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

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## ABSTRACT

**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 (HAD). This systematic review aimed to assess the incidence of HAD in older adults admitted to acute care with two outcomes: firstly in at least one activity of daily living from a set of functional tasks (*e.g.*, Katz Index) and secondly the incidence of functional decline in an individual functional task (*e.g.*, bathing), and to identify any tools or functional tasks used to assess activities of daily living (ADL) in hospitalized older patients.

**Methods.** A rapid systematic review was performed according to the recommendations of the Cochrane Rapid Reviews Methods Group and reported the data according 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 ( $\geq 65$  years), assessment of individual items of activities of daily living at baseline and discharge. Exclusion criterion: studies investigating a specific condition that could affect functional decline and studies that primarily examined a population with cognitive impairment. The protocol was registered on OSF registries (<https://osf.io/9jez4/>) identifier: DOI [10.17605/OSF.IO/9JEZ4](https://doi.org/10.17605/OSF.IO/9JEZ4).

**Results.** Ten studies were included in the final review. Incidence of HAD (overall score) was 37% (95% CI 0.30–0.43). Insufficient data prevented meta-analysis of the individual items. One study provided sufficient data to calculate incidence, with the following values for patients' self-reported dependencies: 32% for bathing, 27% for dressing, 27% for toileting, 30% for eating and 27% for transferring. The proxy reported the following values for patients' dependencies: 70% for bathing, 66% for dressing, 70% for toileting, 61% for eating and 59% for transferring. The review identified four assessment tools, two sets of tasks, and individual items assessing activities of daily living in such patients.

**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 only one study reported adequate information to assess the HAD incidence. At the item level, the latter was higher when

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Additional Information and  
Declarations can be found on  
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disability was reported by the proxies than when it was reported by patients. This review highlights the lack of systematic reporting of data used to calculate HAD incidence. The methodological quality and the risk of bias in the included studies raised some concerns.

**Subjects** Evidence Based Medicine, Geriatrics, Health Policy, Healthcare Services

**Keywords** Functional decline, Activities of daily living, Older patients, Hospitalization

## INTRODUCTION

Functional decline in older adults during hospitalization increases the risk of a longer hospital stay (*Palmer et al., 1994*), a nursing home placement (*Fortinsky et al., 1999*), and increased mortality (*Brown, Friedkin & Inouye, 2004*). The main goal in older adult care is therefore to maintain function (*Izquierdo, Duque & Morley, 2021*) and the ability to perform activities of daily living (ADL) (*Covinsky et al., 1998; Palmer et al., 1994*). During hospitalization older adults are at risk of developing functional decline unrelated to the condition for which they were admitted (*Creditor, 1993*). The loss of independence in at least one activity of daily living is referred to as hospital-associated disability (HAD) (*Covinsky, Pierluissi & Johnston, 2011*). Furthermore, HAD refers to disability acquired during hospitalization or the worsening of a pre-existing disability due to hospitalization (*Covinsky, Pierluissi & Johnston, 2011*).

Previous studies have highlighted methodological issues in assessing functional decline (*Buurman et al., 2011; Loyd et al., 2020*). However, there is currently no consensus on which tool should be used to assess functional decline in these patients, which ADL tasks should be included, how the assessment should be performed (self-reported or performance-based), and what time-frame should be considered (*Buurman et al., 2011*). *Covinsky, Pierluissi & Johnston (2011)* recommend asking patients on admission about their ADL functioning before the onset of acute illness.

A previous study highlighted the magnitude of the HAD problem and reported that the overall prevalence of HAD among older adults admitted to an acute care hospital is 30% (*Loyd et al., 2020*). To the best of our knowledge, the incidence of HAD has not been studied in a systematic review. The aims of this study was to perform a rapid systematic review to: (i) assess the incidence of HAD in older adults admitted to acute care with two outcomes: firstly in at least one activity of daily living from a set of functional tasks (*e.g.*, Katz Index) and secondly the incidence of functional decline in an individual functional task (*e.g.*, bathing), and (ii) identify any tools or functional tasks used to assess ADL in hospitalized older patients.

## MATERIALS & METHODS

### Registration

The protocol of this rapid systematic review registered at OSF registries with the following identifier: DOI 10.17605/OSF.IO/9JEZ4. Portions of this text were previously published as part of a preprint (<https://www.medrxiv.org/content/10.1101/2022.09.22.22279726v1.full>).

## 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 when available and relevant. The full search strategy is shown in the additional material (see [Table S1](#)). The review included prospective and retrospective cohort studies. The control group of randomized controlled trials (RCTs) was eligible when performing a usual or a sham intervention. Inclusion criteria were: studies investigating a general older population ( $\geq 65$  years) who were admitted to hospital for an acute disorder; studies had to assess the individual items of the ADL measurement tool before hospitalization (retrospectively or prospectively) and at the end of hospitalization or after hospital discharge. Exclusion criteria were: studies investigating a specific condition that could have an effect on functional decline (*e.g.*, stroke, brain injury, heart failure, COVID-19, and acute respiratory failure); and studies that primarily examined a population with cognitive impairment.

One reviewer (GK) independently screened all the records based on titles and abstracts (phase 1) and the full-text of the eligible studies (phase 2). A second reviewer (SKM) screened 20% of the same records. If Cohen’s kappa coefficient of agreement was  $>0.80$  for both phases, only 20% of the studies were planned to be screened independently by two reviewers. Disagreements were resolved through discussion.

## Data extraction

Study characteristics (authors, country, study sample size, population age, type of ward, proportion of women, proportion living alone, proportion living in a nursing home, Acute Physiology and Chronic Health Evaluation (APACHE II) score, Charlson Comorbidity Index, number of days of hospitalization, any scale of mental status) were extracted by one reviewer (GK), while incidence data were extracted by three reviewers (HR, SKM, GK) at the same time. Disagreements were resolved through discussion between all three reviewers. The following information was extracted: item type, response options, criteria for the response options, baseline, and discharge assessment (*i.e.*, who performed it and how), baseline and discharge prevalence of ADL dependency, operationalization, and definition of HAD and incidence per item and for the overall score.

