introduction

81 Functional decline in older adults during hospitalization increases the risk of a longer hospital
82 stay (Palmer et al. 1994), a nursing home placement (Fortinsky et al. 1999), and increased
83 mortality (Brown et al. 2004). The main goal in older adult care is therefore to maintain function
84 (Izquierdo et al. 2021) and the ability to perform activities of daily living (ADL) (Covinsky et al.
85 1998; Palmer et al. 1994). During hospitalization older adults are at risk of developing functional
86 decline unrelated to the condition for which they were admitted (Creditor 1993). The loss of
87 independence in at least one activity of daily living is referred to as hospital-associated disability
88 (HAD) (Covinsky et al. 2011). Furthermore, HAD refers to disability acquired during
89 hospitalization or the worsening of a pre-existing disability due to hospitalization (Covinsky et
90 al. 2011).
91
92 Previous studies have highlighted methodological issues in assessing functional decline
93 (Buurman et al. 2011; Loyd et al. 2020). However, there is currently no consensus on which tool
94 should be used to assess functional decline in these patients, which ADL tasks should be
95 included, how the assessment should be performed (self-reported or performance-based), and
96 what time-frame should be considered (Buurman et al. 2011). Covinsky and others (Covinsky et
97 al. 2011) recommend asking patients on admission about their ADL functioning before the onset
98 of acute illness.
99 A previous study highlighted the magnitude of the HAD problem, and reported that the overall
100 prevalence of HAD among older adults admitted to an acute care hospital is 30% (Loyd et al.
101 2020). To the best of our knowledge, the incidence of HAD has not been studied in a systematic
102 review. The aim of this study was to perform a rapid systematic review to: (i) assess the
103 incidence of HAD, (ii) to identify all tools or functional tasks used to assess ADL in hospitalized
104 older patients, and (iii) to evaluate which ADL functional task or set of tasks is the most sensitive
105 to detect changes in disability.

Materials & Methods

Registration

The protocol of this rapid systematic review registered at OSF registries with the following
identifier: DOI 10.17605/OSF.IO/9JEZ4 (https://osf.io/9jez4/).

Study design

A rapid systematic review was performed according to the recommendations of the Cochrane
Rapid Reviews Methods Group (Garritty et al. 2021). Reporting was conducted in accordance
with the PRISMA statement (Page et al. 2021).

Search strategy and selection criteria

A literature search was performed in Medline (via Ovid), EMBASE, and Cochrane Central
Register of Controlled Trials (CENTRAL) databases on 26th August 2021. All authors were
involved in the literature search. The search strategy comprised five search terms related to: (i)
study setting (i.e. hospital), (ii) observed disability in ADL, (iii) incidence and prevalence,
sensitivity to change and responsiveness, (iv) population identification (i.e. older adults), and (v)
articles that cover the aspect of disability acquired in hospitals. The search terms, combined with
the Boolean operator "AND", were applied to titles and abstracts, and MeSH terms were added

