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Transitions in Ageing: changes in our need for care and support

(What Functional Decline Reveals About Earlier Identification and Support)

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Final Report



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Final Report

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This report presents an English Longitudinal Study of Ageing analysis that focuses on the order of functional loss, sex differences in that order, modelled age-patterns across later life, and regional variation in burden.

One Page Summary

Transitions in Ageing: changes in our need for care and support

This report looks at 17 everyday activities from waves 8 to 11 (2016/17 to 2022/23) of the English Longitudinal Study of Ageing. It asks whether difficulties in daily life tend to appear in a predictable pattern, whether that pattern is the same for women and men, how it changes with age, and whether it differs across England. In simple terms, the report asks whether some types of difficulty with activities appear earlier, and others later.

The answer is yes. Difficulties tended to appear first in more physically demanding tasks such as stooping, kneeling or crouching, climbing flights of stairs, lifting or carrying heavier items, pushing or pulling large objects, and heavy house or garden work. Difficulties such as using the toilet, walking across a room, and eating tended to appear later. This does not mean that every person follows the same path. It does suggest that across England as a whole, functional decline has a recognisable pattern.

Women and men shared the same overall pattern, but women were more likely to report difficulty in the earlier and middle parts of it, especially for tasks that depend on strength, mobility and endurance. The regional picture was similar. The order of appearance of difficulties in activities was very similar across England, but some regions were carrying more difficulty than others. In other words, the main regional difference was not a different pattern of decline, but a different level of burden.

This matters, because services often become most involved when people begin to struggle with personal-care tasks that appear later. The findings suggest that important changes are often visible earlier, when mobility, strength, stamina and heavier domestic activities are already becoming harder. The report also identifies a small set of marker activities. Used carefully, these could offer a quick way to understand broadly where a person sits in the trajectory of activities and what kinds of support may be needed next. They should be seen as guides rather than labels, and they would still need testing in real service settings.

The report has one clear practical message. By the time an older person is struggling with personal-care tasks such as going to the toilet, moving around a room, or eating, important earlier warning signs may already have been missed. Intervening sooner, when strength, mobility, stamina and heavier everyday tasks first begin to decline offers an opportunity to influence what happens next. This fits with the direction of the 10 Year Health Plan for England, especially the shift from sickness to prevention and from hospital to community. In plain terms, waiting for the latest and most severe problems to emerge may mean that the opportunity for positive intervention has been missed.

Executive Summary

Transitions in Ageing: changes in our need for care and support

Why this matters

England is ageing and more people are living for longer with illness, frailty and disability. That matters for older people and their families, but it also matters for the health and care system. The key question is not only how long people live, but when everyday activities start to become harder and how services respond when that happens.

Too often, attention is focused on problems that develop later in life, such as needing help with washing, dressing, toileting or eating. Those difficulties matter, but they are often not the first signs of decline. If we wait until those problems are common, we may have missed an earlier point when loss of strength, mobility and endurance was already becoming visible.

That distinction matters in practical terms. The problems that appear later are often the ones that trigger formal support, crisis response, or difficult decisions about independence. But if the aim is to recognise change early, support people well, and avoid / slow down unnecessary deterioration, then earlier action may be more beneficial.

What the report looked at

This report used data from waves 8 to 11 of the English Longitudinal Study of Ageing. It looked at 17 everyday activities, covering mobility, heavier domestic tasks and personal care. The aim was to see whether these difficulties tend to appear in a recognisable pattern, whether that pattern is similar for women and men, how it changes with age, and whether it differs across England.

The analysis does not say that every person follows the same route. People differ, and later life experiences are influenced by many things including illness, housing, income, family support and chance events. Even so, the report shows that, at a population level, functional decline is not random. Some types of difficulty tend to appear earlier, while others tend to appear later.

Put simply, the report asks whether there is a broad order in which everyday difficulties tend to appear, and whether that order can help us understand where people are in the process of ageing and loss of function. It also asks whether the same broad picture applies across England, or whether it is different for women, men and different regions.

What the report found

The clearest early signs were in physically demanding activities. Difficulties tended to appear first in tasks such as stooping, kneeling or crouching, climbing several flights of stairs, lifting or carrying heavier items, pushing or pulling large objects, and heavy house or garden work. Later difficulties included using the toilet, walking across a room, and eating.

That matters because it shifts attention away from the idea that functional decline starts only when people begin to struggle with the most personal or intimate tasks. In practice, decline often appears earlier, with difficulties in activities that depend on strength, balance, stamina and physical reserve.

The report also used a small set of marker activities. These marker activities do not replace the full analysis, but they help show how difficulty rises across later life. Used carefully, they may offer a quick way to understand where an older person sits broadly in the process and where new support needs may be starting to emerge.

The findings also suggest that it is helpful to think about functional loss in broad zones rather than as a single yes-or-no state. Early changes are often about reserve, strength and balance. Middle changes begin to affect heavier domestic and community tasks. Later changes are more closely linked to indoor basic function and personal care. These zones are a way of describing the wider pattern clearly; they are not labels for people or fixed categories that everyone must move through in the same way.

One finding that is worth noting carefully is that dressing appeared earlier in the national hierarchy than many people might expect. That does not mean dressing is always an early problem for every individual. It means that, in this national analysis, it sat earlier than conventional intuition might suggest, when compared with the full set of 17 activities.

Women, men and regional differences

Women and men broadly shared the same overall pattern, but women were more likely to report difficulty in the earlier and middle parts of it, especially for tasks that depend on strength and mobility. This suggests that inequality is not mainly about women following a completely different pathway. It is more about women carrying more burden within the same broad structure.

The regional story was similar. The order of activities was very similar across England, but some regions were carrying more difficulty than others. In simple terms, the main regional difference was not a different pattern of decline. It was a different level of burden on the same broad pattern.

This is important because it means a common national way of thinking about functional decline is plausible, while still recognising that the amount of need is not evenly spread.

That has two practical implications. First, the same broad set of questions about function can make sense across England. Second, the intensity of support, outreach or preventive effort may still need to vary, because the burden of difficulty is not the same everywhere and is not experienced in the same way by women and men.

What this means for services and the 10 Year Health Plan

These findings can inform the implementation of the 10 Year Health Plan for England. They are relevant to the shift from sickness to prevention because they highlight an earlier phase of decline than later personal-care problems alone. They are also relevant to the shift from hospital to community because many of the early warning signs are visible before crisis, admission or major dependency. They are relevant to the shift from analogue to digital because more consistent recording of functional change could help services spot rising risk earlier.