**Table 1** Study characteristics.

Author	Country	Sample size, <i>n</i>	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
<i>Covinsky et al. (2000)</i>	USA	2877	80.5	Medicine	64%	52%	5.1%	NR	NR	NR	1.4 (1.3), SPMSQ
<i>Covinsky et al. (2003)</i>	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
<i>Dharmarajan et al. (2020)</i>	USA	515	82.7 (5.6)	Hospital	65.6%	46.6%	0%	NR	NR	NR	17.9% <sup>b</sup> , MMSE
<i>Hirsch et al. (1990)</i>	USA	71	84 (75–95)	Medicine	59%	7.0%	5.6%	NR	NR	10.1 (2–49)	30.8% <sup>c</sup> last item of CNA
<i>Inouye et al. (1993)</i>	USA	188	78.4 (5.8)	Medicine	59%	45%	4%	13.9 (3.6)	8.5 (2.8) <sup>a</sup>	7 <sup>d</sup> (2–51)	23.5 (5.4), MMSE
<i>Martinez-Velilla et al. (2021)</i>	Spain	149	87.1 (5.2)	Hospital	59%	NR	NR	NR	NR	8 <sup>d</sup>	NR
<i>Mudge, O'Rourke &amp; Denaro (2010)</i>	Australia	615	80.4 (7.5)	Medicine	59%	NR	11%	NR	NR	7 (5–13)	10%, history of dementia
<i>Park et al. (2021)</i>	Republic of Korea	RB: 45 PF: 36 MMF: 37 SF: 58	RB: 77 (73–82) PF: 80 (74–84) MMF: 81 (77–86) SF: 81 (75–84)	Hospital	RB: 31.1% PF: 38.9% MMF: 46.0% SF: 39.7%	NR	RB: 0% PF: 2.8% MMF: 8.1% SF: 53.5%	NR	NR	NR	RB: 82.2% PF: 58.3% MMF: 70.3% SF: 82.8%
<i>Sager et al. (1996)</i>	USA	1279	79 (6.3)	Hospital	62%	37%	0%	NR	NR	8.6 (6.8)	17 (4.0), MMSE
<i>Zelada, Salinas &amp; Baztan (2009)</i>	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

**Notes.**<sup>a</sup>modified version.<sup>b</sup>percentage of persons with a MMSE score <24.<sup>c</sup>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.

### Methodological quality assessment

Methodological quality assessment was performed using the critical appraisal checklist for Studies Reporting Prevalence Data (*Munn et al., 2015*) from the Joanna Briggs Institute (JBI). The JBI checklist was completed independently by two reviewers (SKM, GK). Differences in rating were discussed and resolved. We considered the methodological quality and the risk of bias of a study as low if all questions were rated 'yes', some concern if one of the questions was rated 'unclear' and high if one of the questions was rated 'no'.

### Incidence calculation of hospital-associated disability

The incidence of HAD (total score) was pooled using the statistical software R (*R Core Team, 2022*) and its package meta (*Schwarzer, 2007*). A random effects model was applied based on an inverse variance model with a logit transformation.

Heterogeneity was assessed by the  $I^2$ , which is the proportion of total variability due to between-study heterogeneity (*Deeks, Higgins & Altman, updated February 2022*), to estimate inter-study variability. Tau was estimated with the DerSimonian-Laird estimator (*Schwarzer, 2007*). *Migliavaca et al. (2022)* recommended avoiding the use of an arbitrary cut-off for the  $I^2$  statistics, as it may not be discriminative in incidence studies. Therefore, heterogeneity was explained by discussing the level of dependency at baseline and the method of assessment.

The data required to calculate the incidence of HAD are the number of patients who are dependent and independent at baseline and the evolution of these groups at discharge. If these values were given, the following formula was used to calculate the incidence of the individual ADL task or set of tasks (total score):

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

where a and b represents the number of newly dependent patients (requiring the help of someone else), and the number of patients at risk of developing or increasing dependency respectively. For example, in the study by *Inouye et al. (1993)*, 51 patients were newly dependent at discharge according to the overall score and 188 patients had the potential to decline in one of the ADL tasks.

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

If these values were not reported, an unbiased estimate of the incidence of HAD in that study could not be calculated. In this case, an estimate of the incidence was made by subtracting the percentage of dependency at discharge minus the percentage of dependency at baseline.

### Tools used for assessment of activities of daily living in hospitalized older patients

ADL assessment tools are made up of several items each evaluating individual tasks (*e.g.*, bathing, dressing, transferring, etc.) which together form a tool. The Barthel or Katz Index is an example of a tool composed of several tasks. The literature also mentions task sets that are not defined by the original authors as an index or tool. Other authors propose a set of individual tasks without creating an index.