125 when available and relevant. The full search strategy is shown in the additional material [see
126 Additional file 1 Table 1]. The review included prospective and retrospective cohort studies. The
127 control group of randomized controlled trials (RCTs) was eligible when performing a usual or a
128 sham intervention. Inclusion criteria were: studies investigating a general older population ($\geq$ 65
129 years) who were admitted to hospital for an acute disorder; studies had to assess the individual
130 items of the ADL measurement tool before hospitalization (retrospectively or prospectively) and
131 at the end of hospitalization or after hospital discharge. Exclusion criteria were: studies
132 investigating a specific condition that could have an effect on functional decline (e.g. stroke,
133 brain injury, heart failure, COVID-19, and acute respiratory failure); and studies that primarily
134 examined a population with cognitive impairment.
135 One reviewer (GK) independently screened all the records based on titles and abstracts (phase 1)
136 and the full-text of the eligible studies (phase 2). A second reviewer (SKM) screened 20% of the
137 same records. If Cohen's kappa coefficient of agreement was >0.80 for both phases, only 20% of
138 the studies were planned to be screened independently by two reviewers. Disagreements were
139 resolved through discussion.
140
141 **Data extraction**
142 Study characteristics (authors, country, study sample size, population age, type of ward,
143 proportion of women, proportion living alone, proportion living in a nursing home, Acute
144 Physiology and Chronic Health Evaluation (APACHE II) score, Charlson Comorbidity Index,
145 number of days of hospitalization, any scale of mental status) were extracted by one reviewer
146 (GK), while incidence data were extracted by three reviewers (HR, SKM, GK) at the same time.
147 Disagreements were resolved through discussion between all three reviewers. The following
148 information was extracted: item type, response options, criteria for the response options,
149 baseline, and discharge assessment (i.e. who performed it and how), baseline and discharge
150 prevalence of ADL dependency, operationalization, and definition of HAD and incidence per
151 item and for the overall score.
152
153 **Methodological quality assessment**
154 Methodological quality assessment was performed using the critical appraisal checklist for
155 Studies Reporting Prevalence Data (Munn et al.) from the Joanna Briggs Institute (JBI). The JBI
156 checklist was completed independently by two reviewers (SKM, GK). Differences in rating were
157 discussed and resolved. A further five questions were selected from the JBI checklist that were
158 considered to assess risk of bias (internal validity, i.e. questions 2, 5, 6, 7 and 9). Risk of bias
159 was assessed as low if all five questions were rated 'yes', some concern if one of the questions
160 was rated 'unclear' and high if one of the questions was rated 'no'.
161
162 **Incidence of hospital-associated disability**
163 The incidence of HAD (total score) was pooled using the statistical software R (Team 2013) and
164 its package meta (Schwarzer 2007). A random effects model was applied based on an inverse
165 variance model with a logit transformation.
166 Heterogeneity was assessed by the I^2, which is the proportion of total variability due to between-
167 study heterogeneity (Deeks et al. updated February 2022), to estimate inter-study variability. Tau
168 was estimated with the DerSimonian-Laird estimator (Schwarzer 2007). Miglivaca et al.
169 recommended avoiding the use of an arbitrary cut-off for the I2 statistics, as it may not be

170   discriminative in incidence studies (Migliavaca et al. 2022). Therefore, heterogeneity was
171   explained by discussing the level of dependency at baseline and the method of assessment.
172   The data required to calculate the incidence of HAD are the number of patients who are
173   dependent and independent at baseline and the evolution of these groups at discharge. If these
174   values were given, the following formula was used to calculate the incidence of the individual
175   ADL task or set of tasks (total score):

176 $$HAD\ incidence = \frac{a}{b}$$

177   where, a = number of newly dependent patients (requiring the help of someone else), and b =
178   number of patients at risk of developing or increasing dependency.
179   For example, in the study by Sager et al. (Sager et al. 1996), 51 patients were newly dependent at
180   discharge according to the overall score and 188 patients had the potential to decline in one of
181   the ADL tasks.

182 $$\text{HAD incidence } = \frac{51}{188} = 0.27$$

183
184   If these values were not reported, an unbiased estimate of the incidence of HAD in that study
185   could not be calculated. In this case, an estimate of the incidence was made by subtracting the
186   percentage of dependency at discharge minus the percentage of dependency at baseline.
187
188   **Tools used for assessment of activities of daily living in hospitalized older patients**
189   All ADL tools or sets of tasks used in the assessment of hospitalized older patients were reported
190   narratively.
191
192   **Evaluation of which measure is most sensitive to detect changes in disability**
193   The most sensitive task or set of tasks to detect changes in disability were ranked as follows: (i)
194   per study all ADL tasks were ranked from the highest proportion of disability (= 1) to the lowest
195   (=7); (ii) the mean of the ranking was calculated per item or set of scores.
196   If data were available only in a chart they were extracted using the software WebPlotDigitizer
197   (A. 2021). Due to time constraints, the authors of the included studies were not contacted in case
198   of imprecision in the text.
199
200   **Differences from protocol**
201   It was decided not to integrate the grading system of the GRADE Working Group as predefined
202   the evaluation of the body of evidence due to the lack of a guideline for incidence studies.
203

Results

205   A total of 2,519 records were identified (Medline (via Ovid) 740 records, EMBASE 1,557,
206   CENTRAL 222). After removing 743 duplicates, titles and abstracts of 1,776 articles were
207   screened and 1,431 were excluded. The full text of 345 studies was screened, and a final total of
208   11 studies were included for further analysis (Covinsky et al. 2000; Covinsky et al. 2003;
209   Dharmarajan et al. 2020; Hansen et al. 1999; Hirsch et al. 1990; Inouye et al. 1993; Martinez-
210   Velilla et al. 2021; Mudge et al. 2010; Park et al. 2021; Sager et al. 1996; Zelada et al. 2009).
211   The reasons for exclusion are shown in the study flow diagram (see Figure 1).