The practical message is not that there is a single, simple response. The report does not show that. What it does show is that waiting for later dependency markers may be too late. A better starting point may be to identify earlier changes in strength, mobility, endurance and heavier everyday tasks, and to use those changes to guide review, monitoring and support.

That is also relevant economically. Later functional loss is linked to greater use of health and social care and to higher costs. If services can identify people earlier and intervene, there may be a better chance of supporting independence before needs become more severe and more expensive to manage.

This should not require every older person to go through a long or complicated assessment. One of the useful ideas in the report is that a small number of well-chosen marker activities may provide a quick sense of where difficulties are beginning to gather. That kind of brief functional review could be useful in primary care, community services, prevention work or local care planning, although it would need further testing before being adopted as a formal tool.

The findings also support a broader shift in mindset and resources. If services think of decline only in terms of later dependency, they will tend to notice people later. If they are able to identify earlier changes in mobility, strength and heavier everyday tasks, they may be better able to identify people whose needs are rising before those needs become more complex and harder to manage.

The main takeaway

Functional decline usually becomes visible before the latest and most severe care needs appear. If we wait until older people are struggling with the most basic personal-care tasks, we are likely to have missed earlier warning signs that were already visible in mobility, strength, stamina and heavier daily activities.

This report suggests that later personal-care difficulty should not be treated as the start of the problem. It is often a later stage of a process that began years earlier. There is an opportunity to identify changes sooner, respond earlier, and avoid treating crisis as the first point at which declining function becomes dependency.

That is the central message from this work. Older people do not suddenly move from independence to dependency overnight. The change is often visible earlier, in things that can easily be overlooked because they seem less dramatic or less personal. The challenge for services, families and policymakers is to take those earlier signs seriously enough that support does not begin only when choices have already narrowed.

Full report

Transitions in Ageing: changes in our need for care and support

Introduction

The progressive loss of function in later life is one of the central challenges facing ageing societies. In the United Kingdom, demographic change has altered the balance between longer life and healthy life, with healthy life expectancy now lagging overall survival gains and reaching 60.9 years for females and 60.7 years for males in 2022 to 2024 (1). Across Europe, a substantial share of the years lived after age 65 are lived with disability or chronic limitation, reinforcing the policy importance of maintaining function rather than focusing only on longevity (2).

Functional decline refers to a reduction in the ability to carry out everyday activities necessary for independent living, and it is associated with loss of autonomy, increased health and social care utilisation, institutionalisation and mortality (3). In England, functional disability is closely linked to long-term care use, while unmet need for care remains socially patterned among older adults (4–6).

Understanding how functional decline is structured is therefore critical for public policy because the need for health, care and support does not arrive all at once. Previous research has shown that disability often follows a recognisable hierarchy, with some tasks becoming difficult earlier than others and later basic self-care tasks remaining intact for longer (7–9). At its core, this hierarchy reflects the differing demands that tasks place on physical reserve, coordination, cognition and the everyday environment (10).

Although individual trajectories vary, the hierarchical model provides a useful framework for understanding patterns of loss. Cognitive-first pathways often affect higher-demand IADLs such as medication management or shopping before spreading to basic self-care, whereas physical-first pathways, often shaped by musculoskeletal decline or frailty, tend to produce earlier limitations in mobility, endurance and heavier domestic tasks (11–13).

Clinically and practically, the hierarchy matters because early mobility or IADL difficulty may signal rising vulnerability before later dependence in essential self-care tasks is established. Recent evidence syntheses suggest that some tailored community-based complex interventions can help sustain independence, although the effects of specific service models remain heterogeneous (14).

Despite broad agreement on the existence of hierarchical progression, important limitations remain in the literature. Many studies have been cross-sectional, have relied on relatively small item sets, or have not quantified uncertainty in the ordering itself. In addition, the relative position of some items may vary by age, setting and analytic approach (9,15,16).

Careful choice of study methods is needed. Prevalence describes what is common, whereas Rasch modelling helps answer where an item sits in the broader disablement process. That distinction matters if the aim is not only to describe burden, but also to understand progression, identify earlier warning signs and locate individuals or groups within a functional pathway (7,16).

This report addresses these gaps by providing a national longitudinal account of the English Functional Hierarchy using waves 8 to 11 of the English Longitudinal Study of Ageing (ELSA), a nationally representative cohort of adults aged 50 years and over living in England (17). It examines the national ordering of mobility, instrumental and self-care difficulties, tests how women and men differ within that ordering, and assesses whether regional inequalities reflect genuinely different pathways or the same broad hierarchy carried with different levels of burden.

Study Aim and Research Questions

The study aim was to establish whether a common hierarchy of functional decline can be identified in England using recent longitudinal ELSA data, and to determine how sex, age and region shape the way that hierarchy is experienced.

RQ1: Do the 17 ELSA ADL, IADL and mobility items form a common hierarchy of functional decline in adults aged 50 years and over in England?

RQ2: Do women and men share the same hierarchy, and if not, where do local ordering shifts occur?

RQ3: How do selected points in the hierarchy unfold with age?

RQ4: Do English regions show different hierarchies, or the same hierarchy with different burden?

Data and Methods

Data source

The English Longitudinal Study of Ageing (ELSA) is an ongoing nationally representative panel study of adults aged 50 years and over living in private households in England, first recruited in 2002 with biennial follow-up and refreshment samples to maintain representativeness (17). Waves 8 to 11 were used here because they provided consistent measures for the 17 functional items analysed in this report.

Analytical sample

The main analysis used an unbalanced longitudinal panel. This means respondents were allowed to contribute any eligible observed responses from waves 8 to 11, rather than being restricted to those who were present and complete at all four waves. This approach was chosen to make fuller use of the available information and to avoid making the main analysis conditional on surviving and remaining in the panel across the whole study period.

The final analysed sample included 10,847 unique respondents contributing 26,394 person-wave observations and 448,674 item responses across the 17-item scale. Of these respondents, 4,712 were men and 6,135 were women. Mean age across analysed person-wave observations was 68.9 years, with a standard deviation of 9.4 years and an observed age range of 50 to 89 years.

