






RESEARCH ARTICLE

Informing patterns of health and social care utilisation in Irish older people according to the Clinical Frailty Scale

[version 1; peer review: 2 approved]

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Abstract

Background: There is increasing policy interest in the consideration of frailty measures (rather than chronological age alone) to inform more equitable allocation of health and social care resources. In this study the Clinical Frailty Scale (CFS) classification tree was applied to data from The Irish Longitudinal Study on Ageing (TILDA) and correlated with health and social care utilisation. CFS transitions over time were also explored.

Methods: Applying the CFS classification tree algorithm, secondary analyses of TILDA data were performed to examine distributions of health and social care by CFS categories using descriptive statistics weighted to the population of Ireland aged ≥ 65 years at Wave 5 ($n=3,441$; mean age 74.5 (SD ± 7.0) years, 54.7% female). CFS transitions over 8 years and (Waves 1-5) were investigated using multi-state Markov models and alluvial charts.

Results: The prevalence of CFS categories at Wave 5 were: 6% 'very fit', 36% 'fit', 31% 'managing well', 16% 'vulnerable', 6% 'mildly frail', 4% 'moderately frail' and 1% 'severely frail'. No participants were 'very severely frail' or 'terminally ill'. Increasing CFS categories were associated with increasing hospital and community health services use and increasing hours of formal and informal social care provision. The transitions analyses suggested CFS transitions are dynamic, with 2-year probability of transitioning from 'fit' (CFS1-3) to 'vulnerable' (CFS4), and 'fit' to 'frail' (CFS5+) at 34% and 6%, respectively. 'Vulnerable' and 'frail' had a 22% and 17% probability of reversal to 'fit' and 'vulnerable', respectively.

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report



report

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Conclusions: Our results suggest that the CFS classification tree stratified the TILDA population aged ≥ 65 years into subgroups with increasing health and social care needs. The CFS could be used to aid the allocation of health and social care resources in older people in Ireland. We recommend that CFS status in individuals is reviewed at least every 2 years.

Keywords

Frailty, Clinical Frailty Scale, classification tree, TILDA, health utilisation, social care, transitions, health policy.



This article is included in the [TILDA](#) gateway.

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Introduction

Frailty is a common condition in older adults, although it is not an inevitable part of ageing¹. Frailty occurs when multiple body systems have gradually lost their inbuilt reserves and can occur in any older adult (i.e. aged 65 years and over), but it becomes more prevalent at more advancing ages². Frailty is not a medical diagnosis because it can have different drivers in different individuals. Yet, frailty represents a state of vulnerability in the older person that has been consistently associated with premature loss of independence and adverse health outcomes, independently of chronological age^{3,4}.

Older adults living with frailty are at an increased risk of sudden deterioration in their health following exposure to insults that robust people can more easily withstand. This has become very evident during the coronavirus disease 2019 (COVID-19) pandemic and its aftermath^{5,6}. Not only has frailty been associated with increased risk of COVID-19 mortality in older adults⁷, but in survivors and ‘post-cocooning’ individuals, an increased incidence of deconditioning and need for increased rehabilitative and social care supports have been evident for individuals, families and clinicians alike⁸.

Frailty is intended to capture the usual ‘baseline’ of an older individual, i.e. in the absence of any acute illness that may be confounding the assessment. The frailty paradigm predicts that when a frailer older individual survives an acute illness, there is a higher risk of functional loss, but this will often recover to the pre-existing baseline after a period of rehabilitation. However, in a minority of cases, there may be a permanent functional loss requiring new supports². This is what clinicians call ‘a new baseline’. In older adults who survive an acute hospital admission, the risk of acquiring a lower baseline on discharge is estimated at 30%⁹. In the community, quantification of this risk has been more difficult due to the lack of routinely collected data. Because having acquired a lower ‘new baseline’ may compromise the individual’s independence, it is important to try to restore baseline function as much as possible both during and after the onset of the acute illness. This often requires access to multidisciplinary rehabilitation resources and social supports. Active rehabilitation during and after the acute illness may reduce the risk of a new baseline occurring, which will require new permanent supports¹⁰.

Even in the absence of known interim acute medical events, frailty is a dynamic process that changes over time and can be viewed on a continuum¹¹. An older person can transition in either direction between the different states of frailty, namely robustness or non-frailty, pre-frailty (an intermediate sub-clinical state) and frailty¹². Therefore, the regular and proactive identification of people living with frailty in the community could provide an opportunity to develop more effective and equitable healthcare service planning and delivery for older people¹³. For example, a ‘dip’ in known frailty status could be a focus for prioritisation of referrals towards the still limited number of integrated care ‘hubs’¹⁴ that deliver medical assessment and multidisciplinary rehabilitation and ensure that any reversible new disability can be addressed. Indeed, the gold standard

for the assessment and management of frailty is Comprehensive Geriatric Assessment (CGA). CGA is a holistic and interdisciplinary assessment of an individual and has been demonstrated to reduce adverse outcomes including disability, cognitive decline, need for long-term residential care and death^{10,15}. Even when a lower new baseline has been established despite rehabilitative attempts, frailty identification at that point could also have implications for the prioritisation of social care resources.

It must be noted that even though the identification of frailty may have advantages from the point of view of medical risk stratification and planning of healthcare delivery, the public’s perceptions of frailty are generally negative and many older people with multimorbidity and disability do not identify themselves as frail¹⁶. This is often the case because of a mistaken general perception that ‘nothing can be done’ about frailty, but in fact the correct reading of frailty identification is to facilitate prioritisation and increase equity of access to health and social care resources, where frailty can be fully assessed, addressed and managed.

Despite a lack of agreement on an internationally accepted and easily administered consensus measure of frailty, several methods of screening are commonly used^{17,18}. Among the many available tools, the Clinical Frailty Scale (CFS) has attracted interest for its simplicity and consideration of multiple relevant geriatric dimensions, including multimorbidity and degree of symptom control, mobility, physical activity, help with activities of daily living, dependency, and cognition. The CFS does not assess other important geriatric domains (Figure 1), but the assessed dimensions are reasonably comprehensive and can not only be scored by doctors but a wide range of healthcare and allied health professionals¹⁹. In addition, even though the CFS does not directly assess some important dimensions, it can do so indirectly, since geriatric syndromes tend to overlap (Figure 1).

The initial version of the CFS was validated in people aged 65 years and older from the Canadian Study of Health and Aging²⁰ and has been shown to predict mortality, adverse health outcomes and healthcare utilisation in older people across settings¹⁹. Importantly, the CFS is a baseline frailty instrument and even when used in the acute hospital setting, it is intended to capture the status of the individual two weeks before the onset of the acute illness that lead to hospital admission²¹. Despite the rolling out of dedicated training modules for more accurate CFS scoring^{22,23}, a criticism of the CFS has been the possible subjectivity in the scoring, bringing the possible danger of lack of scoring consistency between individuals and across agencies. However, to address those concerns, the authors of the CFS have published a classification tree method to assist with routine scoring of the CFS²⁴. This also allows the retrospective implementation of the CFS in a dataset when the required CFS decision tree variables have been collected.