212 Cohen's kappa coefficient was > 0.8 in both screening phases (i.e. titles/abstracts and full texts);
213 therefore only 20% of studies were screened by two reviewers independently, as described
214 above.
215 **Figure 1. Flow diagram**
216
217 **Study characteristics**
218 The population characteristics of the included studies are shown in Table 1. Seven studies were
219 performed in the USA, one in Europe, and three in other countries. Sample size ranged from 36
220 to 2,877 participants and the age of study participants ranged from 76 to 87 years. The proportion
221 of women in the study samples under investigation ranged from 31% to 66%. Included studies
222 were conducted in the medicine ward (five studies), general hospital (five studies), and one in the
223 geriatric unit and usual unit which refers to a conventional care unit.
224
225 **Table 1. Study characteristics**
226
227 **Outcome results**
228 The pooled incidence of HAD for the overall score included two studies reporting the Katz Index
229 of ADLs 1963 (Covinsky et al. 2003; Inouye et al. 1993) and two others used the Katz Index of
230 ADLs 1970 (Mudge et al. 2010; Sager et al. 1996) for a total of 4,020 patients. Figure 2 presents
231 the pooled incidence of HAD (total score) of 37% (95% CI 0.31–0.42). Heterogeneity was
232 substantial at 90%. The risk of bias of the four studies raised some concerns. The calculated and
233 estimated incidences of HAD are categorized per ADL task and set of tasks [see Additional file 1
234 Table 2]. Adequate data for the incidence calculation at the item level was reported only by two
235 studies (Covinsky et al. 2000; Hansen et al. 1999). The incidence of HAD for the individual
236 items was in the range 32–93% for bathing, 27–66% for dressing, 8–70% for toileting, 11–61%
237 for eating, 7–59% for transferring, and 10% for walking. For the other studies, it was not
238 possible to calculate the incidence of HAD (either total or single-item level) due to insufficient
239 data. One RCT could not be integrated into Table 2 of the additional file 1 because the authors
240 reported only the mean change in ADL score, and the results of this study were described
241 narratively (Martinez-Velilla et al. 2021). The control group worsened in all items of ADL,
242 negative values indicating a decline in the Barthel mean change score. The three items with the
243 highest mean change score from baseline to discharge were: transferring (–2.06 points; 95% CI –
244 1.44 to –2.71), climbing stairs (–1.36 points; 95% CI –0.84 to –1.91), and toileting (–1.23 points;
245 95% CI –0.76 to –1.69). The score for these individual tasks ranged from 0 points (dependent) to
246 independent with a maximum of 15 points for transferring, 10 points for climbing stairs and 10
247 points for using the toilet.
248 The risk of bias of all studies presented some concerns.
249
250 **Figure 2. Forest plot of the pooled results of overall incidence of hospital-associated**
251 **disability (HAD).**
252
253 Eleven studies were included in the identification of the tools or functional tasks used to assess
254 ADL in hospitalized older patients and in the ranking of the most sensitive task to detect changes
255 in disability (Covinsky et al. 2000; Covinsky et al. 2003; Dharmarajan et al. 2020; Hansen et al.
256 1999; Hirsch et al. 1990; Inouye et al. 1993; Martinez-Velilla et al. 2021; Mudge et al. 2010;
257 Park et al. 2021; Sager et al. 1996; Zelada et al. 2009). The review identified five assessment