In addition to the main analysis, a balanced-panel sensitivity sample was created for respondents with complete information across all four waves and a usable longitudinal weight. This secondary sample was used only as a sensitivity check and not as the main basis for interpretation.

Weighting

The main analysis used the wave-specific ELSA cross-sectional weights for waves 8 to 11. These weights were rescaled to have a mean of 1 within wave before model fitting. This preserved the relative contribution of respondents while preventing the weighted likelihood from being inflated purely because of the scale of the weights.

The balanced-panel sensitivity analysis used the appropriate wave-11 longitudinal weight based on wave 4 baseline, again rescaled to mean 1. In practical terms, the main results should be understood as coming from a weighted longitudinal analysis rather than from a simple unweighted panel.

Descriptive analyses

Three strands of descriptive analysis were used. First, we described the analysed sample at each wave using one record per respondent per wave. These summaries reported the number of respondents contributing to each wave, the number and proportion of men and women, and the mean age and standard deviation. Because the study panel was unbalanced, these wave-specific counts were not added together; a separate overall row described the total number of unique respondents observed across waves 8 to 11.

Second, we estimated observed prevalence of difficulty for every item in the hierarchy. To make fair comparisons between men and women, and between regions with different age structures, we used direct age standardisation. This allowed the report to present each item not only as a latent position in the modelled hierarchy, but also as an age-standardised

percentage of people reporting difficulty, complementing the item-response modelling with an interpretable descriptive burden profile (7,16).

Third, we used the fitted Bayesian model to generate smooth age-related probability curves for a small set of sentinel items selected from distinct positions in the hierarchy. These model-based summaries were used to show how early, middle and later parts of the hierarchy unfolded across age without relying on implausible threshold ages for late items.

Regional differences were also investigated. After checking descriptively that the ordering of items remained highly stable across English regions, we used the fitted Bayesian model to estimate regional stage burden at ages 65 and 85. This was done by predicting difficulty for every item within region, averaging those item-level probabilities within each stage, and standardising the resulting stage values to the same national sex composition.

Bayesian hierarchical item-response modelling

The main inferential analysis used a Bayesian hierarchical Rasch model fitted to the 17 binary physical function items. Rasch-type item-response models are useful in disability research because they place people and items on a shared latent scale and help distinguish person ability from item difficulty. In this setting, the person side of the model represents retained functional ability, while the item side represents how demanding each task is. In the report figures, items positioned further to the right on the fitted scale are tasks that tend to become difficult earlier in the disablement process, while items further to the left are tasks that tend to be retained until later.

The model was designed so that repeated responses from the same person across waves contributed to an age-related trajectory of latent functional ability. This allowed the analysis to examine not only the ordering of items, but also how people move through the hierarchy with age.

The model included:

1. a common item hierarchy across the 17 tasks
2. person-level variation in overall functional ability
3. an age-related decline term so that functional ability could change over time
4. sex differences in average level and age-related change
5. item-specific sex differences, allowing the hierarchy for women to differ from that for men where supported by the data
6. regional adjustments on overall level and age slope, so that regions could differ in burden and pace without requiring a separate hierarchy for every region

This was the main modelling choice of the project. It allowed the analysis to focus on whether England appears to share a broad hierarchy of functional loss, while still testing whether men and women differ in their position within that hierarchy and whether regional inequalities are better understood as differences in burden and timing rather than wholly different sequences of loss.

Prior distributions and model estimation

The Bayesian model used weakly informative prior distributions. These priors were not intended to impose a strong substantive view of the results. Instead, they were used to stabilise estimation, especially for subgroup deviations and item-specific sex effects that may

be weakly identified in some parts of the hierarchy, which is consistent with current Bayesian modelling practice for complex multilevel models (18).

The model was estimated in Stan using Hamiltonian Monte Carlo with the No-U-Turn Sampler (18,19). The final production fit used four chains, 1,000 warm-up iterations per chain and 1,000 post-warm-up iterations per chain, giving 4,000 retained posterior draws in total. The sampler was run with a seed of 20260312, Adapt Delta = 0.95, and Max Treedepth = 13.

Posterior summaries were reported using medians and 95% credible intervals. This made it possible to describe not only the most likely item ordering, but also the uncertainty around that ordering.

Derived outputs

The fitted model was used to generate several outputs for interpretation.

First, we estimated the overall item hierarchy and the corresponding male and female hierarchies. Second, we used posterior predictions to estimate sex-specific probabilities of difficulty for each item at ages 65 and 85. Third, we generated smooth age profiles for Bayesian-selected sentinel items chosen from distinct positions in the hierarchy so that different functional zones could be tracked across age. Fourth, we estimated regional stage burden at ages 65 and 85 by averaging item-level predicted probabilities within stages and standardising those stage values to a common national sex composition.

These outputs allowed the report to describe the structure of the hierarchy, the way sex differences are expressed within it, how selected parts of the hierarchy unfold with age, and how regional inequalities are expressed as differences in burden on the same broad structure.

Convergence assessment and sensitivity analysis

Model performance was assessed using standard Hamiltonian Monte Carlo diagnostics, including the potential scale reduction factor and effective sample size, interpreted using contemporary guidance on rank-normalised R-hat and effective sample size diagnostics (20). The main fit was judged acceptable for interpretation of the hierarchy and subgroup contrasts. A separate balanced-panel sensitivity analysis was also conducted, but because its sampling diagnostics were poor it was treated as exploratory context only and not as confirmatory evidence.

Software

Data management, descriptive analyses and posterior summarisation were carried out in R using cmdstanr and tidyverse workflows, including ggplot2 for figure production. Bayesian estimation was carried out in Stan via the cmdstanr interface (21–24).

Reproducibility

Reproducing the analysis requires approved access to ELSA through the UK Data Service together with the corresponding wave documentation and weighting files. The full codebase to replicate the analyses is available on GitHub at request.

Results

Table 1 describes the analytical sample contributing to the waves 8 to 11 hierarchy analysis. Because the panel is unbalanced, respondents could contribute to one or more waves, so the wave-specific counts should not be summed. The table shows the size, sex composition and age profile of the sample used for both the descriptive and Bayesian analyses.

