Incidence and predictive factors of functional decline in older people living in nursing homes: a systematic review

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Abstract

Objectives; To review the evidence on incidence and predictive factors of functional decline (FD) in nursing home (NH) residents.

Design; A systematic review of the literature.

Setting and Participants; Longitudinal studies involving 60-year-old individuals and older living in a NH and with at least two functional capacity assessments were eligible.

Methods; The search was carried out up to June 2021 and was conducted in Embase, PubMed, Web of Science, Cochrane Library, CINAHL, Scopus, SciELO and Google Scholar databases.

Results; A total of 27 studies met the eligibility criteria, most of which were prospective, recruiting participants in more than one NH, and conducted in a single country. Studies reported a high rate of functional dependency at baseline and FD at follow up; in one year, 38.9% to 50.6% of residents experienced FD. Predictive factors of FD that were significant in at least two of the included studies were: cognitive impairment, functional status at baseline, urinary incontinence, length of institutionalization, age, depression, being married, being male and stroke disease. Protective factors were licensed nursing hours and presence of a geriatrician within the NH staff.

Conclusions and Implications; This review highlights the high incidence of FD in NH residents and identifies risk and protective factors of FD, that may support the design of preventative strategies for this vulnerable and frail population.

Introduction

The pace of population ageing is increasing. Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%. [1] Ageing constitutes and influences complex numerous underlying physiological changes and increases the risk of chronic disease.[2] Since the presence of these health conditions may have different impacts on an older adult's life, it is important to consider not just specific diseases but also how they interact and impact on trajectories of functioning.[3]

The World Health Organization (WHO) defined healthy ageing as the process of developing and maintaining the functional capacity (FC) that enables well-being in older age. FC was defined as the health-related attributes that enable people to be and to do what they have reason to value. It includes all the physical and mental capacities of the individual, as well as the environmental characteristics, and the interactions between the individual and these characteristics.[3] However, ageing has been associated with progressively deteriorating FC trajectories and increased care-dependency [4–6] through progressive functional decline (FD).[7]

Older adults with care dependency need a level of care that in many instances is not possible to provide at home, leading to a nursing home (NH) admission.[8] NH residents are among the frailest of the population with high levels of physical dependency, cognitive impairment, multimorbidity and polypharmacy.[9] It has been recognized that older adults with higher disability profiles tend to deteriorate at higher rates, [10] and disability may be the main driver of NHs expenditure. [11] The WHO stated that NHs' role is to ensure that older adults with a significant loss of FC can still experience healthy ageing by optimizing the individual's trajectory of physical or mental capacity or

compensating for the loss of FC by providing the environmental support and necessary care to maintain the FC at an optimal level to ensure well-being. So rather than focusing simply on meeting older adults' basic needs for survival, the ultimate goal of NHs should be maintaining residents' FC. [3]

Longitudinal studies provide data on trajectories of change in cohorts, enabling better understanding of the impacts of ageing, cohort differences and period effects. [12] In addition, they can provide evidence of early predictors of later declines in health, such as FD; which may be key to better prevent or at least slow down FD, therefore reducing its associated personal and financial costs.[7]

To date, there is only one systematic review that has evaluated incidence of FD in older adults living in NHs, but residents with preexisting physical, mental or emotional disabilities were not included and it stated that further studies should also analyze this population given that these individuals are likely to live in NHs.[7]

In order to understand the complexity of NH residents and making FC the ultimate goal of NH care, there is a need to further understand FD and improve the model of care in this population. The objective of this review was to describe and analyze the incidence and predictive factors of FD in NH residents aged 60 and over.

Methods

This systematic review was registered on PROSPERO (CRD42020180834) and conducted according to PRISMA guidelines.[13]

Data Sources and Search Strategy

A literature search of Embase, PubMed, Web of Science, Cochrane Library, CINAHL, Scopus, SciELO and Google Scholar databases and a manual search was undertaken on March 8, 2020, with an update in June 2021. Search strategy is represented in Supplementary Table 1.