258   tools, two sets of tasks, and individual items assessing ADL: Katz Index of ADLs 1963 (Katz et
259   al. 1963), Katz Index of ADLs 1970 (Katz et al. 1970), Barthel Index (Mahoney & Barthel
260   1965), 8 items from the nine-item Care Needs Assessment tool (Hirsch et al. 1990), 7 ADL items
261   form the Frailty Index (Rockwood & Mitnitski 2011) and 2 activities from the Nagi and Rosow-
262   Breslau scales (Nagi 1976; Rosow & Breslau 1966) integrated in the Frailty Index (Rockwood &
263   Mitnitski 2011), and individual items proposed by Gill (Gill 2014) (bathing, dressing,
264   transferring and walking across the room). Walking was assessed in two studies (Hansen et al.
265   1999; Mudge et al. 2010), while one other study (Inouye et al. 1993) assessed the task of
266   grooming by referring to the Katz Index of ADLs. However, the item walking and grooming
267   were not in the original version of the Katz Index, and were considered separately.
268   Table 2 shows the number of studies that reported the tasks (items) and the ranking of the most
269   sensitive tasks for detecting changes in disability.
270
271   **Table 2. Ranking of the most sensitive tasks or sets of tasks for detecting change in**
272   **disability**
273
274   **Methodological quality**
275   Figure 3 presents a summary plot of the assessment of methodological quality using the JBI
276   checklist. All of the included studies and study sub-groups reported an adequate sample frame
277   and recruitment procedure, and appropriately detailed the study subjects and setting.
278   Approximately 37% of the included studies reported an adequate study sample size, and for
279   approximately 63% it was inadequate. All of the sub-groups described the study subjects and
280   setting well. Adequate analysis with sufficient coverage of the identified sample was conducted
281   in approximately 25% of studies and was unclear in 75% of studies. All study sub-groups were
282   unclear regarding the methods used for identification of the condition. The participant's
283   condition was measured in a standard and reliable way in approximately 37% of the sub-groups
284   and was unclear in 63%. The statistical analysis was adequate in approximately 19% and
285   inadequate in 81% of the included studies. The response rate of the subgroups was good in 13%,
286   unclear in 6%, and inadequate in 81% of the studies under evaluation. The rating of the
287   individual items for each study is available in the additional material [see Additional file 1
288   Figure 1].
289
290   **Figure 3. Joanna Briggs Institute (JBI) checklist summary plot.**
291

Discussion

293   The aims of this systematic review were to evaluate the incidence of HAD, to identify the tools
294   or sets of tasks used in a hospital setting to assess ADL in older people, and to determine which
295   functional task is most sensitive for detecting changes in disability.
296   The pooled incidence of HAD (total score) was 37%. The difference in incidence according to
297   the two versions of the Katz Index of ADLs was 8%. This difference could be explained by the
298   fact that patients in the studies by Sager (Sager et al. 1996) and Mudge (Mudge et al. 2010) were
299   more dependent at baseline compared with the volunteers included in the studies by Inouye
300   (Inouye et al. 1993) and Covinsky (Covinsky et al. 2003). The difference could not be explained
301   by comorbidities (e.g. with the APACHE II score or the Charlson Comorbidity Index) as the
302   authors of the studies by Sager and Mudge did not report these values.

303 Loyd et al. (Loyd et al. 2020) found a prevalence of HAD of 30% in older adults hospitalized for
304 acute care. The current review focused on the number of new cases of HAD, i.e. the incidence of
305 HAD. This latter measure considers the number of new cases of decline over the population at
306 risk of developing a new decline. To our knowledge, no other review has investigated the overall
307 incidence of HAD and the incidence at the item level in a population of older patients over 65
308 years hospitalized for acute care. In general, the incidence of HAD at the item level was higher
309 when disability was reported by the surrogates than when it was reported by patients. Similar
310 results were found in previous research (Rubenstein et al. 1984).
311 Regarding the tools or sets of tasks used in a hospital setting to assess ADL in older people, this
312 review identified that the Katz Index of ADLs was the most reported tool in the included studies.
313 The Barthel Index and the Katz Index of ADLs are the oldest tools used for assessing ADL
314 (Hartigan 2007). Seven studies used the Katz Index of ADLs, and none of them assessed the
315 continence item that was include in the original version (Covinsky et al. 2000; Covinsky et al.
316 2003; Hansen et al. 1999; Inouye et al. 1993; Mudge et al. 2010; Sager et al. 1996). In addition,
317 the Katz Index of ADLs was modified by adding another item of walking in three studies
318 (Hansen et al. 1999; Mudge et al. 2010; Sager et al. 1996) and adding the item grooming in one
319 studies (Inouye et al. 1993).
320 This review found that the most sensitive task or set of tasks for detecting changes in disability
321 was use of the total score, which is a composite score of several tasks. However, this composite
322 score was based on a different set of tasks in individual studies. For example, continence was
323 only included in the total score in Zelada et al.'s study (Zelada et al. 2009). The four next most
324 sensitive tasks for detecting changes in disability were mobility, bathing, dressing, and toileting.
325 It should be noted that items related to mobility and transfer from a chair appeared relatively
326 high in the rankings and were assessed based on only one study. It was observed that the tasks
327 that are generally considered difficult were not ranked as the most sensitive to change. For
328 example, the item walking 1 km may be considered by many older patients as difficult, but this
329 item did not seem very sensitive to change. This observation might be explained by the fact that
330 many subjects were already dependent on help to perform this task and did not have the potential
331 to decline further, hence resulting in a low incidence. The walking item was generally poorly
332 described and was therefore categorized separately from the mobility item due to a lack of
333 information about the similarity of these two items and their judging criteria. The item walking 1
334 km was considered more difficult than the walking task, which usually refers to a smaller
335 distance; hence these functional tasks were categorized separately. This has the disadvantage of
336 resulting in fewer studies per functional task.
337 To determine which was the most sensitive task or set of tasks for detecting changes in disability,
338 a meta-analysis of incidences would have been the preferred method. However, due to
339 heterogeneity between studies and missing data it was not possible to pool the data. Therefore,
340 the mean of the ranking was analysed, and this analysis should be interpreted with caution.
341 Futures studies may change the ranking.
342 An overestimation of HAD might be present for two main reasons. First, differences in the
343 execution of the ADL assessment might have resulted in overestimation of the HAD incidence.
344 In two studies (Inouye et al. 1993; Mudge et al. 2010), the baseline value for ADL ability was
345 asked retrospectively to patients at admission, while ADL ability at discharge was assessed by an
346 experienced healthcare professional. Older patients tend to overestimate their ADL ability
347 (Kempen et al. 1996; Sager et al. 1992), their ability to step over an obstacle (Sakurai et al. 2013)
348 and their motor performance (Kawasaki & Tozawa 2020). Kawasaki and Tozawa hypothesized