The CFS classification tree can be implemented to data already collected in The Irish Longitudinal Study on Ageing (TILDA). As such, we saw the opportunity to apply the new

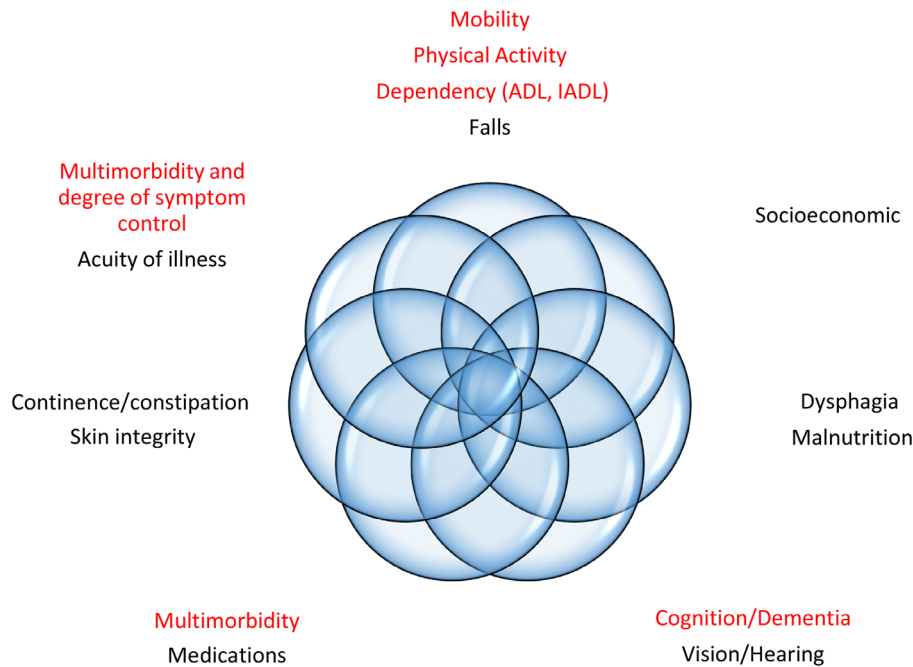


Figure 1. Geriatric dimensions assessed by the Clinical Frailty Scale (in red). ADL: basic activities of daily living (e.g. toileting, transferring, eating). IADL: independent activities of daily living (e.g. managing finances, going shopping, using public transport).

CFS classification tree method to the TILDA data and correlated derived CFS categories with patterns of health and social care utilisation in older people in Ireland. With this, we intended to inform the Irish public and policy makers as to the average levels of health and social care utilisation that can be expected for each of the CFS tree categories. The information presented in this section is based on cross-sectional analyses of TILDA participants from Wave 5 and refers to adults aged ≥ 65 years living in Ireland in 2018. In addition, following recently developed methodology¹², this report also presents evidence on longitudinal transitions of the CFS in TILDA, to demonstrate the dynamic nature of CFS states over time that will require regular review in populations if any health or social care policies are going to be taking the CFS into account.

Methods

Sample

Wave 1 of TILDA (baseline) took place between October 2009 and February 2011, and subsequent data was collected approximately biannually over four longitudinal waves (Wave 2: February 2012 to March 2013; Wave 3: March 2014 to October 2015; Wave 4: January to December 2016; Wave 5: January to December 2018). An overview of the study is available on <https://tilda.tcd.ie/about/where-are-we-now/>. The full cohort profile is described elsewhere²⁵. The analyses presented in this study were restricted to adults aged 65 years and over from Waves 1-5 of the TILDA study.

Operationalisation of the CFS in TILDA

The CFS was operationalised at waves 1-5 of TILDA according to the published CFS Decision Tree²⁴. Six items were used

in the decision tree to distinguish between CFS classes as follows: (i) number of basic activities of daily living requiring help (BADL); (ii) number of instrumental activities of daily living requiring help (IADL); (iii) number of chronic conditions (28 chronic and cardiovascular conditions shown in Table 1); (iv) self-rated health – excellent, very good, good, fair or poor; (v) one item from the Center for Epidemiological Studies Depression scale: during the past week how often have you felt that everything that you did was an effort – rarely or none of the time, some or a little of the time, occasionally or a moderate amount of time, all of the time; and (vi) moderate or vigorous activity on ≥ 1 days in the past week as assessed using the International Physical Activity Questionnaire Short Form (IPAQ-SF)²⁶.

Cross-sectional analyses of CFS and health and social care service use at Wave 5

For the cross-sectional analyses of CFS and health and social care service utilisation, we employed the most recently completed pre-pandemic wave of TILDA data collection. These data were collected through the computer-assisted personal interview (CAPI) between 16th January 2018 and 1st January 2019.

Descriptive statistics were computed with STATA version 15 (StataCorp, College Station, TX) and given as mean values with standard deviation (SD) or 95% confidence intervals (95% CI) and range or proportion (%). As described elsewhere²⁷, we used attrition weights to make estimates representative of the general population aged ≥ 65 years in Ireland. We examined the prevalence of CFS categories and the association between the CFS categories and utilisation of medical and community-based

Table 1. Number of cardiovascular and chronic conditions.

No.	Cardiovascular and chronic conditions
1	High blood pressure or hypertension
2	Angina
3	A heart attack (including myocardial infarction or coronary thrombosis)
4	Congestive heart failure
5	Diabetes or high blood sugar
6	A stroke (cerebral vascular disease)
7	Ministroke or TIA
8	High cholesterol
9	A heart murmur
10	An abnormal heart rhythm (including Atrial Fibrillation)
11	Any other heart trouble (please specify)
12	Chronic lung disease such as chronic bronchitis or emphysema
13	Asthma
14	Arthritis (including osteoarthritis, or rheumatism)
15	Osteoporosis, sometimes called thin or brittle bones
16	Cancer or a malignant tumour (including leukaemia or lymphoma but excluding minor skin cancers)
17	Parkinson's disease
18	Any emotional, nervous or psychiatric problems such as depression or anxiety
19	Alcohol abuse or substance abuse
20	Alzheimer's disease
21	Dementia, organic brain syndrome, senility
22	Serious memory impairment
23	Stomach ulcers
24	Varicose ulcers (an ulcer due to varicose veins)
25	Cirrhosis, or serious liver damage
26	Cataracts
27	Glaucoma
28	Age related macular degeneration

allied healthcare services. We also examined the levels of informal care and formal community support services that support ageing in place, including hours of paid and unpaid care received per month.

Longitudinal analyses: CFS transitions over 8 years (Waves 1-5)

The CFS transitions analyses followed the same methodology as a previously published TILDA paper on frailty phenotype transitions¹². The baseline analytical sample included participants who had complete CFS information at Wave 1. For

subsequent waves, information was collected on transitions in CFS states and attrition due to deaths or missing data. Mortality was ascertained for all study participants at each follow-up wave. TILDA has approval from Ireland's General Register Office (GRO) to link survey respondents to their death certificate information held centrally by the GRO, where every death in the Republic of Ireland must be registered²⁸. Other than deaths, attrition at each wave was classified as 'missing'.

For the visualisation of the longitudinal CFS transitions, alluvial charts were created using the R `ggalluvial` package¹². As well

as transitions in individual CFS categories, we visualised the transitions in the following CFS states: ‘fit’ (CFS1-3), ‘vulnerable’ (CFS4) and ‘frail’ (CFS5 or more). In an alluvial plot, the height of the stacked bars at each wave (which represent whether participants’ status for the given frailty state was yes, no, missing or died) is proportional to the number of participants identified as belonging to this state at each wave. The thickness of the streams connecting the stacked bars between waves are proportional to the number of participants who have the state identified by both ends of the stream. To estimate transition probabilities for the CFS states, we used multi-state Markov models using the R *msm* package, which allows a general multi-state model to be fitted to longitudinal data¹². We obtained matrices of estimated transition probabilities from wave x to wave $x + 1$ (with 95% confidence intervals [CIs]) for each CFS state.

Ethical approval

Ethical approval for each wave was obtained from the Faculty of Health Sciences Research Ethics Committee at Trinity College Dublin, Ireland with the following dates or reference numbers: 2008/05/02 (Wave 1), 2011/10/19 (Wave 2), 2014/06/09 (Wave 3), Ref:150506 (Wave 4) and Ref:170304 (Wave 5). All participants provided written informed consent prior to inclusion in the study.

Results

Sample descriptives: cross-sectional analyses at Wave 5
 Of the 8,504 participants recruited to TILDA at Wave 1, 3,279 did not participate in Wave 5, leaving a sample of $n=5,225$. We removed from our analysis any participant aged less than 65 years of age ($n=1,715$) and those participants who were not present at Wave 1 ($n=55$) or who did not have CFS data ($n=14$). Thus, the analytical sample included $n=3,441$ participants aged ≥ 65 years at Wave 5. The average age was 74.5 years, the age range was 65–103 years, and 54.7% were female.

Sample descriptives: CFS transitions at Waves 1–5

TILDA recruited a total of 8,504 participants at Wave 1, of whom 4,998 (58.8%) were aged less than 65 years. Of the remaining 3506 Wave 1 participants, $n=3,503$ had complete CFS information. The mean (SD; minimum-maximum) age and sex percentage of participants remaining at the study at each wave were as follows: For wave 1 participants ($n=3,503$) 73.3 (6.4; 65–105) years and 52.5% female; for Wave 2 ($n=2,893$): 75.0 (6.2; 67–97) years and 52.6% female; for Wave 3 ($n=2,471$): 76.9 (5.9; 69–98) years and 53.1% female; for Wave 4 ($n=2,096$): 78.5 (5.6; 71–101) years and 53.0% female; and for Wave 5 ($n=1,743$): 80.0 (5.3; 73–103) years and 53.4% female.