Eligibility Criteria and Primary Outcomes

Original research studies were eligible for inclusion if they fulfilled the following inclusion criteria: longitudinal (prospective and retrospective) studies with at least two functional assessments (at baseline and at follow up) reporting functional decline incidence and/or predictive factors for functional decline, measured with tools to assess activities of daily living (e.g., Barthel Index), with no restrictions about the follow-up period limit, publication year or language; involving individuals living in a NH who were at least 60 years old; those studies including both community and NH-dwelling individuals were included if data from residents living in NHs were differentiated and could be extracted. Studies were excluded if they were cross-sectional, included only disabled individuals with preexisting conditions (e.g., only residents with dementia) or with total functional dependency for activities of daily living at baseline. Interventional studies were considered eligible only when there was a control group that had not received any intervention and the outcomes were consistent with the aims of this review, and only data from the control group was considered.

The primary outcome of this review was decline in FC, the presence of FD was considered if the FC score was worse than the initial score.[7]

Study Selection, Data Extraction, and Analysis

Covidence software was used to manage and screen all retrieved studies. In the preliminary stage, the search strategy was as comprehensive as possible to include the greatest number of studies (high sensitivity) and then gradually narrowed according to the inclusion and exclusion criteria. Duplicated studies were removed from the list. The selection was carried out by 4 researchers (P.M., S.R., J.J., V.R.) working in pairs (independent to each other). The first selection was focused on the title and abstract. Disagreements were rationalized by an independent researcher (P.M. or J.J.). A second selection was followed, after critically reading the complete articles using the blind peer-review method. Conflicts were discussed between both researchers to reach a consensus; when this was not possible another researcher (J.J. or M.G.) was added to the discussion and the decision was made when full agreement was achieved.

Five authors (P.M., E.M., S.R., V.R., J.J.) were responsible for extracting the following data from the selected articles: (1) study identification (author, citation); (2) study characteristics (study setting, study design, sample size, baseline, follow-up, withdrawals); (3) definition of FD; (4) instruments adopted for data collection and the data collected; (5) incidence of FD and confidence intervals; (6) FC trajectory; (7) associated factors related to FD. Data extraction was carried out using the blind peer-review method. Any discrepancies during the data extraction were solved through discussion with a third reviewer (P.M. or J.J.). Missing data of eligible studies was sought by contacting authors via e-mail. If no response was obtained from the authors after a second request by e-mail, the study was excluded.

Quality Assessment

Risk of bias assessment was carried out by 5 researchers (P.M., J.J., M.G., D.L., P.F.). The quality of the studies included was assessed using the Study Quality Assessment Tool for observational cohort and cross-sectional studies developed by National Heart, Lung, and Blood Institute (NHLBI).[14]

Results

After removing duplicate articles, 5,840 titles and abstracts were screened for eligibility. After title and abstract screening, 429 studies were retrieved for full-text review. Finally, a total of 27 studies met the eligibility criteria. Figure 1 shows the flow diagram for identification of eligible trials.

((Insert Figure 1 here))

Study Characteristics

Characteristics of the 27 studies are described in Table 1. Most studies were prospective [15–34]and conducted in a single country: 9 in Europe,[7,16,19,21,23,26,27,31,34] 8 in North America, [15,30,32,35–39] 6 in Asia [17,18,20,24,28,29] and 1 in South America. [25] One study was implemented in two European countries [33] and another one within a multi-national setting (7 European countries, plus Israel).[22]

((Insert Table 1 here))

The number of facilities where the studies recruited participants ranged from 1 [16,27] to 1097, [30] but most studies included more than one facility. [15,17–26,29–32,34–36,38–41] All studies were conducted in NHs, except 4 [17,18,28,29] which were carried out in veteran homes (VHs). The follow-up period ranged from 120 days [38] to 9 years [20], most studies having a period between 1 and 3 years. [15,16,19,21–33,37]

The most common cutoff point for age as an inclusion criteria was +65 years [15,16,18,19,21,23,24,26,28–30,34–40], the lower and higher being +60 [25,31] and +80 (38), respectively. Some studies considered time since admission as a criterion for selecting residents: 5 studies only included newly admitted residents [15,32,35,36,41] and 9 selected only residents who had been in the facility for a specific time period (16,17,20–22,26,27,29,34), ranging from 30 days [31,34] to 1 year.[37] Some studies specifically excluded residents with a certain level of FC score or total dependency.[16,18,21,23,25,28,29,31–33,37] Some conditions were frequently excluded: terminal state, [16,19,25,27,30,34] comatose, [25,30,35–37] tube feeding, [19,27,35,36,40] acute illness, [16,19,27] cognitive impairment, [23,33,37] inability to complete assessment, [18,29] bedridden [35,36] and quadriplegic. [35,36]

Sample size between studies ranged from 110 [23] to 71,388. [37] All studies, except one, [17] had a mean age of participants of 80-88 years with a higher proportion of women ranging from 54.2% [17] to 85.1%; [27] studies conducted in VHs only included men. [17,18,28,29]

The methodological quality assessment of all studies is summarized in Supplementary Table 2.