349 that the patients' overestimation of their physical or functional capacities might be explained by
350 the absence of recognition of their decline in motor performance (Kawasaki & Tozawa 2020).
351 Observer-based assessments of ADL tasks by healthcare professionals were more accurate than
352 patients' self-reported ADL values (Applegate et al. 1990; Elam et al. 1991).
353 Furthermore, this review included studies investigating pathologies that should not have a long-
354 lasting effect on functional disability. However, it seems that there might be a combination of
355 HAD and disease-related disability. Covinsky et al.'s study (Covinsky et al. 2003) was the only
356 one to present the disability trajectories of each patient group and their development over time.
357 These authors reported the percentage of patients whose ADL values declined between baseline
358 (two weeks before hospitalization) and hospital admission (which is related to the condition) and
359 those who had not recovered by discharge.
360 We believe that this combination of HAD and disease-related disability may also have
361 contributed to an overestimation of HAD. In general, the studies did not separately report the
362 numbers of persons with a disease-related disability and those with HAD, but only reported a
363 combined total. Hence, it is unclear whether the failure to recover is due to hospitalization.
364 Moreover, the current ADL assessment tools present measurement properties limitations. For
365 example, the Barthel Index showed a floor (Dromerick et al. 2003) and ceiling effect (de Morton
366 et al. 2008; Dromerick et al. 2003; Nielsen et al. 2016). Two of the studies included in the
367 current review reported a ceiling effect of the Katz Index of ADLs (Mudge et al. 2010; Sager et
368 al. 1996).
369 A strength of the current study is that, to the best of our knowledge, this is the first review to
370 investigate the incidence of HAD in a population of older patients over 65 years of age,
371 hospitalized for acute care. To our knowledge, previous systematic reviews did not assess the
372 incidence of HAD at the item level.
373 The study has a number of limitations. The screening process was performed independently by
374 two reviewers for only 20% of the records. However, we believe that this has only limited
375 negative influence, as the agreement between the reviewers was high (above the predefined
376 kappa coefficient of agreement of 0.8) and this procedure is accepted and suggested in rapid
377 systematic review (Garritty et al. 2021). Another limitation is that we could not conduct a meta-
378 analysis for the individual tasks due to insufficient data. With our reported methods, the certainty
379 in the presented estimated incidence of HAD at the item level is very low. The estimated
380 incidence, calculated as the difference between the discharge and baseline prevalence, should be
381 interpreted with caution, as this does not consider the change over time of independent and
382 dependent patients from baseline to discharge. The prevalence of disability at discharge does not
383 distinguish between: (i) those who remain dependent between baseline and discharge, (ii) the
384 newly dependent, and (iii) those who became independent at discharge. Therefore, these
385 estimated incidences cannot be considered true incidence. In addition, small sample size bias
386 cannot be totally excluded in the current review.
387
388 **Implications and further research**
389 Further studies should investigate the reasons for the overestimation of HAD. As reported above,
390 there is a need to develop a more sensitive tool that reflects the true functional status of older
391 patients (over 65 years) before hospitalization for acute care. The systematic integration of
392 proxies in the evaluation of functional status before hospitalization, in addition to the patient
393 self-reported assessment, needs to be deepened. Regarding the implication for healthcare
394 professionals, activities such as mobility, bathing, and dressing seem to be the most sensitive to