Prevalence of CFS categories at Wave 5

The CFS categories identified in TILDA were: CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. CFS classes 8 (very severely frail) and 9 (terminally ill) were not observed in TILDA. The prevalence, or the proportion of the community-dwelling population aged ≥ 65 years, by CFS frailty status at Wave 5, is provided in [Figure 2](#). Results show that 73.6% of adults aged 65 years and over were classified as very fit, fit or managing well, while 16% were considered vulnerable or living with very mild frailty. The remaining 10.5% were classified as having some degree of frailty; within the latter, mild frailty was most prevalent (5.5%), followed by moderate (4.3%) and severe frailty (0.7%).

Utilisation of medical services and the CFS

At Wave 5, TILDA participants were asked about the number of times they visited a range of medical services including the General Practitioner (GP), a hospital outpatient clinic and the Emergency Department (ED), the number of overnight hospital admissions, and the number of nights spent in hospital over the previous 12 months. We examined the average number of

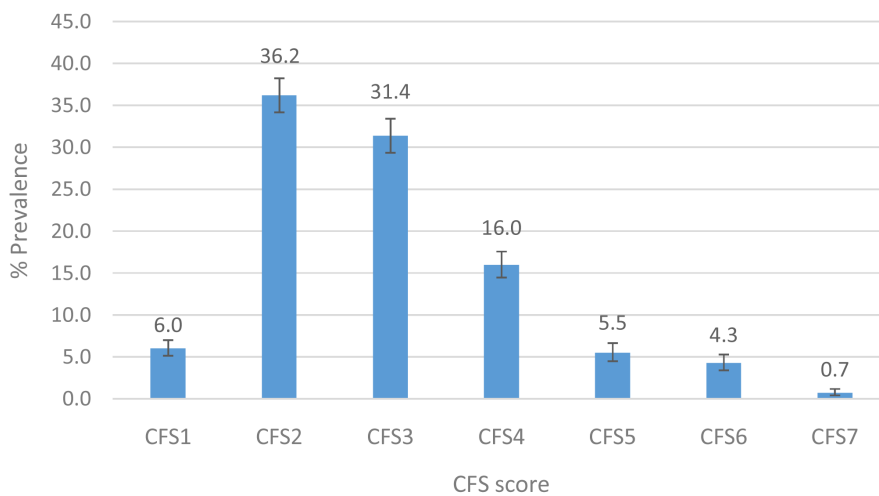


Figure 2. Prevalence of the CFS categories in TILDA Wave 5 (≥ 65 years). CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

visits/admissions in the previous 12 months to each service by older adults in Ireland.

Figure 3, Figure 4 and Figure 5 show the mean number of GP, outpatient and ED visits in the previous twelve months. For each of these services, the mean number of visits increased with higher levels of CFS, for GP (CFS1-CFS7: 2.5–5.9), outpatient (0.7–3.9) and ED (0.1–0.9) visits. This represents an approximately 2-fold, 6-fold and 9-fold increase in utilisation of GP, outpatient and ED services, respectively, between those in the lowest and highest CFS groups.

Figure 6 and Figure 7 show the mean number of overnight hospital admissions and the length of hospital stay (in nights) in the

previous twelve months. A similar pattern was observed for overnight hospital admissions (0.2–1.0 admissions) and for length of hospital stay (6.6–26.1 nights), representing a 5-fold and 4-fold increase, respectively, between those in the lowest and highest CFS groups.

Utilisation of community-based allied health care and the CFS

In TILDA, data are also collected on community-based healthcare services other than those provided by GPs and hospitals. Participants were asked (yes/no) if they had utilised any of the community-based allied healthcare services in the preceding twelve months, excluding any services for which they had paid anything other than a token or nominal amount.

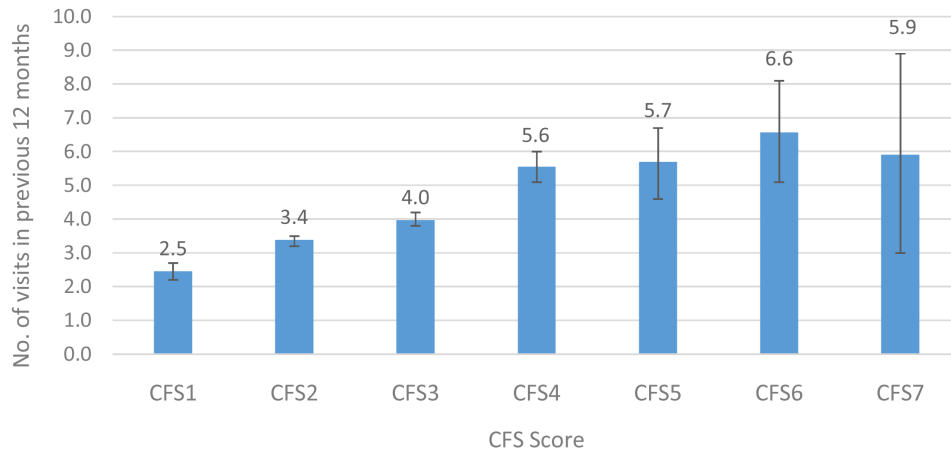


Figure 3. GP visits (mean) in the previous 12 months by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

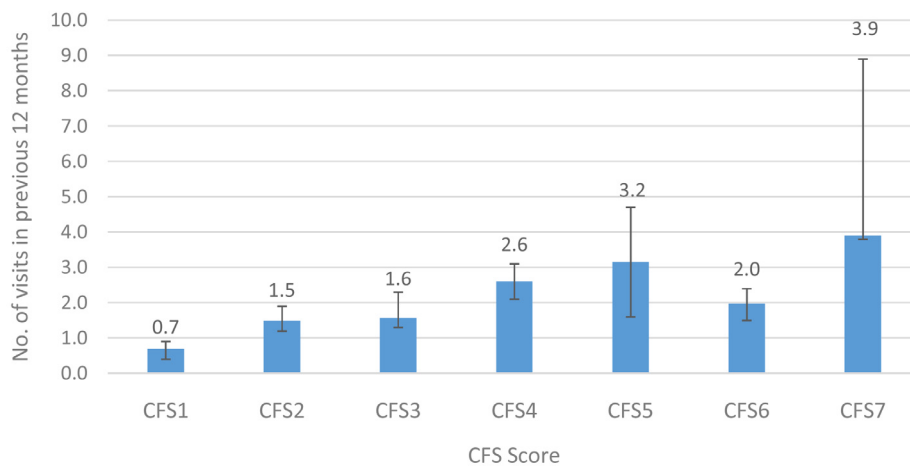


Figure 4. Outpatient clinic visits (mean) in the previous 12 months by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

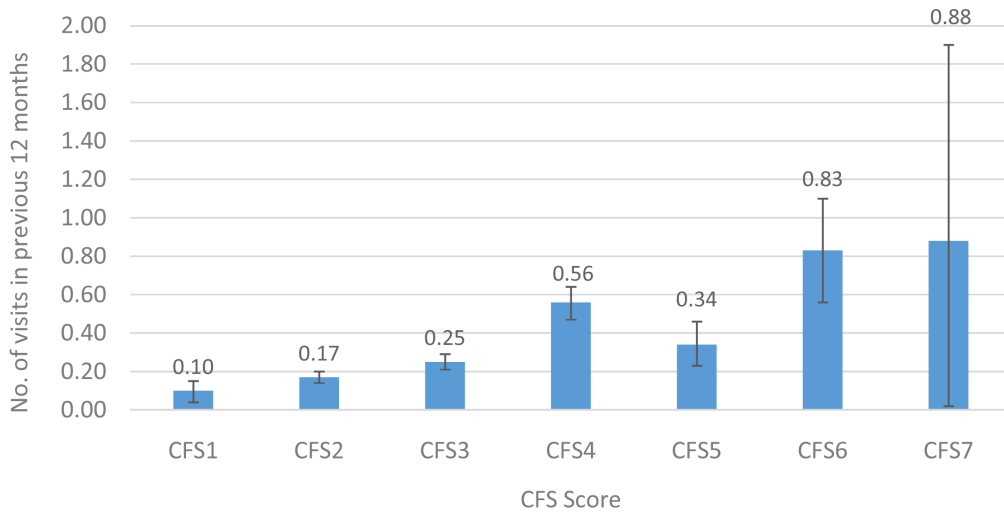


Figure 5. Emergency Department visits (mean) in the previous 12 months by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