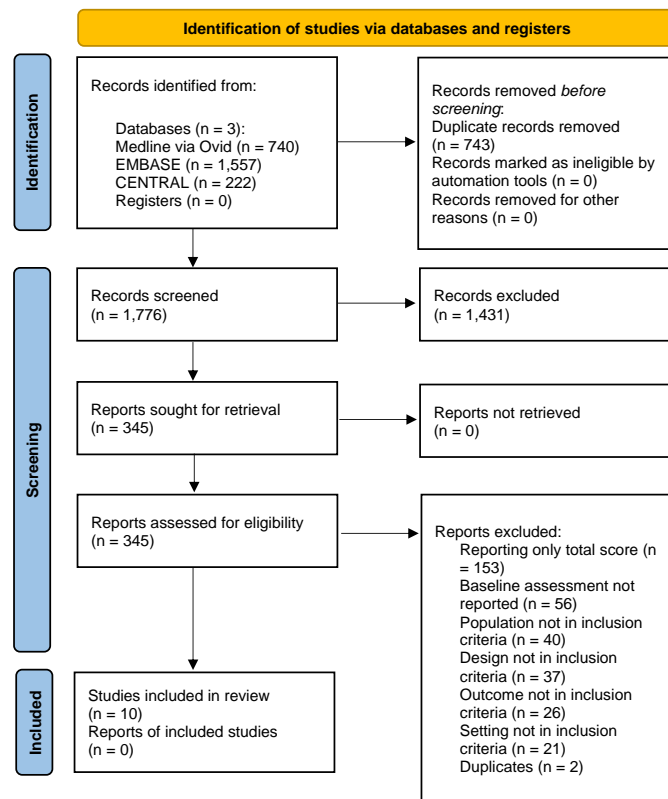


Figure 1 PRISMA flow diagram.

Full-size DOI: 10.7717/peerj.16036/fig-1

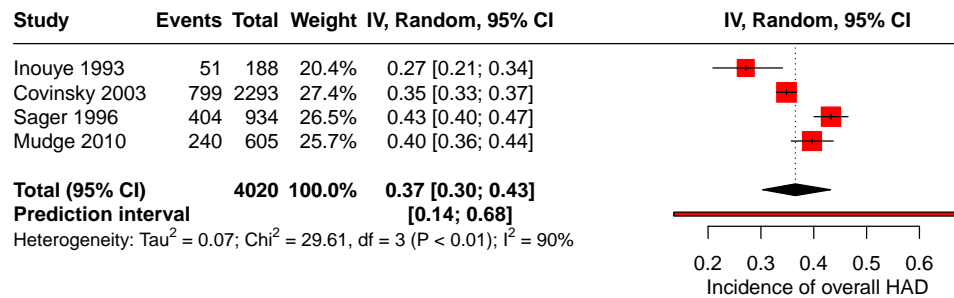
The ADL tools assess whether patients are dependent or independent. For example, the Barthel Index scores the individual tasks from 0 points (dependent) to independent with a maximum of 15 points for transferring, 10 points for climbing stairs and 10 points for using the toilet.

All ADL tools or sets of tasks used in the assessment of hospitalized older patients were reported narratively.

## RESULTS

A total of 2,519 records were identified (Medline (*via* Ovid) 740 records, EMBASE 1,557, CENTRAL 222). After removing 743 duplicates, titles and abstracts of 1,776 articles were screened and 1,431 were excluded. The full text of 345 studies was screened, and a final total of 10 studies were included for further analysis (*Covinsky et al., 2000; Covinsky et al., 2003; Dharmarajan et al., 2020; Hirsch et al., 1990; Inouye et al., 1993; Martinez-Velilla et al., 2021; Mudge, O'Rourke & Denaro, 2010; Park et al., 2021; Sager et al., 1996; Zelada, Salinas & Baztan, 2009*). The reasons for exclusion are shown in the study flow diagram (see Fig. 1).

Cohen's kappa coefficient was  $>0.8$  in both screening phases (*i.e.*, titles/abstracts and full texts); therefore only 20% of studies were screened by two reviewers independently, as described above.



**Figure 2** Forest plot of the incidence of overall hospital-associated disability.

Full-size DOI: [10.7717/peerj.16036/fig-2](https://doi.org/10.7717/peerj.16036/fig-2)

Table 1 shows the population characteristics of the included studies. Six studies were performed in the USA, one in Europe, and three in other countries. The sample size ranged from 36 to 2,877 participants and the age of study participants ranged from 77 to 87 years. The proportion of women in the study samples under investigation ranged from 31% to 66%. Included studies were conducted in the medicine ward (five studies), general hospital (four studies), and one in the geriatric unit and usual unit which refers to a conventional care unit.

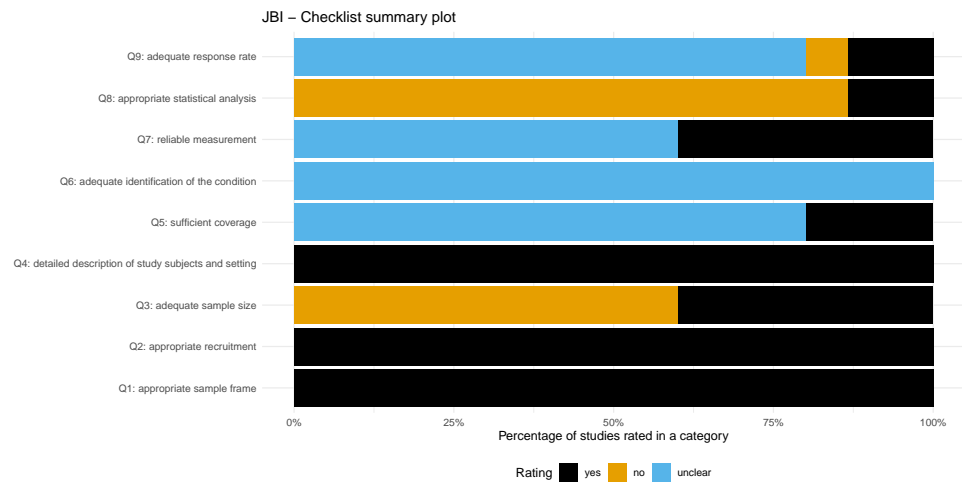
### Outcome results

The pooled incidence of HAD for the overall score included two studies reporting the Katz Index of ADLs 1963 (Covinsky *et al.*, 2003; Inouye *et al.*, 1993) and two others used the Katz Index of ADLs 1970 (Mudge, O'Rourke & Denaro, 2010; Sager *et al.*, 1996) for a total of 4,020 patients. Figure 2 presents the pooled incidence of HAD (total score) of 37% (95% CI [0.30–0.43]). Heterogeneity was substantial at 90%.