395 detect changes in disability. The development of targeted training interventions for these ADL
396 activities should be considered in future studies.
397 HAD is a relevant problem, and a systematic appraisal of existing intervention studies addressing
398 this problem is missing. Future research should consider interview methods to help patients
399 better remember their abilities at home in order to reflect their true ability in ADL function.
400

Conclusions

402 Functional decline in older patients over 65 years of age, due to hospitalization for acute care, is
403 an important problem, with an incidence of 37% based on the overall score of ADL assessment.
404 This incidence might be overestimated, due to a combination of disease-related disability and
405 HAD, while measurement tools may also present some limitations. Furthermore, it is not
406 possible to draw a definitive conclusion on the incidence of HAD at the item level, as there is
407 insufficient data reported to enable the results of individual tasks to be pooled. This systematic
408 review found that the most relevant ADL tasks for detecting disability are mobility, bathing, and
409 dressing, although this result should be interpreted with caution. Further studies should
410 investigate the overestimation of HAD and how to overcome this limitation.
411

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414

Declaration

416 **Authors' information:**
417 This rapid systematic review protocol has not been published in a peer-reviewed journal.
418 However, it is registered at OSF registries (https://osf.io/9jez4/) identifier: DOI
419 10.17605/OSF.IO/9JEZ4.
420

421 **Ethics approval and consent to participate:**
422 Not applicable.
423

424 **Availability of data and materials:**
425 All data generated or analyzed during this study are included in this published article [and the
426 Additional file 1].
427

428 **Authors' contributions:**
429 CRediT roles: GK, HR, BD, TJ, SKM: Conceptualization, Methodology and Validation. GK:
430 Investigation. GK, SKM: Resources. GK, HR, BD, TJ, SKM: Formal analysis, Data Curation.
431 GK: Writing - Original Draft, Writing – Review & Editing. GK, HR, SKM: Visualization. HR,
432 BD, TJ, SKM: Supervision and Writing – Review & Editing. All authors revised and approved
433 the final version of the manuscript.
434

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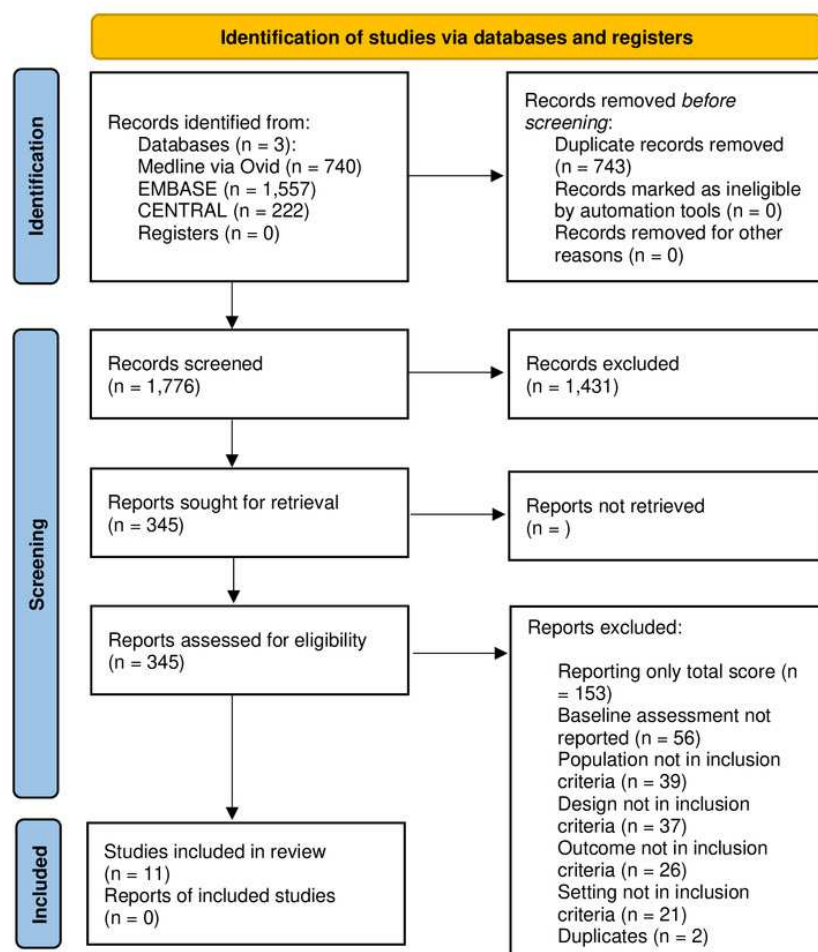
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Figure 1