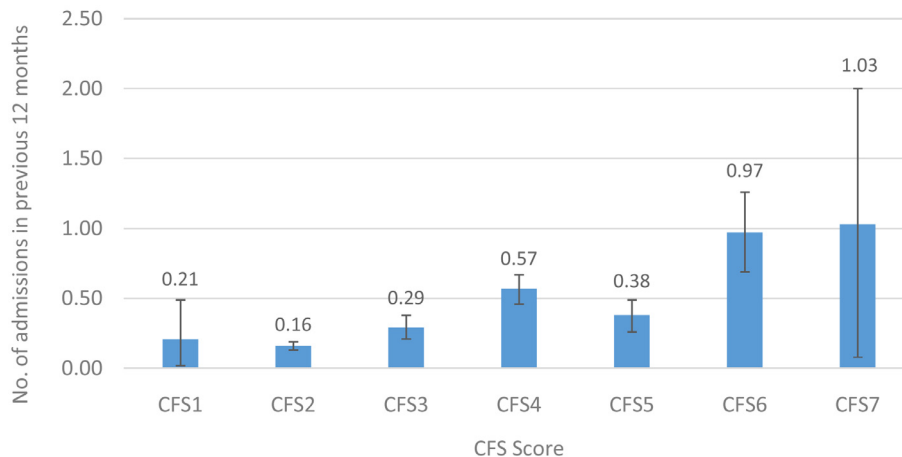


Figure 6. Overnight hospital admissions (mean) in the previous 12 months by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

This included state-provided physiotherapy, occupational therapy (OT), public health nurse (PHN), dietician, hearing, dental, optician, psychological/counselling, social work services, speech and language therapy, chiropody, day centre and respite services. Using the binary variable for each of the thirteen services, we generated a count of the mean number of total community services received.

The mean number of state-provided community-based services received and the proportion of each individual service received by CFS groups is provided in [Figure 8](#) and [Figure 9](#), respectively. The mean number of state community-based services received increased progressively with higher levels of CFS,

from 0.3 for participants classified as CFS1 to 2.0 services for those classified as CFS7.

Examining the proportion of each of the thirteen community-based services received by CFS group, there seemed to be a large degree of heterogeneity across the different services ([Figure 9](#)). The highest proportions of services received by those classified as having mild to severe frailty (CFS5-CFS7) were: respite care (88%), day centre (59%), speech and language (54%), public health nurse (46%), psychological/counselling (31%), OT and chiropody (30%) and physiotherapy (23%). 13% or less of dental, dietician, optical and hearing/audiology services were received by those living with mild to severe frailty.

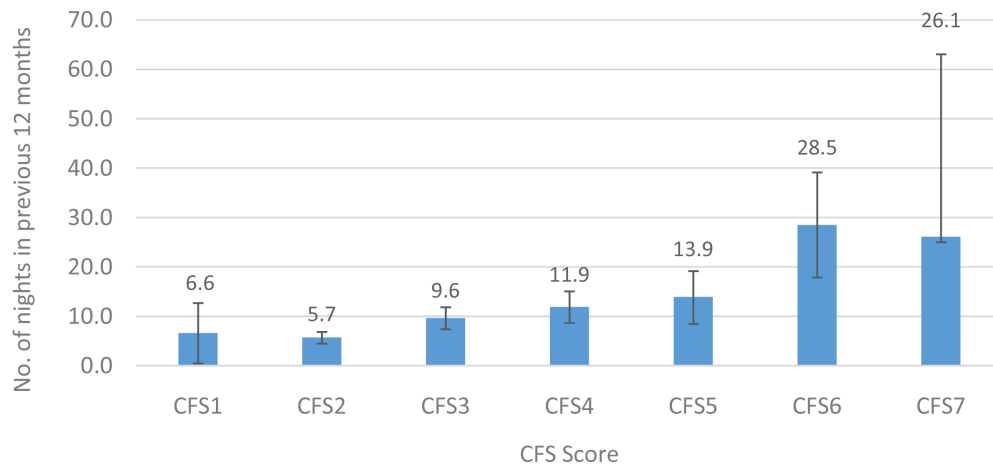


Figure 7. Length of hospital stay (mean nights) in the previous 12 months by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

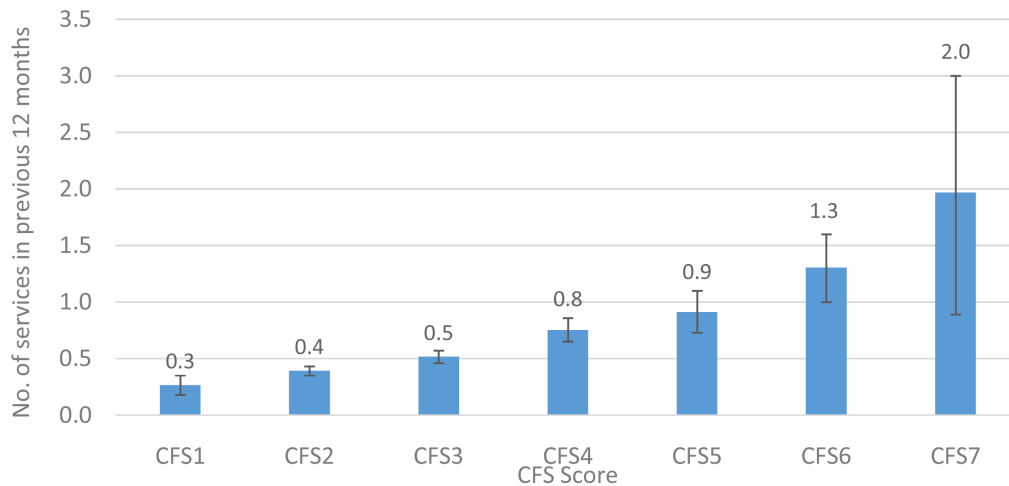


Figure 8. Number of community-based allied health care services received (mean) in the previous 12 months, by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

Utilisation of community-based services supporting ageing in place and the CFS

Here we present data on informal care and formal state provided care services, which are delivered in the home or are available to support independent living in the home. Informal care was measured by asking participants if they received any help with ADLs or IADLs and who provided that help, e.g. help with ADL and IADL limitations from a spouse/partner, child, relative or other. Participants were also asked if they paid for private non-state care services, namely a personal care attendant or home help. Formal care provided by the State was assessed by asking participants if they were in receipt of

community support services, e.g. home help, personal care attendant, meals-on-wheels, and home care packages. Finally, for both informal and formal care, participants were asked how many hours per day and how many days per month they received each of the informal or formal care services. From this data we calculated hours of unpaid and paid informal care per month and hours of formal state provided care per month.