The calculated and estimated incidences of HAD are categorized per ADL task and set of tasks (see Table S2). Calculated and estimated incidences of HAD categorized per ADL task and set of tasks). Adequate data for the incidence calculation at the item level was reported only by one study (Covinsky *et al.*, 2000). These authors separated the patient reported and the proxy reported dependency in ADL. The incidence of HAD for the individual items was respectively 32% and 70% for bathing, 27% and 66% for dressing, 27% and 70% for toileting, 30% and 61% for eating, 27% and 59% for transferring. For the other studies, it was not possible to calculate the incidence of HAD (either total or single-item level) due to insufficient data. One RCT could not be integrated into Table S2 because the authors reported only the mean change in ADL score, and the results of this study were described narratively (Martinez-Velilla *et al.*, 2021). The control group worsened in all items of ADL, negative values indicating a decline in the Barthel mean change score. The three items with the highest mean change score from baseline to discharge were: transferring (−2.06 points; 95% CI −1.44 to −2.71), climbing stairs (−1.36 points; 95% CI −0.84 to −1.91), and toileting (−1.23 points; 95% CI −0.76 to −1.69).

Ten studies were included in the identification of the tools or functional tasks used to assess ADL in hospitalized older patients (Covinsky *et al.*, 2000; Covinsky *et al.*, 2003; Dharmarajan *et al.*, 2020; Hirsch *et al.*, 1990; Inouye *et al.*, 1993; Martinez-Velilla *et al.*,





**Figure 3** JBI-Checklist summary plot.

[Full-size](#) [DOI: 10.7717/peerj.16036/fig-3](https://doi.org/10.7717/peerj.16036/fig-3)

2021; Mudge, O'Rourke & Denaro, 2010; Park et al., 2021; Sager et al., 1996; Zelada, Salinas & Baztan, 2009). The review identified four assessment tools, two sets of tasks, and individual items added to original tools. The identified tools were: two references of the Katz Index (1970, 1963), the Barthel Index (Mahoney & Barthel, 1965), the nine-item Care Needs Assessment tool (Hirsch et al., 1990) and 7 ADL tasks form the Frailty Index (Rockwood & Mitnitski, 2011). The first set of tasks is composed of 2 activities coming from the Nagi (1976) and the Rosow & Breslau scale (1966) which were integrated in the Frailty Index (Rockwood & Mitnitski, 2011). The second sets of tasks was proposed by Gill (2014) (bathing, dressing, transferring and walking across the room). Walking was assessed in one study (Mudge, O'Rourke & Denaro, 2010), while one other study (Inouye et al., 1993) assessed the task of grooming by referring to the Katz Index of ADLs. However, the item walking and grooming were not in the original version of the Katz Index, and were considered separately.

### Methodological quality

Figure 3 presents a summary plot of the assessment of methodological quality using the JBI checklist. All the included studies and study sub-groups reported an adequate sample frame and recruitment procedure. Sixty percent of the included study sub-groups reported an inadequate study sample size. All studies and sub-groups described in detail the study subjects and setting. Adequate analysis with sufficient coverage of the identified sample was conducted in 20% of studies sub-groups. All study sub-groups were unclear regarding the methods used for identification of the condition. Sixty percent of study sub-groups were rated unclear for the reliability of the measurement of participant's condition. The

statistical analysis was inadequate in approximately 86% of sub-groups. The response rate of the subgroups was unclear or inadequate in 86%.

Overall, the [Covinsky et al. \(2000\)](#) study showed some concern for methodological quality. All the other studies showed a high risk of bias. The rating of the individual items for each study is available in the additional material (see [File S3](#)).

## DISCUSSION

The aims of this systematic review were to evaluate the overall incidence of HAD as well as the incidence of HAD at the items level and to identify the tools or sets of tasks used in a hospital setting to assess ADL in older people.

The pooled overall incidence of HAD (total score) was 37%. [Inouye et al. \(1993\)](#) and [Covinsky et al. \(2003\)](#), who used the version of the Katz Index published in 1963, showed a lower overall incidence of HAD between 27% and 35% compared to [Mudge, O'Rourke & Denaro \(2010\)](#) and [Sager et al. \(1996\)](#). [Mudge, O'Rourke & Denaro \(2010\)](#) and [Sager et al. \(1996\)](#) who used the version of the same instrument published in 1970, showed a higher incidence of between 40% and 43% overall incidence of HAD compared to [Inouye et al. \(1993\)](#) and [Covinsky et al. \(2003\)](#). This difference could be explained by the fact that patients in the studies by [Mudge, O'Rourke & Denaro \(2010\)](#) and [Sager et al. \(1996\)](#) were more dependent at baseline compared with the participants included in the studies by [Inouye et al. \(1993\)](#) and [Covinsky et al. \(2003\)](#). We were unable to investigate whether this difference was explained by comorbidities (e.g., with the APACHE II score or the Charlson Comorbidity Index) as the authors of the studies by Sager and Mudge did not report these values.

[Loyd et al. \(2020\)](#) found a prevalence of HAD of 30% in older adults hospitalized for acute care. The current review focused on the number of new cases of HAD, *i.e.*, the incidence of HAD. This latter measure considers the number of new cases of decline over the population at risk of developing a new decline, whereas prevalence takes into account the number cases of decline over the overall population. To our knowledge, no other review has neither investigated the overall incidence of HAD nor the incidence at the item level in a population of older patients over 65 years hospitalized for acute care. In general, the incidence of HAD at the item level was higher when disability was reported by the proxies than when it was reported by patients. Similar results were found in previous research ([Rubenstein et al., 1984](#)).