Table 1. Analytical sample used in the waves 8 to 11 hierarchy analysis

Wave	All (n)	Men, n (%)	Women, n (%)	Mean age (SD)*
8	6,991	3,091 (44.2)	3,900 (55.8)	69.7 (8.6)
9	7,037	3,068 (43.6)	3,969 (56.4)	68.7 (9.9)
10	6,123	2,663 (43.5)	3,460 (56.5)	68.6 (9.5)
11	6,243	2,676 (42.9)	3,567 (57.1)	68.5 (9.6)
Overall unique respondents	10,847	4,712 (43.4)	6,135 (56.6)	68.9 (9.4)

** Note: the overall mean age (SD) is calculated across analysed person-wave occasions in the main sample, not from a single baseline age per person.*

Table 2 shows the national weighted age-standardised prevalence of difficulty for all 17 items, ranked from most to least common. This provides the descriptive burden profile in the observed population. It is not the same as the modelled hierarchy, but it gives the empirical context against which the Bayesian item ordering can be interpreted.

Table 2. Age-standardised prevalence of difficulty for all 17 items in the main hierarchy, ranked highest to lowest

Item	Domain	Overall age-standardised prevalence of difficulty (%)	Men age-standardised prevalence (%)	Women age-standardised prevalence (%)	Women minus men (percentage points)
Stoop, kneel or crouch	Mobility	36.0	30.8	40.8	10.0
Climb several flights	Mobility	29.3	22.4	35.5	13.1
Lift or carry 10lb+	Mobility	20.1	12.3	27.2	14.9
Push or pull objects	Mobility	16.5	11.0	21.5	10.4
House and garden work	IADL	14.2	11.6	16.7	5.1
Climb one flight	Mobility	13.2	9.9	16.2	6.3
Walking 100 yards	Mobility	12.9	11.5	14.2	2.7
Dressing	ADL	12.7	12.5	12.8	0.2
Reach overhead	Mobility	10.3	8.2	12.3	4.0
Bathing or showering	ADL	8.8	7.5	10.1	2.5
Shopping for groceries	IADL	8.7	6.4	10.9	4.6
Getting in/out of bed	ADL	6.5	5.1	7.8	2.7
Pick up a coin	ADL	5.2	4.5	5.8	1.3
Preparing a hot meal	IADL	5.2	4.3	6.0	1.7
Using the toilet	ADL	4.3	3.4	5.2	1.8
Walk across room	ADL	3.8	3.3	4.4	1.1
Eating	ADL	2.7	2.0	3.3	1.3

Notes: overall prevalence is the national weighted age-standardised prevalence of difficulty for each item. Men and women are age-standardised to the same overall age distribution of the analytical sample. Positive values in the final column indicate higher prevalence among women.

The modelled national hierarchy of functional decline

Figure 1 shows the modelled national hierarchy from the weighted Bayesian Rasch analysis. Based on posterior median item positions with 95% credible intervals, it sets out the relative order in which different functional difficulties tend to emerge. The broad pattern is clear: the early end is dominated by mobility and strength demanding tasks, while the late end is dominated by indoor basic function and core self-care.

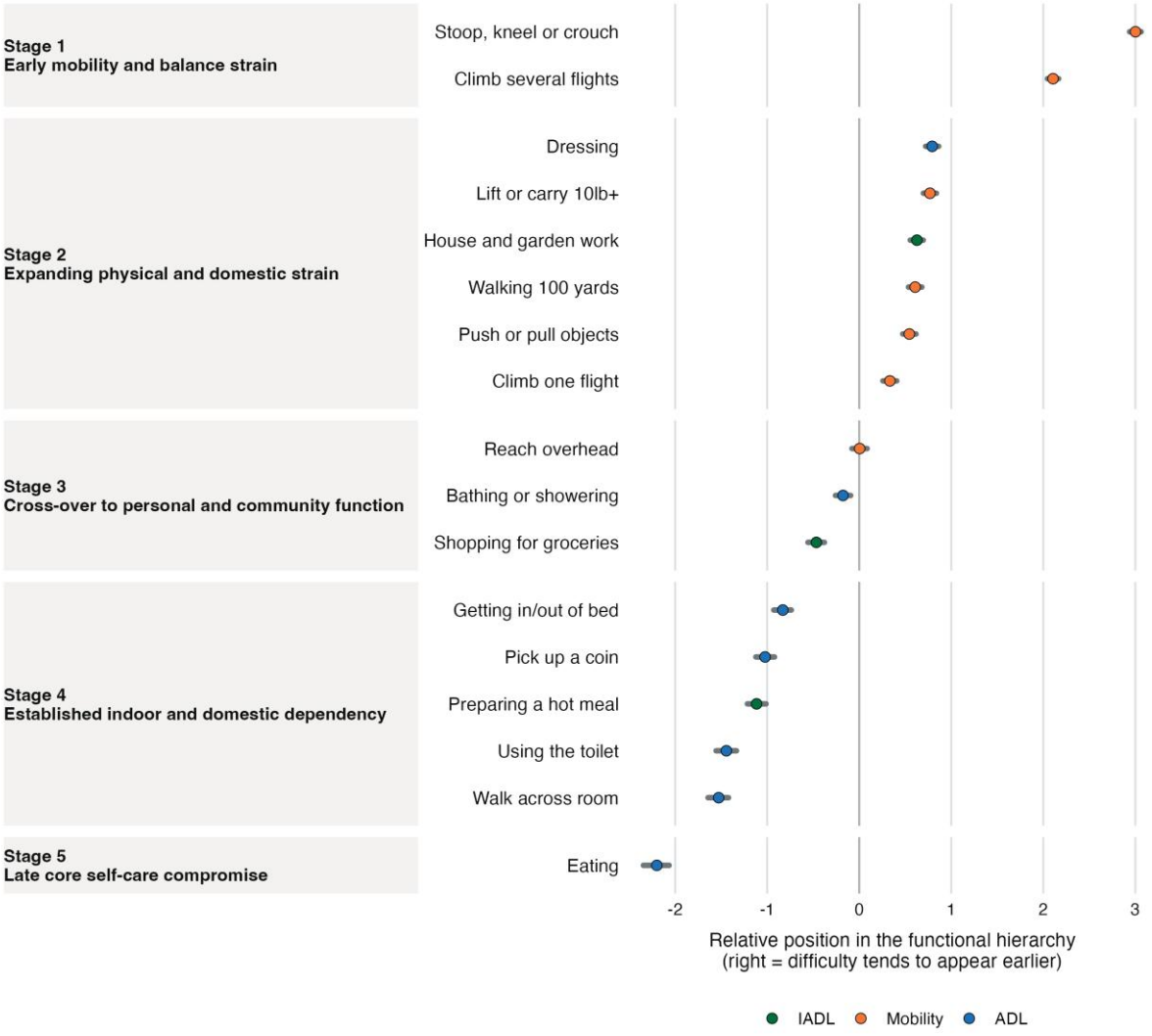


Figure 1. Modelled national hierarchy of functional decline. Points show posterior medians and lines show 95% credible intervals from the weighted Bayesian Rasch model. Values further to the right indicate functions that tend to become difficult earlier in the overall process.