Studies with the lowest quality only fulfilled 6 out of 14 items [17,39] while the studies with the highest quality fulfilled 12 items.[25,27,28] Sample size justification (Q5) was only carried out by one study. [25]

Functional Capacity Assessment

Functional related information from the 27 studies included are described in Table 2. FC was assessed with a wide variety of instruments; there were even differences in how the same instrument was used across studies. The most frequently used instrument was the Minimum Data Set (MDS) which was used in 10 studies with variations: 6 studies used the MDS Long Form scale ADL with a score of 0-28 and 7 items; [21,22,32,35,36,38] 2 used the MDS-ADL hierarchical scale with a score of 0-28 but only 4 items; [29,41] 1 used the MDS+ with a score of 0-20 with 5 items; [37] and 1 used the MDS ADL-7 with the same score as the MDS Long Form scale ADL but a different item. [30] Barthel Index was used in 6 studies: 5 used a score of 0-100 and 10 items;[19,23,24,26,40] and 1 used a score of 0-28 with only 7 items. [25] Katz index was used in 6 studies evaluating the same 6 items: 5 used a score of 0-6; [16,27,31,33,34] 1 used a score of 4-18.[17] RUG-III ADL was used in 2 studies using a score of 4-18 and 4 items.[18,28] Finally, the following instruments were used only by 1 study: total dependency score with a score of 0-33 and 8 items;[15] ADL Self-Performance Hierarchy Scale with a score of 0-6 and 4 items;[20] and ADL FC with a score of 0-5 and 5 items.[39]

Eating and Toileting were the only items evaluated within all the studies. Other items used to evaluate FC were: transferring (n=23; 85.2%), dressing (n=22; 81.5%), personal hygiene (n=18; 66.7%), bathing (n=16; 59.3%), locomotion (n=16; 59.3%), continence (n=11; 40.7%), bed mobility (n=10; 37.0%), fecal continence (n=5; 18.5%) and stairs (n=5; 18.5%).

High variability in measurements of FC limited comparability between studies and therefore a meta-analysis was unfeasible.

Functional Capacity at Baseline

Comparison of FC at baseline was only feasible among studies that used the same instrument. Studies using the MDS Long Form Scale ADL reported a mean FC at baseline ranging from 12.4 to 15 (for a maximum of 28 being totally dependent).[21,22,32,35,36,38] The total score ranged from 36.9 to 76.5 (for a maximum of 100 being totally independent) in those studies that used the Barthel Index [19,23,24,26,40] and a range of 2 to 5.1 (for a maximum of 6 being totally independent) for those using the Katz Index. [16,27,31,33,34]

((Insert Table 2 here))

Functional Decline Criteria

Criteria for FD were similar among studies: 10 studies considered a variation of 1 point on the FC score in the follow-up; [17,18,21–23,25,26,28,32,37] 4 considered a variation of 2 points

[16,29,34,41] and 1 a variation of 4 points;[38] 11 studies did not report the criteria.[7,15,19,20,24,27,30,31,33,35,36,39] Whether this variation was an increase or decrease in the follow-up score depended on the instrument's scoring method.

Residents' death or discharge from the NH were the main causes of dropout among the studies. Most studies directly excluded these cases from the data analysis.[16,17,19,21,22,24,27–29,31,33,35,36,38,40,41] However, some studies used different methods to account for dropouts: using a mixed-effect model,[20,37] applying a survival analysis,[39] using data from the latest assessment,[23,30] incorporating new individuals to compensate[25], imputing a maximal dependency score to deaths [15,32] or considering death as cases of FD.[34] Management of deaths and discharges was not reported in 2 studies[18,26] whereas 4 reported how deaths were considered but not discharge.[16,19,23,32]