[Loyd et al. \(2020\)](#) included 15 articles, of which we included three in this present rapid systematic review ([Hirsch et al., 1990](#); [Inouye et al., 1993](#); [Sager et al., 1996](#)). Although all twelve studies addressed the issue of HAD, they were excluded on the basis of our inclusion criteria for the following reasons: (i) nine studies did not report the incidence of individual tasks ([Boyd et al., 2009](#); [Brown et al., 2016](#); [Brown, Friedkin & Inouye, 2004](#); [Chodos et al., 2015](#); [Fimognari et al., 2017](#); [Gill et al., 2004](#); [Landefeld et al., 1995](#); [Sourdet et al., 2015](#); [Zaslavsky, Zisberg & Shadmi, 2015](#)); (ii) three studies reported incidence of individual task but assessed functional declines between admission to discharge and not from baseline to discharge ([McVey et al., 1989](#); [Murray et al., 1993](#); [Palese et al., 2016](#)).

None of the twelve studies reported individual ADL incidence or baseline assessment results in the supplementary or online literature.

Regarding the tools or sets of tasks used in a hospital setting to assess ADL in older people, this review identified that the Katz Index of ADLs was the most reported tool in the included studies. The Barthel Index and the Katz Index of ADLs are the oldest tools used for assessing ADL (*Hartigan, 2007*). Six studies used the Katz Index of ADLs, and none of them assessed the continence item that was included in the original version (*Covinsky et al., 2000; Covinsky et al., 2003; Inouye et al., 1993; Mudge, O'Rourke & Denaro, 2010; Sager et al., 1996; Zelada, Salinas & Baztan, 2009*). In addition, the Katz Index of ADLs was modified by adding another item of walking in two studies (*Mudge, O'Rourke & Denaro, 2010; Sager et al., 1996*) and adding the item grooming in one study (*Inouye et al., 1993*).

An overestimation of HAD might be present for two main reasons. First, differences in the execution of the ADL assessment might have resulted in overestimation of the HAD incidence. In two studies (*Inouye et al., 1993; Mudge, O'Rourke & Denaro, 2010*), the baseline value for ADL ability was asked retrospectively to patients at admission, while ADL ability at discharge was assessed by an experienced healthcare professional. Older patients tend to overestimate their ADL ability (*Kempen et al., 1996; Sager et al., 1992*), their ability to step over an obstacle (*Sakurai et al., 2013*) and their motor performance (*Kawasaki & Tozawa, 2020*). Kawasaki and Tozawa hypothesized that the patients' overestimation of their physical or functional capacities might be explained by the absence of recognition of their decline in motor performance (*Kawasaki & Tozawa, 2020*). Observer-based assessments of ADL tasks by healthcare professionals were more accurate than patients' self-reported ADL values (*Applegate, Blass & Williams, 1990; Elam et al., 1991*).

Furthermore, this review included studies investigating pathologies that should not have a long-lasting effect on functional disability. However, it seems that there might be a combination of HAD and disease-related disability. For the overall HAD, *Covinsky et al. (2003)* and *Mudge, O'Rourke & Denaro (2010)* were the only ones to present the disability trajectories of each patient group and their development over time. These authors reported the percentage of patients whose ADL values declined between baseline (two weeks before hospitalization) and hospital admission (which is related to the condition) and those who had not recovered by discharge.

We believe that this combination of HAD and disease-related disability may also have contributed to an overestimation of HAD. In general, the studies did not separately report the numbers of persons with a disease-related disability and those with HAD, but only reported a combined total. Hence, it is unclear whether the failure to recover is due to hospitalization.

Moreover, the current ADL assessment tools present measurement properties limitations. For example, the Barthel Index showed a floor (*Dromerick, Edwards & Diringier, 2003*) and ceiling effect (*de Morton, Keating & Davidson, 2008; Dromerick, Edwards & Diringier, 2003; Nielsen et al., 2016*). Two of the studies included in the current review reported a ceiling effect of the Katz Index of ADLs (*Mudge, O'Rourke & Denaro, 2010; Sager et al., 1996*).

A strength of the current study is that, to the best of our knowledge, this is the first review to investigate the incidence of HAD in a population of older patients over 65 years of age, hospitalized for acute care. To our knowledge, previous systematic reviews did not assess the incidence of HAD at the item level.

The study has a number of limitations. The screening process was performed independently by two reviewers for only 20% of the records. However, we believe that this has only limited negative influence, as the agreement between the reviewers was high (above the predefined kappa coefficient of agreement of 0.8) and this procedure is accepted and suggested in rapid systematic review (*Garritty et al., 2021*). Another limitation is that we could not conduct a meta-analysis for the individual tasks due to insufficient data. With our reported methods, the certainty in the presented estimated incidence of HAD at the item level is very low. The estimated incidence, calculated as the difference between the discharge and baseline prevalence, should be interpreted with caution, as this does not consider the change over time of independent and dependent patients from baseline to discharge. The prevalence of disability at discharge does not distinguish between: (i) those who remain dependent between baseline and discharge, (ii) the newly dependent, and (iii) those who became independent at discharge. Therefore, these estimated incidences cannot be considered true incidence. In addition, small sample size bias cannot be totally excluded in the current review.

### **Implications and further research**

Further studies should investigate the reasons for the overestimation of HAD. As reported above, there is a need to develop a more sensitive tool that reflects the true functional status of older patients (over 65 years) before hospitalization for acute care. The systematic integration of proxies in the evaluation of functional status before hospitalization, in addition to the patient self-reported assessment, needs to be deepened.

This study highlighted the fact that there is a lack of systematic reporting of data in order to assess the incidence of HAD in older patients aged over 65 years. This means that future cohort or intervention studies will have to report in detail the trajectory of such patients between before hospitalization, on admission and on discharge. Indeed, when retrospectively assessing patients' ADL at home, it is necessary to detail the number of people being dependent for each item of ADL. On admission, it is important to describe which of the independent and dependent patients have improved, worsened, or maintained their status prior to hospitalization. At discharge, it is essential to describe which of the independent and dependent patients on admission have improved, worsened, or maintained their status compared with admission. Only in this way will it be possible to determine the number of people with a new decline and to determine its incidence. This review also raises public awareness of the need for careful interpretation of study data.