Figure 10 and Figure 11 show the results by CFS categories. There was a progressive increase in the total number of hours of unpaid informal and paid (non-state) care received by participants in the CFS5 to CFS7 groups. There was a 2-fold

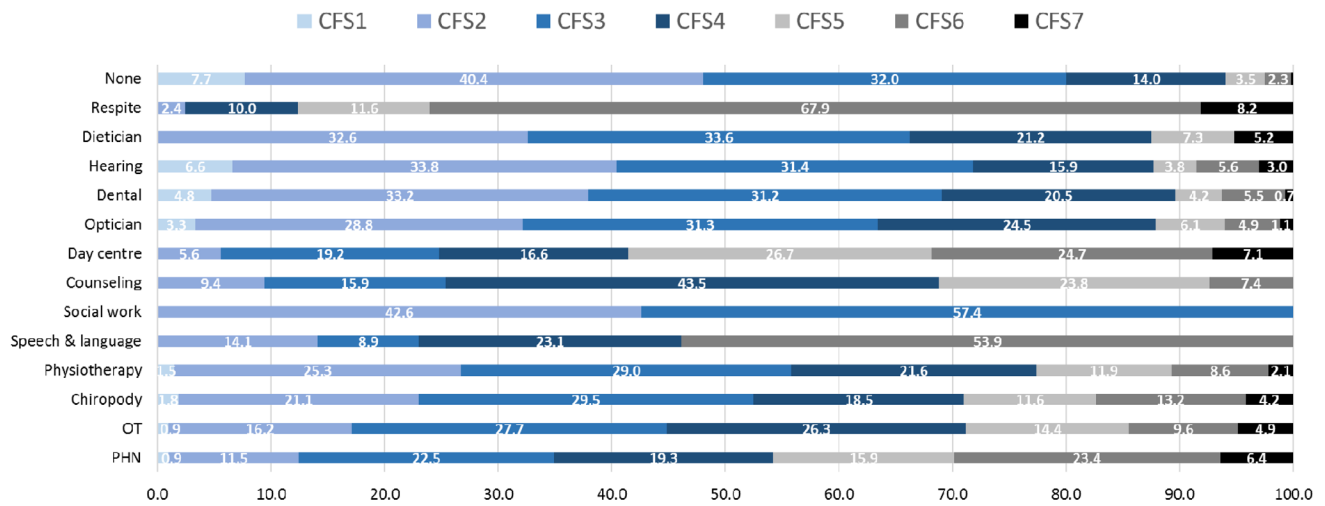


Figure 9. Proportion of community-based, allied health care services received in the previous 12 months, by CFS. CFS - Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty; OT - occupational therapy; PHN - public health nurse.

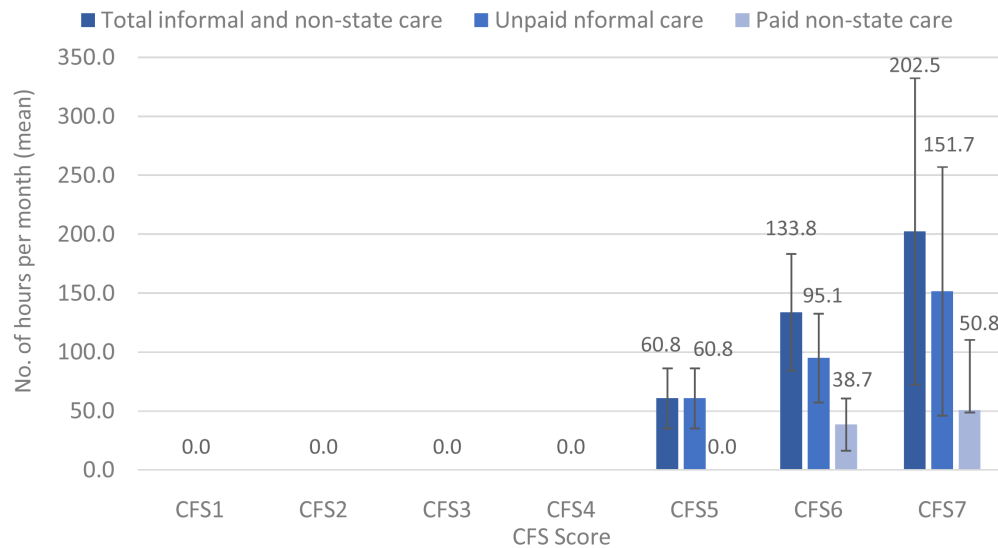


Figure 10. CFS by total hours per month (mean) of unpaid informal and paid non-state care. CFS – Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

increase in the total hours of care between those living with mild versus moderate frailty, and a more than 3-fold increase in the total hours of care between those living with mild versus severe frailty (Figure 10). This same pattern was observed when we separated the hours per month of paid non-state care and unpaid informal care (Figure 10). It is notable that participants with mild frailty (CFS5) received informal unpaid but not paid non-state care services. Also of note, is that most non-state care was unpaid informal care provided by family, relatives and others. On a monthly basis, unpaid informal carers provided

100%, 71% and 75% of non-state care hours received by people living with mild, moderate, and severe frailty, respectively.

Total hours per month of formal state care received by CFS categories are provided in Figure 11. There was a progressive increase in the total number of hours of state provided formal care received by participants across groups CFS1 to CFS6 with a possible slight dip in hours received by the CFS7 group. Participants in groups CFS1-4 received ≤3.2 hours per month, while those with mild (CFS5), moderate (CFS6) and

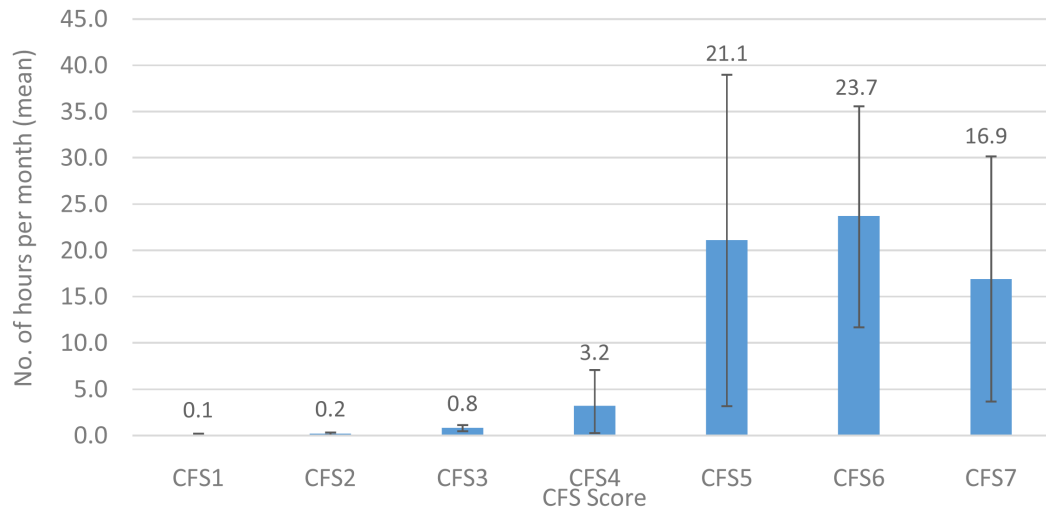


Figure 11. CFS by total hours per month (mean) of formal state care. CFS – Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty. Error bars: 95% confidence interval.

severe frailty (CFS7) received 7-, 7- and 5-fold more hours of formal state care, respectively. Also of note, is that for every hour of formal state care received per month by those who were mild to severely frail, unpaid informal carers provided between 3–10 hours, and paid non-state carers provided between 0–3 hours of care.

CFS transitions across Waves 1-5

The alluvial plots showing the transitions between CFS categories and states and deaths at each wave is shown in [Figures 12A and 12B](#), respectively. As expected, the cumulative proportions of deaths and missing data increased across waves. The results of the alluvial plots suggested a dynamic picture of CFS transitions in TILDA over 8 years, both for individual CFS categories and also considering CFS states: ‘fit’ (CFS1-3), ‘vulnerable’ (CFS4) and ‘frail’ (CFS \geq 5).

[Figure 13](#) visually shows the results of the multi-state Markov models showing the mean 2-year probability of transitions in CFS states in TILDA. Probabilities from ‘fit’ to ‘vulnerable’, and ‘fit’ to ‘frail’ were 34% and 6%, respectively. ‘Vulnerable’ had a 22% probability of reversal to ‘fit’, and a 16% risk of progression to ‘frail’. ‘Frail’ had a 6% probability of reversal to ‘fit’, a 17% probability of reversal to ‘vulnerable’, and a 25% risk of death. Risks of death for ‘fit’ and ‘vulnerable’ states were low (2% and 5%, respectively). [Table 2](#) shows the transition probabilities with 95% confidence intervals (95% CI).

Discussion

The aim of the present study was to apply the CFS classification tree to data from adults aged 65 years and over from The Irish Longitudinal Study on Ageing (TILDA) and correlate derived CFS categories with patterns of health and social care utilisation in older people in Ireland assessed in Wave 5 of the

study (year 2018). In addition, we explored how CFS categories and states changed over 8 years in TILDA between Wave 1 (2010) and Wave 5. Our results suggest that the CFS classification tree was able to stratify the TILDA population aged 65 or more in subgroups with increasing health and social care needs. The CFS classification tree could be used to aid the allocation of health and social care resources in older people in Ireland, but given the frequency of CFS transitions in the population, it is recommended that CFS status is reviewed at least every 2 years in individuals, or sooner when there is a change of individual circumstances.