Functional Decline Results

FD incidence was reported in 15 studies.[15–18,21–23,25,26,28,29,34,37,38,41] Among these, there was consistently a lower incidence of FD when they had shorter follow-up periods and higher FD criteria on variation points; 3 studies with 1-year follow-up and 1-point criteria reported a percentage of 38.9% to 50.6%;[21,22,26] Jerez *et al.* shared the same criteria with 2-year follow-up, describing an incidence of 56%.[25] In contrast, Dosa *et al*. with 120 days of follow-up and 4-point criteria had a much lower incidence: 5.1-5.8%.[38] VHs reported a lower incidence of FD in comparison of NH, reporting an incidence of 11.3% with 1-point criteria and 18 months follow-up.[28]

Predictive Factors

The FD predictors were investigated in 23 included studies: [15–18,20–29,31,32,34–37,39–41] 3 of them used a bivariate analysis [23,27,41] and the rest used a multivariate analysis.[15–18,20–22,24–26,28,29,31,32,34–37,39,40] Matching up the variables that were entered in the different analysis, 122 different variables emerged. We categorized them into institutional level variables (n=17; 13.9%) and individual level variables (n=105; 86.1%), the latter including those considered biological (n=81; 66.4%) and psychosocial (n=24; 19.7%).

Across all the studies, 49 different predictive factors emerged as significant within the different multivariate analysis. Biological predictive factors are depicted in Figure 2 and psychosocial and institutional-level predictive factors in Figure 3.

((Insert Figure 2 here))

((Insert Figure 3 here))

The predictive factors of FD that were significant in multivariate analyses within at least two of the included studies were: cognitive impairment;[18,20,22,24,25,32,37,39,40] function status at baseline;[15,17,22,26,32,40] urinary incontinence;[22,25,35,36,39] length of institutionalization;[20,28,32,39,40] age;[22,24,28,39] depression;[20,21,24,40] being married;[20,24,37] stroke;[20,28,39] poor balance;[32,35,36] being male; [15,39] number of chronic conditions;[24,40] Parkinson's disease;[18,39] history of a fall;[36,40] hospitalization;[17,25] multicomponent Resident Assessment Protocol (RAP), a proxy indicator of care complexity;[18,28] and

Alzheimer's disease.[20,39] Whereas the protective factors of FD that were significant in multivariate analysis within at least two of the included studies were institutional level variables: licensed nursing hours [15,21] and presence of a geriatrician.[21,22] Further information is detailed in Supplementary Tables 3, 4 and 5.

Discussion

This review analyzed the incidence of FD and its predictive factors in older adults living in NHs. We found a high rate of functional dependency and dramatic FD in NH residents, ranging from 38 to 50% in one year. Cognitive impairment, FC at baseline, urinary incontinence, and length of institutionalization were the most prevalent significant predictive factors of FD among this population, whereas licensed nursing hours and presence of a geriatrician within the NH staff were identified as protective factors.

Rates of dependency at baseline and FD at follow-up in NH residents were exceptionally high. This matches with the existing literature reporting that long-term residents are among the frailest population with the lowest levels of FC,[3,9] and that higher disability profiles tend to have faster FD transitions.[10] In contrast, the previous systematic review reported that NH residents had a slow FD as a result of a floor effect and improvements in nursing care offered; however, in the previous review, residents with preexisting physical, mental or emotional disabilities were not included. Given that such older adults live in NHs, including these populations in the current review gives a more accurate picture and may explain the differences in FD reported.

In terms of predictive factors, there were a wide range of variables analyzed. Most studies focused on individual biological variables over institutional or psychosocial. The

predictive factors of FD identified in more than one study were cognitive impairment, functional status at baseline, urinary incontinence, length of institutionalization, age, depression, being married, being male and stroke disease, sorted by number of studies that reported on these and were significant. Some of these individual-level predictive factors are potentially preventable or modifiable, such as urinary incontinence, FC, depression or cognition.[42–44] Interventions to modify these risk factors should be further emphasized considering their importance in FD. Those factors that may not be modifiable, should be discussed with the professionals and institutions to increase their understanding and the best way to appropriately manage them.