Figure 1 provides the structural map used throughout the report, showing where mobility, heavier domestic function, personal function and later basic self-care sit relative to one another. The shaded bands are interpretive overlays on a single fitted hierarchy, not empirically estimated latent stages.

At the early end of the hierarchy, the clearest markers are stooping, kneeling or crouching and climbing several flights of stairs. These tasks appear well separated from the rest of the scale and indicate a loss of physical reserve before more obvious dependency is seen. The next part of the hierarchy includes lifting or carrying weight, pushing or pulling, walking 100 yards,

climbing one flight of stairs, and heavy domestic work. It is also notable that dressing sits in this zone rather than at the very end of the hierarchy. This does not mean dressing is universally earlier for all people; it means that within this modelled national structure it sits earlier than conventional intuition might suggest.

The middle of the hierarchy marks a cross-over from early physical strain into wider functional restriction. Reaching overhead, bathing or showering, and shopping for groceries sit together in this part of the scale, suggesting that the consequences of reduced strength, balance and endurance are beginning to affect personal function and community participation.

The latter part of the hierarchy is characterised by getting in and out of bed, picking up a coin, preparing a hot meal, using the toilet, and walking across a room. By this stage, the pattern is less about demanding tasks falling away and more about a narrowing of day-to-day autonomy within the home. Eating is the final marker at the lowest end of the hierarchy, indicating that it is one of the last functions to become difficult in this national sample.

For interpretation, the hierarchy is described using five functional zones: early mobility and balance strain; expanding physical and domestic strain; cross-over to personal and community function; established indoor and domestic dependency; and late core self-care compromise. These are reporting aids laid over a single hierarchy, not separate latent classes. They provide a concise shorthand for later discussion of timing and inequality.

The next question is whether women and men carry the same burden within this shared structure.

Sex differences in the functional hierarchy

Figures 2A and 2B show the posterior predicted probability of difficulty for all 17 items at ages 65 and 85, separately for men and women, with items kept in the national hierarchy order. They therefore show where any sex difference sits within the same structure mapped in Figure 1. Figure 2C then shows the item-specific sex shifts in the hierarchy, termed differential item functioning (DIF). In plain terms, it shows whether a task sits relatively earlier or later for women than for men once both are placed on the same underlying functional scale.

The probability plots show how likely men and women are to report difficulty with each task at a given age under the fitted model. DIF shows whether an item occupies a different relative position within the hierarchy for women than for men once both are placed on the same underlying scale. The two are related, but they are not the same.

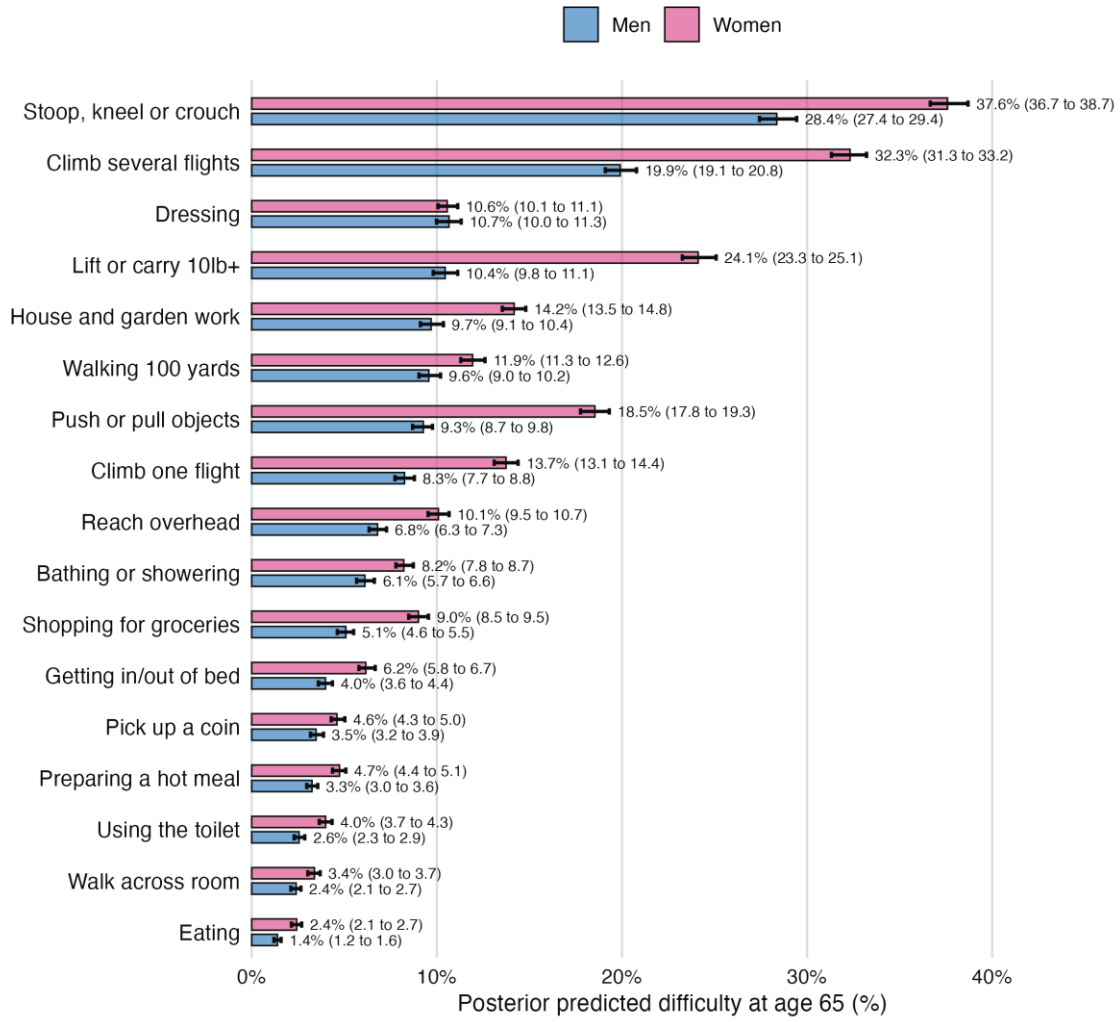


Figure 2A. Posterior predicted probability of difficulty by item at age 65, shown separately for men and women. Bars show posterior median predicted probability and black error bars show 95% credible intervals. Items are ordered by the national hierarchy.