The National Clinical Programme for Older People has previously highlighted the key roles that the identification of frailty can play in supporting the evolution of age-attuned and age-accommodating services that support timely access to ambulatory care. Indeed, frailty tools could help identify population groups who may have complex care needs as indicated by high levels of health and social care utilisation, for whom timely management of frailty using Comprehensive Geriatric Assessment may help improve both patient and system outcomes¹⁴. Even though no gold standard recommendation exists for the use of the CFS as a frailty identification tool, the CFS has gained currency among professionals for its ease of implementation and ability to incorporate overall clinical judgement in the scoring.

Ageing in place is a key goal of the Irish National Positive Ageing Strategy, which explicitly refers to the Government policy of supporting older people to live in dignity and independence in their own homes and communities for as long as possible. Services such as home helps, home care packages, meals-on-wheels, day centre care and respite care are recognised in the strategy as integral both to supporting this Government’s

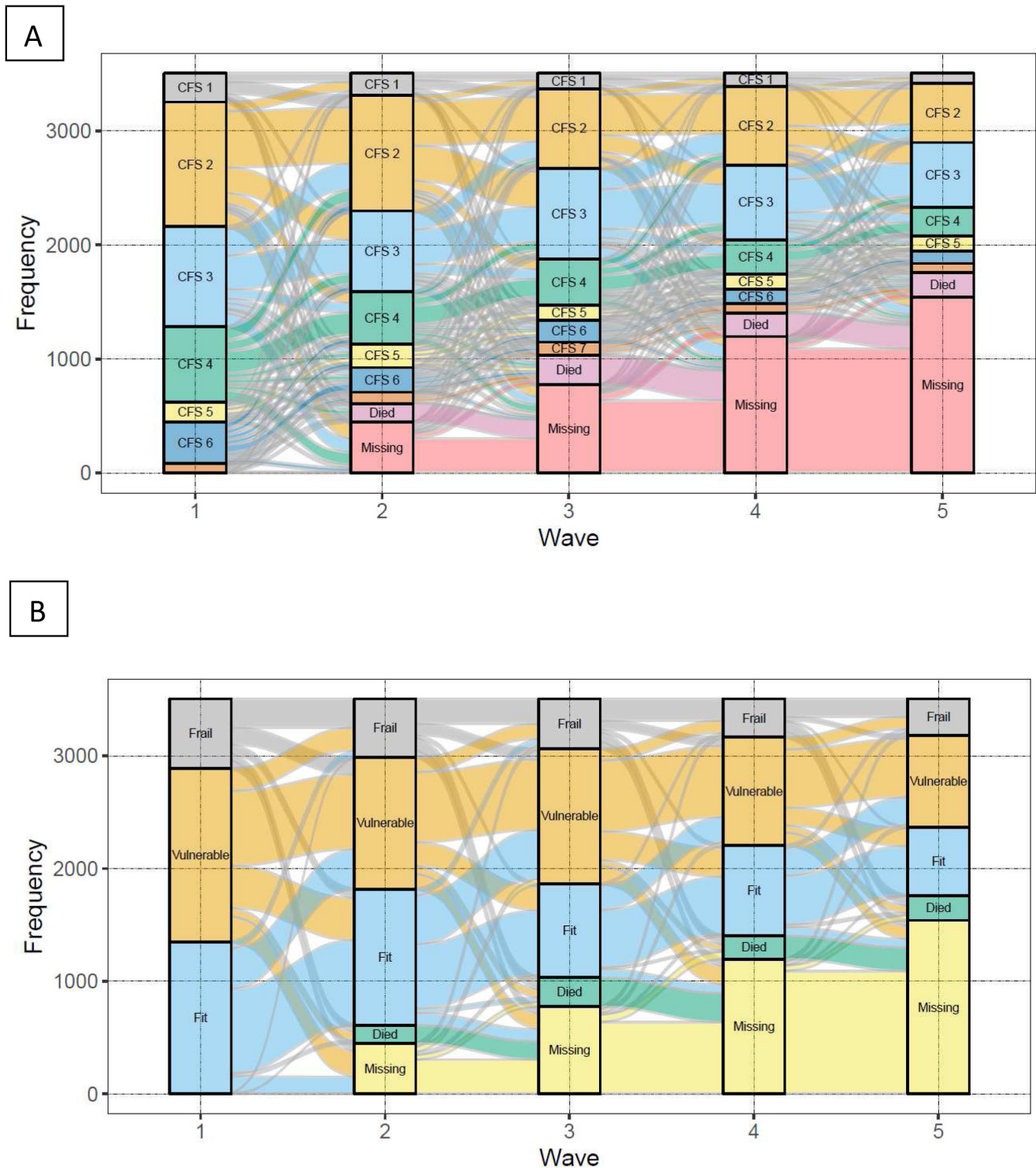


Figure 12. Alluvial plots of CFS group (A) and CFS states (B) transitions in TILDA over 8 years (Waves 1 to 5). CFS – Clinical Frailty Scale; CFS1 - Very fit; CFS2 - Fit; CFS3 - Managing well; CFS4 - Very mild frailty (or vulnerable); CFS5 - Mild frailty; CFS6 - Moderate frailty; and CFS7 - Severe frailty.

policy and older people’s own preferred wishes to remain in their own homes²⁹. Our results suggest scope for considering

implementation of the CFS to aid allocation of public resources supporting ageing in place policies.

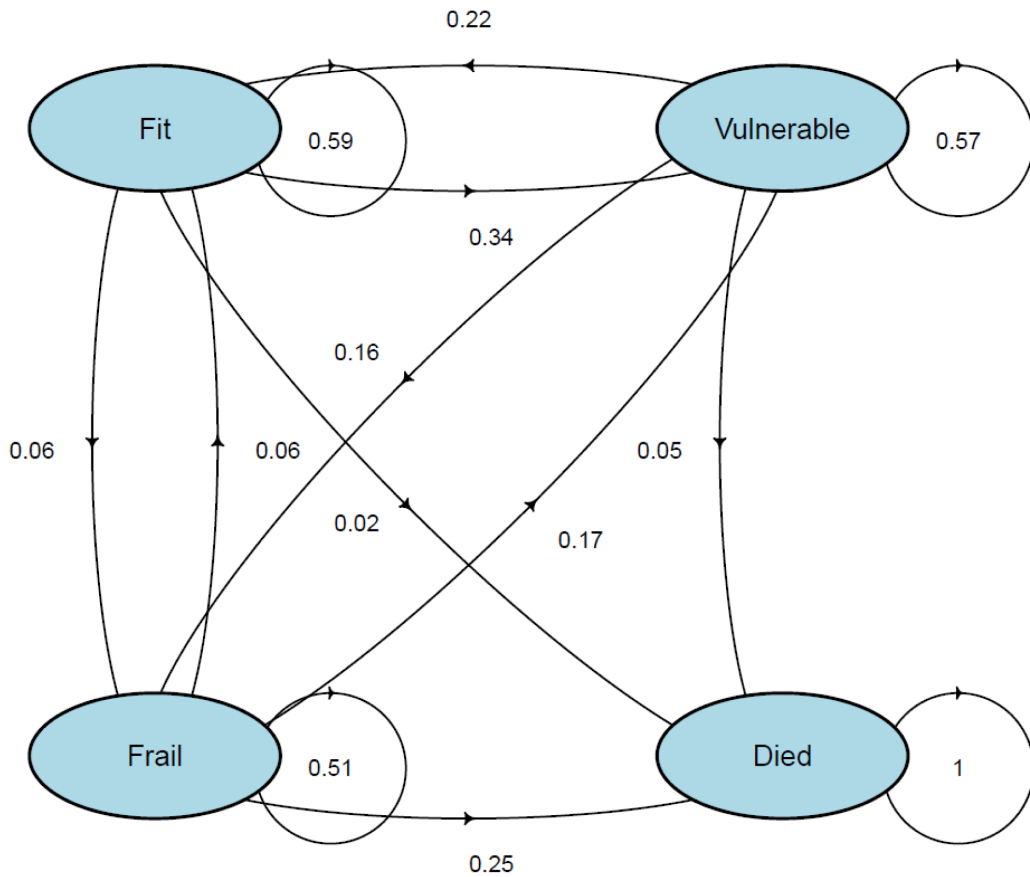


Figure 13. Multi-state Markov models showing the mean 2-year probability of transitions in CFS states.