HAD is a relevant problem, and a systematic appraisal of existing intervention studies addressing this problem is missing. Future research should consider interview methods to help patients better remember their abilities at home in order to reflect their true ability in ADL function.

## CONCLUSIONS

Functional decline in older patients over 65 years of age, due to hospitalization for acute care, is an important problem, with an incidence of 37% based on the overall score of ADL assessment. This incidence might be overestimated, due to a combination of disease-related disability and HAD, while measurement tools may also present some limitations. Furthermore, it is not possible to draw a definitive conclusion on the incidence of HAD at the item level, as there is insufficient data reported to enable the results of individual tasks to be pooled. This review highlights the lack of systematic reporting of data used to calculate the incidence of HAD. It is important to report the trajectory of dependent and independent people at each timepoints (baseline, admission, and discharge) and describe whether they have improved, deteriorated or maintained their status compared to the previous timepoint. Further studies should investigate the overestimation of HAD and how to overcome this limitation.

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The authors declare there are no competing interests.

### Author Contributions

- Katia Giacomino conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.
- Roger Hilfiker conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.
- David Beckwée conceived and designed the experiments, performed the experiments, authored or reviewed drafts of the article, and approved the final draft.
- Jan Taeymans conceived and designed the experiments, performed the experiments, authored or reviewed drafts of the article, and approved the final draft.
- Karl Martin Sattelmayer conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.

### Data Availability

The following information was supplied regarding data availability:

The raw data are available in the Supplemental File.

### Supplemental Information

Supplemental information for this article can be found online at <http://dx.doi.org/10.7717/peerj.16036#supplemental-information>.

## REFERENCES

- Applegate WB, Blass JP, Williams TF. 1990.** Instruments for the functional assessment of older patients. *New England Journal of Medicine* 322:1207–1214 DOI 10.1056/NEJM199004263221707.
- Boyd CM, Ricks M, Fried LP, Guralnik JM, Xue QL, Xia J, Bandeen-Roche K. 2009.** Functional decline and recovery of activities of daily living in hospitalized, disabled older women: the women's health and aging study I. *Journal of the American Geriatrics Society* 57:1757–1766 DOI 10.1111/j.1532-5415.2009.02455.x.
- Brown CJ, Foley KT, Lowman Jr JD, MacLennan PA, Razjouyan J, Najafi B, Locher J, Allman RM. 2016.** Comparison of posthospitalization function and community mobility in hospital mobility program and usual care patients: a randomized clinical trial. *JAMA Internal Medicine* 176:921–927 DOI 10.1001/jamainternmed.2016.1870.
- Brown CJ, Friedkin RJ, Inouye SK. 2004.** Prevalence and outcomes of low mobility in hospitalized older patients. *Journal of the American Geriatrics Society* 52:1263–1270 DOI 10.1111/j.1532-5415.2004.52354.x.
- Buurman BM, van Munster BC, Korevaar JC, de Haan RJ, de Rooij SE. 2011.** Variability in measuring (instrumental) activities of daily living functioning and functional decline in hospitalized older medical patients: a systematic review. *Journal of Clinical Epidemiology* 64:619–627 DOI 10.1016/j.jclinepi.2010.07.005.
- Chodos AH, Kushel MB, Greysen SR, Guzman D, Kessell ER, Sarkar U, Goldman LE, Critchfield JM, Pierluissi E. 2015.** Hospitalization-associated disability in adults admitted to a safety-net hospital. *Journal of General Internal Medicine* 30:1765–1772 DOI 10.1007/s11606-015-3395-2.
- Covinsky KE, Palmer RM, Counsell SR, Pine ZM, Walter LC, Chren MM. 2000.** Functional status before hospitalization in acutely ill older adults: validity and clinical importance of retrospective reports. *Journal of the American Geriatrics Society* 48:164–169 DOI 10.1111/j.1532-5415.2000.tb03907.x.
- Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, Burant CJ, Landefeld CS. 2003.** Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *Journal of the American Geriatrics Society* 51:451–458 DOI 10.1046/j.1532-5415.2003.51152.x.
- Covinsky KE, Palmer RM, Kresevic DM, Kahana E, Counsell SR, Fortinsky RH, Landefeld CS. 1998.** Improving functional outcomes in older patients: lessons from an acute care for elders unit. *The Joint Commission Journal on Quality Improvement* 24:63–76 DOI 10.1016/s1070-3241(16)30362-5.
- Covinsky KE, Pierluissi E, Johnston CB. 2011.** Hospitalization-associated disability: she was probably able to ambulate, but I'm not sure. *Jama* 306:1782–1793 DOI 10.1001/jama.2011.1556.
- Creditor MC. 1993.** Hazards of hospitalization of the elderly. *Annals of Internal Medicine* 118:219–223 DOI 10.7326/0003-4819-118-3-199302010-00011.
- de Morton NA, Keating JL, Davidson M. 2008.** Rasch analysis of the barthel index in the assessment of hospitalized older patients after admission for an acute

medical condition. *Archives of Physical Medicine and Rehabilitation* **89**:641–647 DOI [10.1016/j.apmr.2007.10.021](https://doi.org/10.1016/j.apmr.2007.10.021).