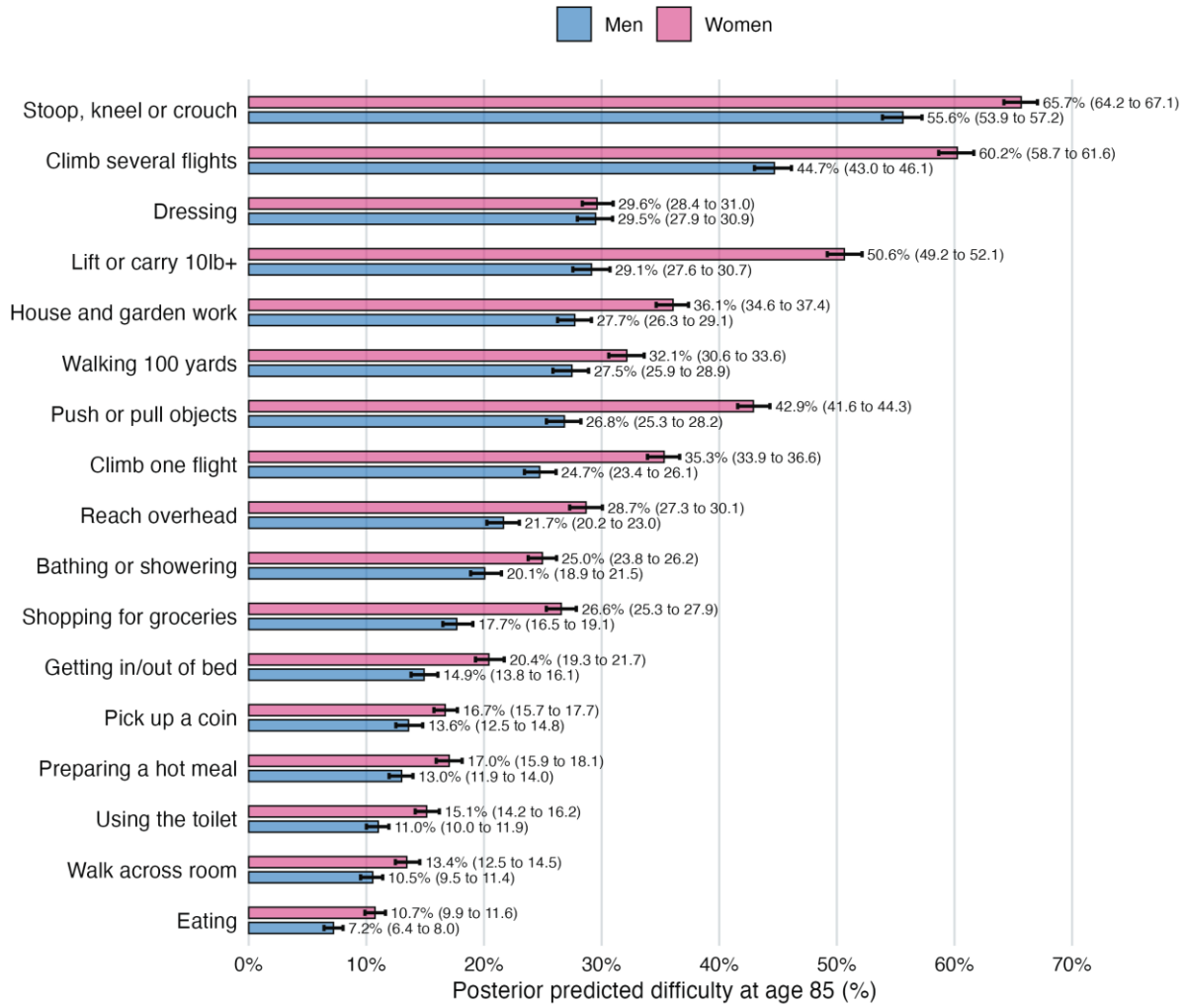


Figure 2B. Posterior predicted probability of difficulty by item at age 85, shown separately for men and women. Bars show posterior median predicted probability and black error bars show 95% credible intervals. Items are ordered by the national hierarchy.