Table 2. Mean 2-year probability (95% Confidence Intervals) of transitions in CFS states in TILDA.

CFS State	Fit	Vulnerable	Frail	Died
Fit	0.59 (0.54,0.60)	0.34 (0.31,0.35)	0.06 (0.05,0.08)	0.02 (0.01,0.08)
Vulnerable	0.22 (0.21,0.24)	0.57 (0.55,0.58)	0.16 (0.14,0.17)	0.05 (0.04,0.09)
Frail	0.06 (0.06,0.08)	0.17 (0.15,0.19)	0.51 (0.49,0.54)	0.25 (0.23,0.28)
Died	0.00 (0.00,0.00)	0.00 (0.00,0.00)	0.00 (0.00,0.00)	1.00 (1.00,1.00)

CFS – Clinical Frailty Scale; Fit = CFS 1-3; Vulnerable = CFS 4; Frail = CFS 5-7.

The results of our study suggest appropriate distributions of CFS categories, as could be expected for a population-based study. As TILDA is a relatively healthy sample of community-dwelling older adults, participants taking part during waves of data collection do not present as very severely frail or terminally ill. Thus, CFS classes 8 and 9 were not observed in the TILDA cohort during data collection waves. Hence, our results cannot be extrapolated to the most vulnerable population of very severely frail and terminally ill individuals,

including people living in nursing homes who are often over-represented in those two categories.

In terms of utilisation of medical services, there seemed to be an increase in GP visits between CFS 1 and 6 (3 to 7 visits in the past year), but at CFS 7 it seemed to slightly decline⁶, which may correspond to the increase in hospital outpatient visits for the CFS 7 (5 in the past year). CFS 6 and 7 had higher ED attendances and overnight hospital admissions, and a clearly

longer hospital length of stay (26–29 days). It is possible that very long hospital length of stays may be indicative of the need to transition to a non-home setting on discharge (e.g. nursing home).

In terms of community care, there were increasing numbers of community services used with increasing CFS levels. Of particular note was the high use of respite and day centre services among those living with frailty in CFS groups 5–7, underscoring the recognition that these services are integral to the Irish National Positive Ageing Strategy, Government policy and older people's own preference to age in place at home. Community rehabilitative services such as OT, physiotherapy, dietician and speech and language therapy services are important to aid functional recovery after hospital discharge following an acute illness, and they may reduce the risk of a new hospital-associated disability becoming a permanent 'new baseline' post-discharge. This may also be the case in COVID-19 'post-cocooning' scenarios without a hospital admission. Thus, to avoid having to implement unnecessary and costly large permanent care packages to support home living, it would be prudent to expand the provision of these community and 'hub' services beyond the service levels reported here.

With respect to the number of hours received per month of formal state care, paid non-state care and informal unpaid care, all three measures increased steeply between CFS 5 and 7. This reflects the growing burden of ADL and IADL disability with increasing frailty. The vast majority of hours of care per month was provided by unpaid informal carers, i.e. relatives and others, followed by paid non-state care, and formal state provided care. We noted that the CFS5 group received formal and informal care but no paid non-state care, suggesting that while additional care is required this may be balanced against an individual's ability to pay for additional care. There was a possible reduction in the number of formal care hours per month from CFS6 (23.7) to CFS7 (16.9), which contrasts sharply with the steep increase in informal unpaid and paid non-state care hours between these groups. Again, this suggests increased demand for the provision of formal state community support services for those who are severely frail, the excess of which may currently be carried by unpaid informal carers and by paid non-state provided care.

In relation to the transitions in CFS states in TILDA, the dynamic nature of CFS transitions in TILDA over 8 years is very evident, with the mean probability of remaining in the same state after two years ranging from 59% ('fit') to 51% ('frail'). This suggests that CFS status should be reviewed at least every 2 years for individuals. These data differ somewhat from our observations for frailty phenotype transitions¹², where remaining in the same state after two years ranged from 71% ('non-frail') to 46% ('frail'). It would suggest the CFS is also a dynamic measure that may capture a greater level of negative transition

among those who are 'fit' or 'non-frail'. However, caution is advised given the different age groups retrospectively classified using the CFS in this study (≥ 65 years) and using the frailty phenotype in the previously published study (≥ 50 years).

Our study has various limitations. Firstly, the CFS decision tree is retrospective and does not involve the contemporaneous direct assessment and incorporation of the rater's clinical judgement on the individual. Indeed, every case is different and individualised decisions should not be replaced by one size fits all. CFS scoring performed by the patient's side by trained professionals is likely to be more accurate than the retrospective application of a classification tree without clinical judgement being applied. Furthermore, the CFS has only been validated in those aged 65 years and over, so we do not recommend use for service planning in those under the age of 65. The TILDA sampling frame does not include people with dementia at baseline or people living in nursing homes, and as such these data may underestimate numbers in receipt of both informal care and formal community support services for the total population aged 65+ years in Ireland.

In conclusion, the CFS classification tree could be used to aid the allocation of health and social care resources in people aged 65 and over in Ireland, but given the frequency of CFS transitions in the population, it is recommended that CFS status is reviewed at least every 2 years in individuals, or sooner when there is a change of individual circumstances. Ideally, the scoring of the CFS should be part of an expanding, well-trained health and social care workforce with an emphasis on maximisation of community supports, care 'hubs' and ambulatory supports.

Data availability

Underlying data

The first four waves of TILDA data are available from the Irish Social Science Data Archive (ISSDA) at www.ucd.ie/issda/data/tilda/. Wave 5 data is under preparation for submission and will be submitted to ISSDA within due course. Due to the sensitive nature of death registration data, the death data reported here are not publicly accessible at this time. Requests to access currently unavailable data can be made directly to TILDA (tilda@tcd.ie) and will be considered on a case-by-case basis.

To access the TLDA survey data, please complete an ISSDA Data Request Form for Research Purposes, sign it, and send it to ISSDA by email (issda@ucd.ie).

For teaching purposes, please complete the ISSDA Data Request Form for Teaching Purposes, and follow the procedures, as above. Teaching requests are approved on a once-off module/workshop basis. Subsequent occurrences of the module/workshop require a new teaching request form.

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Open Peer Review

Current Peer Review Status:  

Version 1

Reviewer Report 22 June 2021

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 **Jordi Amblàs-Novellas** 

Central Catalonia Chronicity Research Group (C3RG), Centre for Health and Social Care Research (CESS), University of Vic/Central University of Catalonia (UVIC-UCC), Vic, Spain

In this interesting manuscript, the authors conducted a prospective analysis using data from the TILDA database in order to assess the relationship between the CFS categories (obtained via CFS classification tree method) with patterns of health and social care utilization in older people in Ireland. On the other hand, the authors demonstrate the dynamic nature of CFS states over time using a multi-state Markov model.

GENERAL COMMENTS

The reviewer wants to congratulate the authors for the results obtained, which are very relevant, and for the very rich and interesting discussion developed.

In the opinion of the reviewer, this study provides 4 very relevant contributions:

1. As far as the reviewer knows, the CFS Decision Tree recently published by Theou et al. (doi: 10.1093/ageing/afab006)¹ is used for the first time in a large database, demonstrating its usefulness in retrospective data analysis.
2. A particularly relevant element of this study is the assessment of both the use of health and social services. Unfortunately, many times the studies only report metrics from the health field, thus limiting the global analysis of costs in these populations.
3. Beyond the clinical utility of the CFS, it places great emphasis on the usefulness of the results obtained for health and social policies (for example, the allocation of care resources in older people).
4. Finally, this article provides more evidence on the dynamic nature of frailty, emphasizing the need for periodic assessment of the degree of frailty of the population (the authors propose that CFS status should be reviewed at least every 2 years in individuals, or sooner

when there is a change of individual circumstances).