Flow diagram

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only
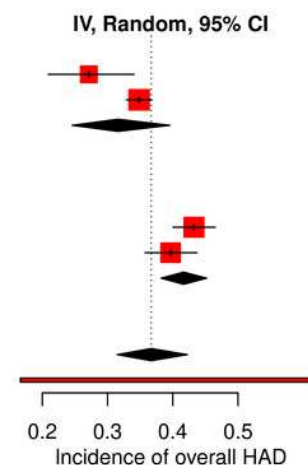
Figure 2

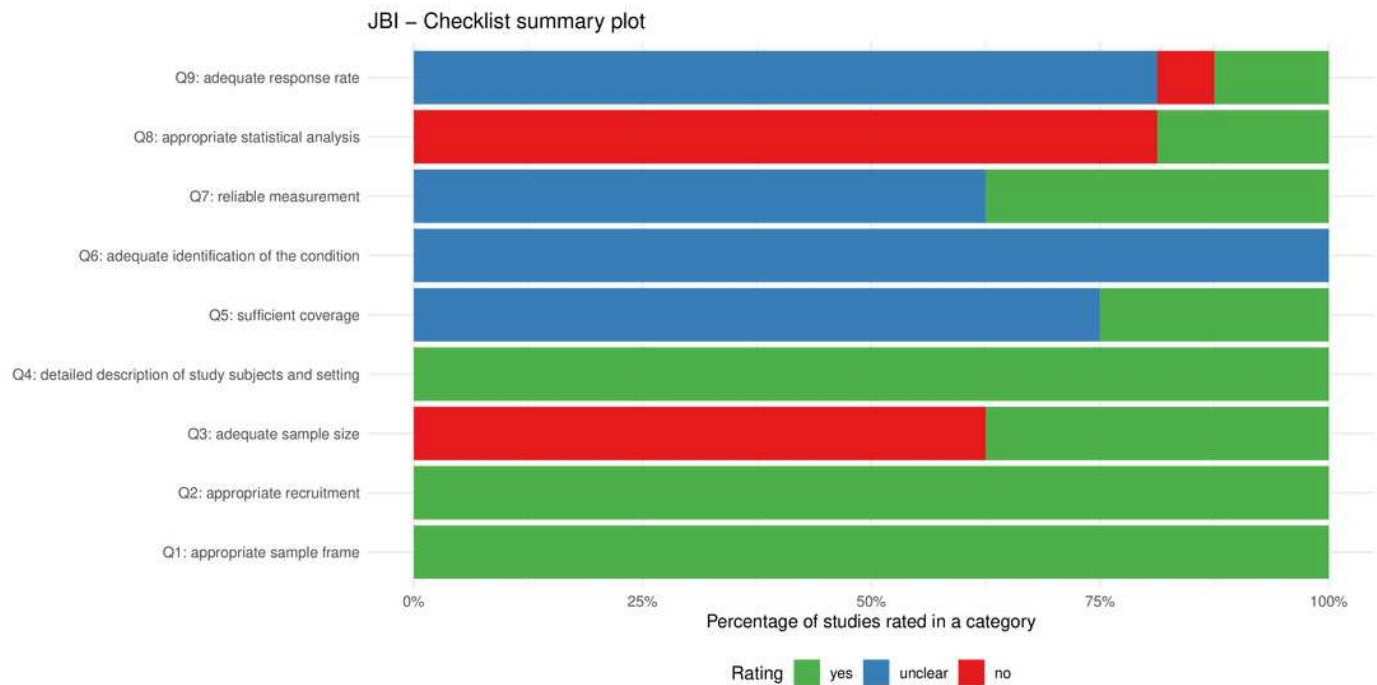Forest plot of the overall incidence of hospital-associated disability

Figure 3

Joanna Briggs Institute (JBI) checklist summary plot

Table 1(on next page)

Study characteristics

a, modified version; b, percentage of persons with a MMSE score <24; c, MMSE < 19 points; CNA, nine-item care needs assessment; d, median; GU, geriatric unit; MMF, mild-to-moderate frailty; MMS, Mini-Mental State Examination; NR, not reported; PF, pre-frail; RB, robust; SF, severe frailty; SPMSQ, Short Portable Mental Status Questionnaire; UU, usual unit.