It must be highlighted that the only protective factors of FD that appeared significant within at least two of the included studies were institutional level variables, specifically licensed nursing hours and the presence of a geriatrician. The importance and necessity to study institutional level variables has already been reported in the literature,[7] studying and improving these factors should be further emphasized to achieve what WHO stated as the ultimate goal of NHs care: optimize the FC trajectories of the residents.[3] These protective factors highlight the necessity of having an adequate workforce capacity in NH, particularly of highly trained care workers. Increasing care workers pay and benefits, improving their working conditions, providing education, career progression or academic opportunities could help NHs to retain and recruit highly trained care workers and improve their working capacity by boosting their status and increasing their capabilities and skills.[3]

It must be noted that there was considerable variation in methodology of the included studies. FD was generally expressed as a variation in FC score at the follow-up period

compared to baseline, even though a high proportion of studies did not report how it was calculated. Several methodological factors have a relevant influence on FD rates and should be taken into consideration. The longer the follow-up period, the more likely it is that a decline may occur, and a better FD pattern description with less incident episodes. Lower criteria points for FD are more sensible and increase the likelihood that the decline will be detected. Incorporating only new residents as an inclusion criterion may yield different FC trajectories than including longer-term residents.[7] Strategies taken to cope with sample dropouts (due to death or transitions to other NH) such as imputing a maximal dependency score to deaths or using data from the latest assessment may have different influences on the results of FD; in addition, they may be a valuable option to generate more balanced longitudinal studies because of the large number of dropouts that emerge in these cohorts.[7]

Concerning FC assessment, every study used different instruments, each considering different items and scoring methods, making it difficult to perform metanalysis and further comparisons to better understand the outcomes.[7] Because of the high levels of dependency in NH residents, changes may be slow and imperceptible over time. So, it is suggested that instruments are used that assess every single ADL and are discriminative enough to capture minor changes within activities. In addition, they should be capable of capturing which abilities decline, remain stable, or improve over time, in this sense, instruments with 5-point Likert scale (e.g. modified Barthel Index) seem to be sensitive to minor deviations.[7,45] Importantly, urinary incontinence is considered an ADL for FC assessment in Katz [16,17,27,31,33,34] and Barthel index;[19,23,24,26,40] yet, it was found to be a risk factor for FD when it was considered as an independent variable for FD.[22,25,35,36,39] As a geriatric syndrome, urinary incontinence may be considered independently of FC

and, therefore, strategies like using a modified version of Barthel Index (excluding continence) could be a valuable option to assess FC.[25]

Four included studies were based in VH from Taiwan and reported higher FC at baseline as well as a lower FD rate. [17,18,28,29] Residents of VH in Taiwan are mainly soldiers who participated in the Chinese Civil War in the mid-1940s, these residents tend to be physically fit and cognitively intact, which makes them somewhat like community-dwelling older people.[28] Therefore, when studying NH characteristics and dynamics, the existing differences between NHs and VHs should be taken into consideration.

The main limitation of this systematic review was the large heterogeneity of study characteristics and tools used to assess and consider FD, making a meta-analysis unfeasible and hindering the comparisons and understandings of outcomes. Furthermore, there could be relevant factors (mainly institutional-related) that remain underexplored by scientific literature that may have an influence on FD. Therefore, the possibility of publication bias exists and should be considered. Nonetheless, this review has deepened the current understanding of FD by identifying its incidence, predictive factors and methodological aspects used in NH studies that could be improved.

Conclusions and Implications

This review found a dramatically high rate of functional dependency and FD in NH residents. The FD rate is influenced by certain study characteristics such as the follow up period, residents' eligibility criteria, FC instrument, FD criteria and dropouts. The existing methodological variations across studies hinder further comparison and understanding of the outcomes.

Cognitive impairment, functional status at baseline, length of institutionalization, age, urinary incontinence, depression, being married, being male and stroke disease can be considered significant predictive factors of FD in NH residents. Protective factors were licensed nursing hours and presence of a geriatrician, highlighting the necessity of having a good workforce capacity of highly trained care workers. These factors should be considered when planning and applying preventive interventions to optimize FC in older people living in NHs.

Conflicts of interest

The authors declare no conflicts of interest.

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Figure Legends

- Figure 1: **PRISMA flow diagram** for identification of eligible trials.

- Figure 2: **Biological predictive factors of functional decline**. The full set of biological factors that appeared significant in a multivariate analysis within included studies: Total number of residents (number of studies). NH: Nursing home. *proxy indicator of care complexity.

- Figure 3: **Psychosocial and institutional predictive factors of functional decline**. The full set of psychosocial and institutional factors that appeared significant in a multivariate analysis within included studies: Total number of residents (number of studies). NH: Nursing home.