SPECIFIC COMMENTS:

- 1. TITLE:** The title is explicit and clear
- 2. ABSTRACT:** It is easy to follow, it highlights the main results and it conforms to the rules of the journal. As a minor comment, it would be useful to specify the numerical category of the CFS, together with its description. For example: 6% 'very fit' (CFS 1), 36% 'fit' (CFS 2), 31% 'managing well' (CFS3), ... "
- 3. BACKGROUND:** The background gives enough information to contextualize the research question. It explains appropriately the study aims. The reviewer has only one minor comment related to Figure 1: Although the intention of the authors is to demonstrate the interrelation of the different dimensions, the fact is that the figure is not enough explanatory. Perhaps using different colours for each of the geriatric syndromes would be clearer. On the other hand, note that the concept of "multimorbidity" is repeated.
- 4. METHODS:** The aims, the design of the study, the characteristics of participants and the description of materials are developed adequately, and the statistical analysis is appropriate. It is especially interesting the use of the alluvial charts for the visualization of the longitudinal CFS transitions, as well as the use of the multistate Markov models to estimate transition probabilities for the CFS states from wave x to wave $x + 1$.

A small limitation of the methodological approach is the source of data collection:

1. Usually, the most reliable source for obtaining clinical data is direct patient assessment. In this case, obtaining the CFS has been inferred retrospectively from a database previously designed for another purpose. It should also be noted that in the original study by Theou *et al.* (doi: 10.1093/ageing/afab006)¹ the CFS classification had been performing by professionals synchronously with the Comprehensive Geriatric Assessment.
2. On the other hand, usually, the most reliable source for obtaining data related to the use of resources are those coming from the information/billing systems. In this case, the uses of resources (number of times they visited a range of medical services over the previous 12 months) have been obtained through people self-declaration.

Although the authors comment on the first limitation, it might also be advisable to mention this second one.

- 5. RESULTS:** The results are clear and follow a logical sequence. A large number of figures are provided, which greatly facilitate the understanding of the results.

The reviewer only has 2 minor comments:

1. It is surprising that CFS classes 8 (very severely frail) and 9 (terminally ill) were not observed in TILDA. As mentioned by the authors, the results certainly cannot be extrapolated to the most vulnerable population of severely frail and terminally ill individuals. However, given the fact that the sickest people are often those who require more care and make greater use of health and social services, the non-representation of these classes could represent a

bias and should be taken into account as an overall limitation of the study. This also has implications related to health and social policies.

2. Figure 9: It is not clear to the reviewer if the results represented in this figure correspond to absolute values of resource use for each CFS category, or if they have been adjusted according to the prevalence of each CFS category. For example: Is the total spending on day centres, 7.1%, attributable to 0.7% of the total number of people with CFS?

6. DISCUSSION: The discussion is clear and well-focused, although it lacks detail in the comparison of the results obtained with the evidence published so far. Many of the authors' claims could be contrasted with some of the many interesting publications that analyze:

1. 1) the outcomes and use of resources (especially healthcare resources) in relation to the degree of frailty, also using the CFS.

For example:

<https://bmgeriatr.biomedcentral.com/articles/10.1186/s12877-020-01801-7>²

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7458601/>³

<https://pubmed.ncbi.nlm.nih.gov/28112778/>⁴

<https://bmgeriatr.biomedcentral.com/articles/10.1186/s12877-020-01800-8>⁵

2. 2) The dynamic evolution of frailty over time, also using the CFS.

For example:

<https://academic.oup.com/ageing/article/48/4/547/5480913>⁶

<https://onlinelibrary.wiley.com/doi/abs/10.1111/ggi.13522>⁷

<https://academic.oup.com/ageing/article/49/6/974/5825993>⁸

[https://doi.org/10.1016/S2666-7568\(20\)30059-3](https://doi.org/10.1016/S2666-7568(20)30059-3)⁹

<https://doi.org/10.1186/s12889-021-10688-x>¹⁰

Regarding the limitations, certainly, the non-inclusion of people with dementia involves an important bias. Some of the limitations previously discussed by the reviewer could also be incorporated.

The conclusions provide, in a clear way, an explanation of the importance and relevance of the study reported.

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Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Frailty, complexity, end-of-life, integrated care

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 07 June 2021

<https://doi.org/10.21956/hrbopenres.14478.r29515>

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I have read with interest the manuscript titled “Informing patterns of health and social care utilization in Irish older people according to the Clinical Frailty Scale” by O’Halloran *et al* submitted for publication to the HRB Open Research.

This interesting manuscript addresses a topic of great importance and relevance. In an aging population, the use of better indicators of vulnerability (beyond chronological age alone) may be the best strategy for decision-making in terms of health policies. In this way, the authors use a valid scale to identify the most frail older people to show that, indeed, those in highly vulnerable conditions are those who use more resources, both at hospital and community levels.

On the other hand, the use of Markov models seems an ingenious strategy to demonstrate the dynamics of frailty, to show the probability of changing from one state to another and, most importantly, to clarify the potential for intervention on frailty syndrome to prevent people from suffering from the deleterious health outcomes associated with this geriatric syndrome.

The methodology is clear, and the TILDA cohort is correctly explained even for those who are not familiar with it.

The statistical plan is also consistent with the objectives of the study.

The results are clear. However, at some point they can be redundant in the sense that they all point in the same direction (thankfully). In this way, it is not clear to me if that many figures are necessary to show the gradient between greater frailty and a higher need for any type of health service. It is up to the authors and the editor to decide if there is room for everything in the publication. However, it is necessary to underline that the graphs elegantly illustrate the gradient seen between a state of progressive frailty and the greater need to use different health resources.

In my opinion, the discussion is consistent with the objectives of the study. The usefulness of the CFS and its potential for application at different levels are resumed, including for public health policies. Limits are also recognized. In particular, the impossibility of applying it to extremely frail people. This fact should be underlined, and caution is encouraged in the interpretation of the results. The conclusion is also strong with everything mentioned in the text.

From my point of view, it is not very clear to me what wants to be presented in Figure 1. The superposition of the multiple determinants of frailty is clear, perhaps it should be pointed out more clearly in the text at the bottom of the figure.

Correct the “type” of TILDA survey data, near the bottom of page 14.

This is a very nice work from the Irish group that deserves to be disseminated and replicated to improve its external validity.

Thanks for letting me read it and comment on it.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Frailty and ageing.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 10 Jun 2021

Aisling O'Halloran, Trinity College Dublin, Dublin, Ireland

Reviewer 1:

José Alberto Avila Funes, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico City, Mexico; Inserm U1219 Bordeaux Population Health Center. University of Bordeaux, Bordeaux, France.

The authors would like to thank Prof Avila Funes for his thoughtful and generous review of our paper.

Our responses to the specific points raised by the reviewer are as follows:

'The results are clear. However, at some point they can be redundant in the sense that they all point in the same direction (thankfully). In this way, it is not clear to me if that many figures are necessary to show the gradient between greater frailty and a higher need for any type of health service. It is up to the authors and the editor to decide if there is room for everything in the publication. However, it is necessary to underline that the graphs elegantly illustrate the gradient seen between a state of progressive frailty and the greater need to use different health resources'.

Response: The authors agree that there is a strong degree of repetition regarding the different medical, community and informal and formal health care services. As HRB Open Research is an online Open Research platform, there are no restrictions to the number of

table and figure elements we may include in the paper. The authors have decided to keep all of the figures as they can provide useful data for other researchers and policy makers. In addition, as the reviewer points out, the graphs illustrate the progressive gradient between greater frailty and higher use across a broad range of different types of health and social services. This underlines the utility of the CFS as a potential tool to aid in the equitable allocation of health services resources in this study

'From my point of view, it is not very clear to me what wants to be presented in Figure 1. The superposition of the multiple determinants of frailty is clear, perhaps it should be pointed out more clearly in the text at the bottom of the figure'.

Response: We have clarified our description of Figure 1 as follows:

Figure 1. Multiple overlapping geriatric syndromes (black) and the dimensions screened by the Clinical Frailty Scale (red).

'Correct the "type" of TILDA survey data, near the bottom of page 14'.

Response: This typo 'TLDA' has been corrected to 'TILDA' at the bottom of page 14 as requested.

Competing Interests: No competing interests to declare.