1 **Table 1. Study characteristics**

Author	Country	Sample size, *n*	Age, years, mean (SD) or (range)	Type of ward	Proportion of women, %	% Living alone	% Living in nursing home	APACHE II score mean (SD) or % of patients per category	Charlson Comorbidity Index mean (SD) or % of patients per category	Mean number of days of hospitalization (SD) or (range)	Mental status mean (SD), tool or % of patients with cognitive impairment
Covinsky 2000 (Covinsky et al. 2000)	USA	2877	80.5	Medicine	64%	52%	5.1%	NR	NR	NR	1.4 (1.3), SPMSQ
Covinsky 2003 (Covinsky et al. 2003)	USA	2293	79.5	Medicine	63.6%	35.2%	4.9%	0–2: 32.3%, 3–5 37.1%, >6: 30.8%	0: 19.8%, 1–2: 47.0%, 3–4: 22.1%, >5: 11.1%	6.3	NR
Dharmarajan 2020 (Dharmarajan et al. 2020)	USA	515	82.7 (5.6)	Hospital	65.6%	46.6%	0%	NR	NR	NR	17.9% [b], MMSE
Hansen 1999 (Hansen et al. 1999)	USA	73	80.4 (7)	Hospital	66%	45%	0%	NR	NR	7.5 (5.0)	2.1% [b], MMSE
Hirsch 1990 (Hirsch et al. 1990)	USA	71	84 (75–95)	Medicine	59%	7.0%	5.6%	NR	NR	10.1 (2-49)	30.8% [c,] last item of CNA
Inouye 1993 (Inouye et al. 1993)	USA	188	78.4 (5.8)	Medicine	59%	45%	4%	13.9 (3.6)	8.5 (2.8) [a]	7 [d] (2 - 51)	23.5 (5.4), MMSE
Martinez-Velilla 2021 (Martinez-Velilla et al. 2021)	Spain	149	87.1 (5.2)	Hospital	59%	NR	NR	NR	NR	8 [d]	NR
Mudge 2010 (Mudge et al. 2010)	Australia	615	80.4 (7.5)	Medicine	59%	NR	11%	NR	NR	7 (5–13)	10%, history of dementia
Park	Republ	RB: 45	RB: 77 (73–	Hospital	RB: 31.1%	NR	RB: 0%	NR	NR	NR	RB: 82.2%

Study		N	Age	Setting							
2021 (Park et al. 2021)	...ic of Korea	PF: 36 MMF: 37 SF: 58	82) PF: 80 (74–84) MMF: 81 (77–86) SF: 81 (75–84)		PF: 38.9% MMF: 46.0% SF: 39.7%		PF: 2.8% MMF: 8.1% SF: 53.5%				PF: 58.3% MMF: 70.3% SF: 82.8%
Sager 1996 (Sager et al. 1996)	USA	1279	79 (6.3)	Hospital	62%	37%	0%	NR	NR	8.6 (6.8)	17 (4.0), MMSE
Zelada 2009 (Zelada et al. 2009)	Peru	GU: 68 UU: 75	GU: 79.6 (6.8) UU: 76.1 (7.2)	Geriatric, usual unit	GU: 61.8% UU: 56%	NR	NR	GU: 9 (2.87) UU: 8.4 (3.11)	GU: 3.6 (1.98) UU: 3.1 (1.6)	GU: 7.5 (4.3) UU: 9.92 (7.74)	GU: 22.4 (6.35) UU: 2.7 (1.91), MMSE

a, modified version; b, percentage of persons with a MMSE score <24; c, MMSE < 19 points; CNA, nine-item care needs assessment; d, median; GU, geriatric unit; MMF, mild-to-moderate frailty; MMS, Mini-Mental State Examination; NR, not reported; PF, pre-frail; RB, robust; SF, severe frailty; SPMSQ, Short Portable Mental Status Questionnaire; UU, usual unit.

Table 2(on next page)

Ranking of the most sensitive tasks or sets of tasks for detecting change in disability

1 **Table 2. Ranking of the most sensitive tasks or sets of tasks for detecting change in**
2 **disability**

Number of sub-groups reporting this item	Item	Mean rank
7	Overall	1.57
1	Mobility	2
14	Bathing	2.5
14	Dressing	3.07
14	Toileting	3.86
1	Transferring from a chair	4
8	Walking	4
4	Walking up and down a flight of stairs	5
13	Transferring	5.15
6	Grooming	5.17
14	Eating	5.79
2	Continence	6
1	Incontinence of bowel or bladder	6
2	Walking 1 km	6.25

3

4