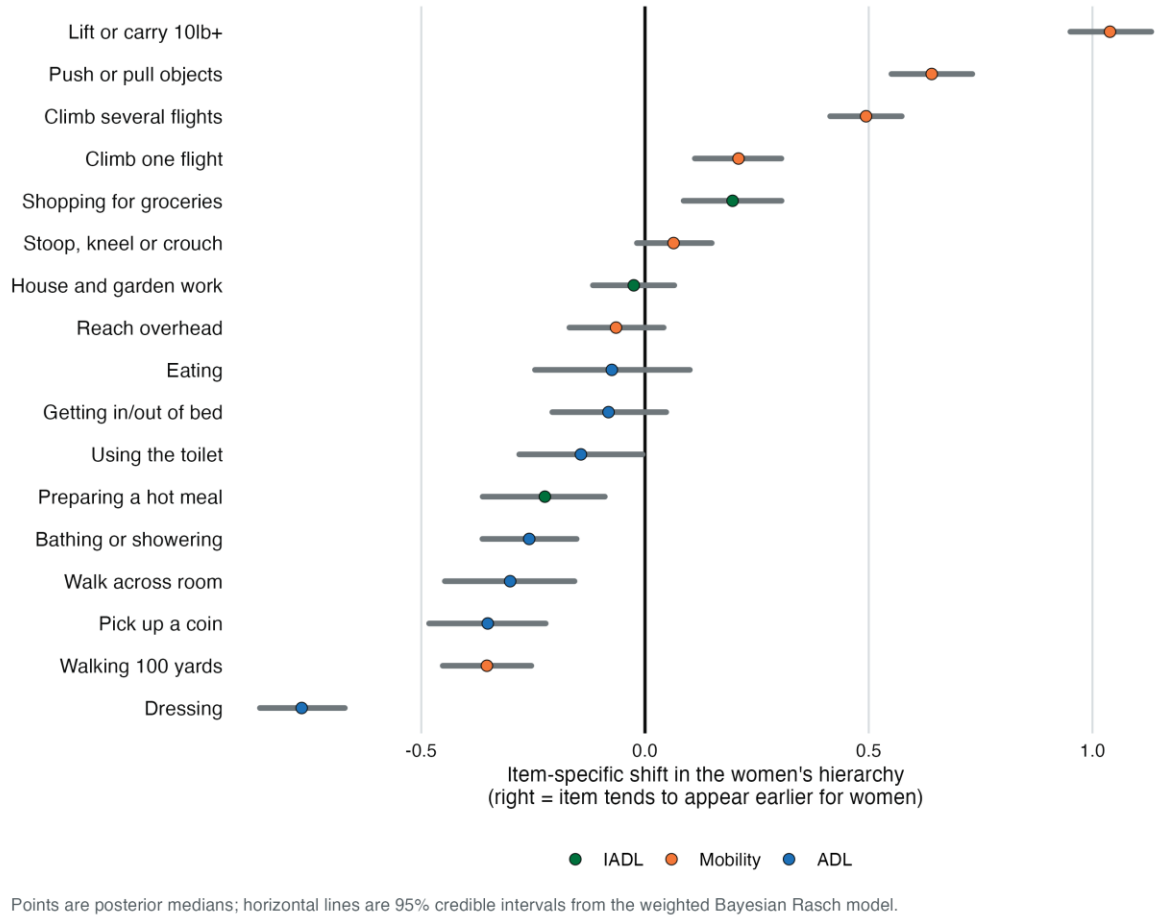


Figure 2C. Item-specific sex shifts in the hierarchy, termed differential item functioning (DIF), coloured by functional domain. Positive values indicate items that sit earlier in the women's hierarchy than in the men's; points are posterior medians and horizontal lines are 95% credible intervals.

The figures indicate a shared hierarchy with some local reordering rather than two different structures. The main sex-specific shifts occur in the middle of the hierarchy, where lifting, pushing, climbing one flight and walking 100 yards change position relative to dressing and to one another. Figure 2C shows that these shifts are concentrated mainly in mobility and strength-heavy tasks.

At age 65, women and men still follow the same broad hierarchy, but the separation is already visible. The largest gaps are concentrated in the physically demanding part of the hierarchy. The posterior predicted probability of difficulty climbing several flights was 19.9% in men (95% credible interval 19.1% to 20.8%) and 32.3% in women (31.3% to 33.2%). For lifting or carrying 10lb+, the corresponding probabilities were 10.4% (9.8% to 11.1%) and 24.1% (23.3% to 25.1%). For pushing or pulling objects, they were 9.3% (8.7% to 9.8%) and 18.5% (17.8% to 19.3%). Shopping for groceries also showed a clear gap at 5.1% in men (4.6% to 5.5%) and 9.0% in women (8.5% to 9.5%). By contrast, dressing showed almost no difference at this age: 10.7% in men (10.0% to 11.3%) and 10.6% in women (10.1% to 11.1%).

By age 85, predicted difficulty is higher in both sexes across the whole hierarchy, but the same structure remains. The most pronounced differences are still concentrated in the earlier and middle mobility-strength zone. Climbing several flights rose to 44.7% in men (43.0% to 46.1%) and 60.2% in women (58.7% to 61.6%). Lifting or carrying 10lb+ rose to 29.1% in men (27.6% to 30.7%) and 50.6% in women (49.2% to 52.1%). Pushing or pulling objects rose to 26.8%

in men (25.3% to 28.2%) and 42.9% in women (41.6% to 44.3%). Shopping for groceries also widened to 17.7% in men (16.5% to 19.1%) and 26.6% in women (25.3% to 27.9%). Again, dressing remained much closer between the sexes at 29.5% in men (27.9% to 30.9%) and 29.6% in women (28.4% to 31.0%).

Overall, women and men share the same broad ordering, but women carry greater burden in the early and middle mobility-strength zone. Dressing is the clearest contrast item: within this modelled national structure it sits earlier than conventional intuition might suggest, but it does not show the same degree of sex inequality as the physically demanding items.

The practical implications of these sex differences for prevention and targeting are considered in the discussion.

The next step is to move from these fixed-age contrasts to the age-profile of selected markers within the hierarchy.

Modelled age profiles for selected sentinel items

Figure 3 shows modelled difficulty curves for six sentinel items across later life, plotted separately for men and women. The curves come directly from the weighted Bayesian Rasch model. In each panel, the line is the posterior median predicted probability of difficulty and the shaded ribbon is the 95% credible band. These are model-based summaries of how difficulty is expected to change with age, rather than simple observed proportions.