- Deeks JJ, Higgins JPT, Altman DG. updated February 2022.** Chapter 10: analysing data and undertaking meta-analyses. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA, eds. *Cochrane handbook for systematic reviews of interventions*. Chichester (UK): John Wiley & Sons.
- Dharmarajan K, Han L, Gahbauer EA, Leo-Summers LS, Gill TM. 2020.** Disability and recovery after hospitalization for medical illness among community-living older persons: a prospective cohort study. *Journal of the American Geriatrics Society* **68**:486–495 DOI [10.1111/jgs.16350](https://doi.org/10.1111/jgs.16350).
- Dromerick AW, Edwards DF, Diringer MN. 2003.** Sensitivity to changes in disability after stroke: a comparison of four scales useful in clinical trials. *Journal of Rehabilitation Research and Development* **40**:1–8.
- Elam JT, Graney MJ, Beaver T, el Derwi D, Applegate WB, Miller ST. 1991.** Comparison of subjective ratings of function with observed functional ability of frail older persons. *American Journal of Public Health* **81**:1127–1130 DOI [10.2105/ajph.81.9.1127](https://doi.org/10.2105/ajph.81.9.1127).
- Fimognari FL, Pierantozzi A, De Alfieri W, Salani B, Zuccaro SM, Arone A, Palleschi G, Palleschi L. 2017.** The severity of acute illness and functional trajectories in hospitalized older medical patients. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences* **72**:102–108 DOI [10.1093/gerona/glw096](https://doi.org/10.1093/gerona/glw096).
- Fortinsky RH, Covinsky KE, Palmer RM, Landefeld CS. 1999.** Effects of functional status changes before and during hospitalization on nursing home admission of older adults. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* **54**:M521–M526 DOI [10.1093/gerona/54.10.m521](https://doi.org/10.1093/gerona/54.10.m521).
- Garritty C, Gartlehner G, Nussbaumer-Streit B, King VJ, Hamel C, Kamel C, Affen-gruber L, Stevens A. 2021.** Cochrane rapid reviews methods group offers evidence-informed guidance to conduct rapid reviews. *Journal of Clinical Epidemiology* **130**:13–22 DOI [10.1016/j.jclinepi.2020.10.007](https://doi.org/10.1016/j.jclinepi.2020.10.007).
- Gill TM. 2014.** Disentangling the disabling process: insights from the precipitating events project. *The Gerontologist* **54**:533–549 DOI [10.1093/geront/gnu067](https://doi.org/10.1093/geront/gnu067).
- Gill TM, Allore HG, Holford TR, Guo Z. 2004.** Hospitalization, restricted activity, and the development of disability among older persons. *Jama* **292**:2115–2124 DOI [10.1001/jama.292.17.2115](https://doi.org/10.1001/jama.292.17.2115).
- Hartigan I. 2007.** A comparative review of the Katz ADL and the Barthel Index in assessing the activities of daily living of older people. *International Journal of Older People Nursing* **2**:204–212 DOI [10.1111/j.1748-3743.2007.00074.x](https://doi.org/10.1111/j.1748-3743.2007.00074.x).
- Hirsch CH, Sommers L, Olsen A, Mullen L, Winograd CH. 1990.** The natural history of functional morbidity in hospitalized older patients. *Journal of the American Geriatrics Society* **38**:1296–1303 DOI [10.1111/j.1532-5415.1990.tb03451.x](https://doi.org/10.1111/j.1532-5415.1990.tb03451.x).
- Inouye SK, Wagner DR, Acampora D, Horwitz RI, Cooney Jr LM, Hurst LD, Tinetti ME. 1993.** A predictive index for functional decline in hospitalized elderly medical patients. *Journal of General Internal Medicine* **8**:645–652 DOI [10.1007/BF02598279](https://doi.org/10.1007/BF02598279).

- Izquierdo M, Duque G, Morley JE. 2021.** Physical activity guidelines for older people: knowledge gaps and future directions. *The Lancet Healthy Longevity* 2:e380–e383.
- Katz S, Downs TD, Cash HR, Grotz RC. 1970.** Progress in development of the index of ADL. *Gerontologist* 10:20–30 DOI 10.1093/geront/10.1\_part\_1.20.
- Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. 1963.** Studies of illness in the aged. The index of Adl: a standardized measure of biological and psychosocial function. *Jama* 185:914–919 DOI 10.1001/jama.1963.03060120024016.
- Kawasaki T, Tozawa R. 2020.** Motor function relating to the accuracy of self-overestimation error in community-dwelling older adults. *Frontiers in Neurology* 11:599787 DOI 10.3389/fneur.2020.599787.
- Kempen GI, Steverink N, Ormel J, Deeg DJ. 1996.** The assessment of ADL among frail elderly in an interview survey: self-report versus performance-based tests and determinants of discrepancies. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* 51:P254–P260 DOI 10.1093/geronb/51b.5.p254.
- Landefeld CS, Palmer RM, Kresevic DM, Fortinsky RH, Kowal J. 1995.** A randomized trial of care in a hospital medical unit especially designed to improve the functional outcomes of acutely ill older patients. *New England Journal of Medicine* 332:1338–1344 DOI 10.1056/NEJM199505183322006.
- Loyd C, Markland AD, Zhang Y, Fowler M, Harper S, Wright NC, Carter CS, Buford TW, Smith CH, Kennedy R, Brown CJ. 2020.** Prevalence of hospital-associated disability in older adults: a meta-analysis. *Journal of the American Medical Directors Association* 21:455–461 DOI 10.1016/j.jamda.2019.09.015.
- Mahoney FI, Barthel DW. 1965.** Functional evaluation: the barthel index. *Maryland State Medical Journal* 14:61–65.
- Martinez-Velilla N, De Asteasu MLSaez, Ramirez-Velez R, Zambom-Ferraresi F, Garcia-Hermoso A, Izquierdo M. 2021.** Recovery of the decline in activities of daily living after hospitalization through an individualized exercise program: secondary analysis of a randomized clinical trial. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 76:1519–1523 DOI 10.1093/gerona/glab032.
- McVey LJ, Becker PM, Saltz CC, Feussner JR, Cohen HJ. 1989.** Effect of a geriatric consultation team on functional status of elderly hospitalized patients. A randomized, controlled clinical trial. *Annals of Internal Medicine* 110:79–84 DOI 10.7326/0003-4819-110-1-79.
- Migliavaca CB, Stein C, Colpani V, Barker TH, Ziegelmann PK, Munn Z, Falavigna M. 2022.** Meta-analysis of prevalence: I(2) statistic and how to deal with heterogeneity. *Research Synthesis Methods* 13:363–367 DOI 10.1002/jrsm.1547.
- Mudge AM, O'Rourke P, Denaro CP. 2010.** Timing and risk factors for functional changes associated with medical hospitalization in older patients. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 65:866–872 DOI 10.1093/gerona/glq069.
- Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. 2015.** Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence



- and cumulative incidence data. *International Journal of Evidence-Based Healthcare* 13:147–153 DOI 10.1097/XEB.0000000000000054.
- Murray AM, Levkoff SE, Wetle TT, Beckett L, Cleary PD, Schor JD, Lipsitz LA, Rowe JW, Evans DA. 1993. Acute delirium and functional decline in the hospitalized elderly patient. *Journal of Gerontology* 48:M181–M186 DOI 10.1093/geronj/48.5.m181.
- Nagi SZ. 1976. An epidemiology of disability among adults in the United States. *The Milbank Memorial Fund Quarterly Health and Society* 439–467.
- Nielsen LM, Kirkegaard H, Ostergaard LG, Bovbjerg K, Breinholt K, Maribo T. 2016. Comparison of self-reported and performance-based measures of functional ability in elderly patients in an emergency department: implications for selection of clinical outcome measures. *BMC Geriatrics* 16:199 DOI 10.1186/s12877-016-0376-1.
- Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hrobjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Bmj* 372:n71 DOI 10.1136/bmj.n71.
- Palese A, Gonella S, Moreale R, Guarnier A, Barelli P, Zambiasi P, Allegrini E, Bazoli L, Casson P, Marin M, Padovan M, Picogna M, Taddia P, Salmaso D, Chiari P, Frison T, Marognolli O, Benaglio C, Canzan F, Ambrosi E, Saiani L, Group E. 2016. Hospital-acquired functional decline in older patients cared for in acute medical wards and predictors: findings from a multicentre longitudinal study. *Geriatric Nursing* 37:192–199 DOI 10.1016/j.gerinurse.2016.01.001.
- Palmer RM, Landefeld CS, Kresevic D, Kowal J. 1994. A medical unit for the acute care of the elderly. *Journal of the American Geriatrics Society* 42:545–552 DOI 10.1111/j.1532-5415.1994.tb04978.x.
- Park CM, Kim W, Rhim HC, Lee ES, Kim JH, Cho KH, Kim DH. 2021. Frailty and hospitalization-associated disability after pneumonia: a prospective cohort study. *BMC Geriatrics* 21:111 DOI 10.1186/s12877-021-02049-5.
- R Core Team. 2022. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. Available at <https://www.r-project.org/>.
- Rockwood K, Mitnitski A. 2011. Frailty defined by deficit accumulation and geriatric medicine defined by frailty. *Clinics in Geriatric Medicine* 27:17–26 DOI 10.1016/j.cger.2010.08.008.
- Rosow I, Breslau N. 1966. A Guttman health scale for the aged. *Journal of Gerontology* 21:556–559 DOI 10.1093/geronj/21.4.556.
- Rubenstein LZ, Schairer C, Wieland GD, Kane R. 1984. Systematic biases in functional status assessment of elderly adults: effects of different data sources. *Journal of Gerontology* 39:686–691 DOI 10.1093/geronj/39.6.686.
- Sager MA, Dunham NC, Schwantes A, Mecum L, Halverson K, Harlowe D. 1992. Measurement of activities of daily living in hospitalized elderly: a comparison of self-report and performance-based methods. *Journal of the American Geriatrics Society* 40:457–462 DOI 10.1111/j.1532-5415.1992.tb02011.x.

- Sager MA, Franke T, Inouye SK, Landefeld CS, Morgan TM, Rudberg MA, Sebens H, Winograd CH. 1996.** Functional outcomes of acute medical illness and hospitalization in older persons. *Archives of Internal Medicine* **156**:645–652 DOI [10.1001/archinte.1996.00440060067008](https://doi.org/10.1001/archinte.1996.00440060067008).
- Sakurai R, Fujiwara Y, Ishihara M, Higuchi T, Uchida H, Imanaka K. 2013.** Age-related self-overestimation of step-over ability in healthy older adults and its relationship to fall risk. *BMC Geriatrics* **13**:1–9 DOI [10.1186/1471-2318-13-44](https://doi.org/10.1186/1471-2318-13-44).
- Schwarzer G. 2007.** meta: An R package for meta-analysis. *R News* 40–45.
- Sourdet S, Lafont C, Rolland Y, Nourhashemi F, Andrieu S, Vellas B. 2015.** Preventable iatrogenic disability in elderly patients during hospitalization. *Journal of the American Medical Directors Association* **16**:674–681 DOI [10.1016/j.jamda.2015.03.011](https://doi.org/10.1016/j.jamda.2015.03.011).
- Zaslavsky O, Zisberg A, Shadmi E. 2015.** Impact of functional change before and during hospitalization on functional recovery 1 month following hospitalization. *Journals of Gerontology Series a: Biomedical Sciences and Medical Sciences* **70**:381–386 DOI [10.1093/gerona/glu168](https://doi.org/10.1093/gerona/glu168).
- Zelada MA, Salinas R, Baztan JJ. 2009.** Reduction of functional deterioration during hospitalization in an acute geriatric unit. *Archives of Gerontology and Geriatrics* **48**:35–39 DOI [10.1016/j.archger.2007.09.008](https://doi.org/10.1016/j.archger.2007.09.008).