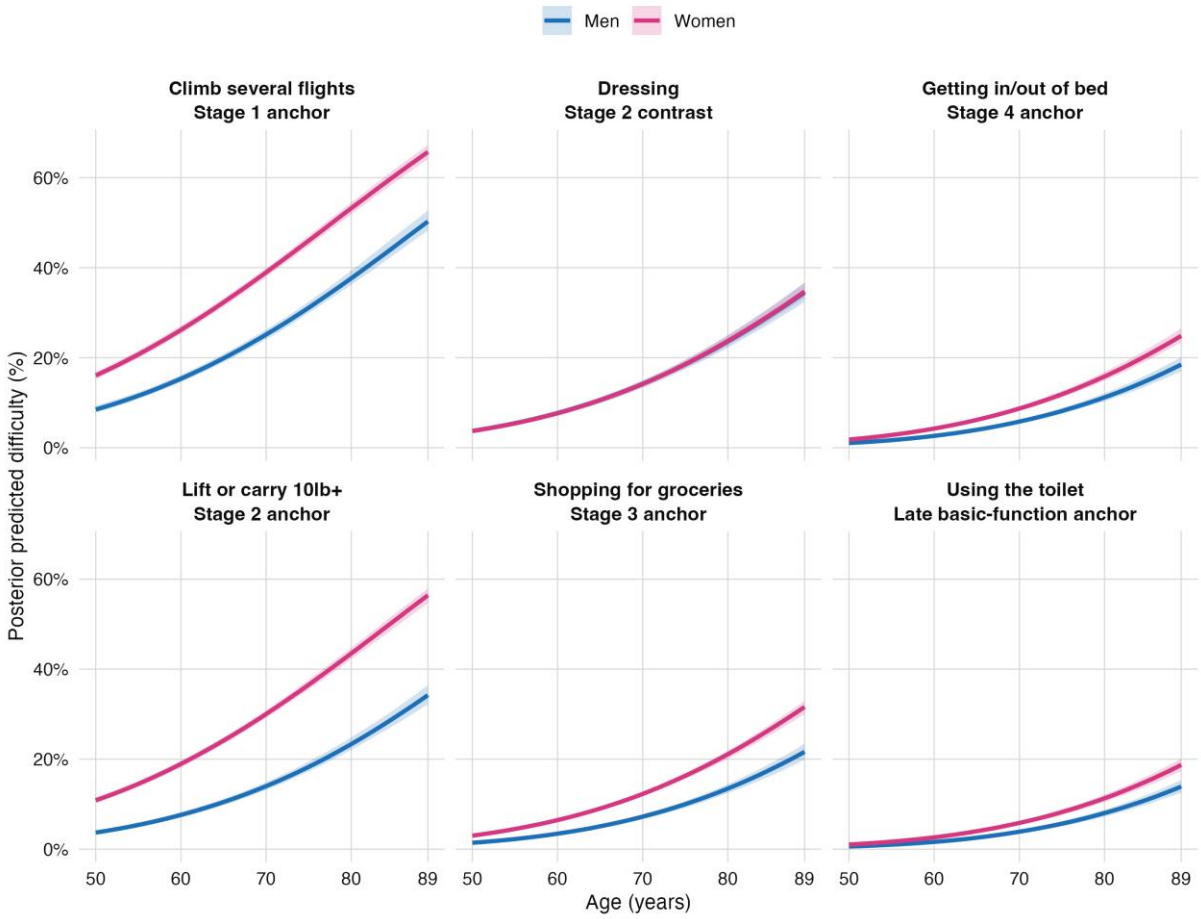


Figure 3. Posterior predicted probability of difficulty for Bayesian-selected sentinel items, shown separately for men and women.

The figure should be read alongside Figure 1. Figure 1 provides the structural map; Figure 3 follows selected anchors from that map over age.

A sentinel item is a marker task chosen to represent a broader part of the hierarchy. It does not summarise the whole scale; it anchors a functional zone so that age-related change can be followed in a smaller set of curves. Like the stage labels, sentinel items are reporting choices built on the fitted hierarchy, not a second latent model.

The sentinel-item approach rests on the five-stage structure identified in the Bayesian hierarchy:

- Stage 1: early mobility and balance strain, centred on reserve-demanding mobility.
- Stage 2: expanding physical and domestic strain, covering strength, flexibility, heavier domestic work, and ambulation.

- Stage 3: cross-over to personal and community function, covering shoulder use, bathing, and community participation tasks.
- Stage 4: established indoor and domestic dependency, covering transfers, fine-motor reach, meal preparation, and indoor basic function.
- Stage 5: late core self-care compromise, represented by the very late end of the hierarchy.

The curves should therefore be read as markers of broader zones of the hierarchy.

The sentinel items were selected from distinct posterior positions in the hierarchy:

- Climb several flights: stage 1 anchor, selected as an early reserve-mobility marker.
- Lift or carry 10lb+: stage 2 anchor, selected because it showed the strongest women-earlier shift in the Bayesian model.
- Dressing: stage 2 contrast item, retained because the model places an ADL unexpectedly early, making it important for interpretation.
- Shopping for groceries: stage 3 anchor, selected as a cross-over item linking physical strain to broader community function.
- Getting in/out of bed: stage 4 anchor, selected as a later transfer marker and sign of emerging indoor dependency.
- Using the toilet: late basic-function anchor, retained because it remains highly relevant to care and support thresholds.

Eating remains the stage 5 late marker in the full hierarchy, but it is not shown here because its predicted probability remains very low across most of the observed age range and therefore contributes less to understanding how the earlier and middle parts of the hierarchy unfold.

The main value of the figure is that it shows how distinct parts of the hierarchy evolve over continuous age, not just whether one item is earlier or later than another. The early reserve and strength-heavy items rise first and most steeply. Climbing several flights and lifting or carrying 10lb+ both show clear upward curves across age, with women consistently above men throughout the range. By age 60, the probability of difficulty climbing several flights was 15.3% (95% credible interval 14.5% to 16.2%) in men and 26.2% (25.3% to 27.1%) in women. For lifting or carrying 10lb+, the corresponding values were 7.6% (7.0% to 8.3%) in men and 18.9% (18.2% to 19.6%) in women. This means the sex difference is already embedded in the earlier part of the disablement pathway rather than appearing only once severe disability is established.

The middle part of the hierarchy shows a different pattern. Shopping for groceries rises later than the reserve and strength-heavy items, which is consistent with its position as a cross-over marker between physical strain and wider day-to-day participation. By age 80, the probability of difficulty shopping for groceries was 13.5% (12.5% to 14.4%) in men and 21.1% (20.1% to 21.9%) in women. Dressing also rises across age, but the curves for men and women remain much closer together. At age 70, the probability of difficulty dressing was 14.2% (13.3% to 15.0%) in men and 14.2% (13.5% to 14.9%) in women. That makes dressing useful as a contrast item. It sits relatively early in the hierarchy, but it does not carry the same degree of sex inequality as the physically demanding mobility and strength tasks.

The later markers, getting in and out of bed and using the toilet, rise more slowly and remain lower through much of the age range. Even by age 89, the posterior predicted probability of difficulty getting in and out of bed was 18.5% (17.0% to 20.1%) in men and 24.9% (23.4% to

26.6%) in women, while the corresponding probabilities for using the toilet were 13.9% (12.5% to 15.4%) and 18.7% (17.3% to 20.2%). This shows that the later, policy-salient markers of dependency sit further down the process than the earlier mobility and strength markers where sex differences are most pronounced.

The implications of these age profiles for identification and planning are considered in the Discussion.

Regional variation

The final question is whether the national hierarchy remains recognisable across England and, if so, whether regional variation is better understood in terms of burden than order.

Figures 4A and 4B answer that question using posterior predicted stage burden at ages 65 and 85. For each region and age, the model predicts difficulty separately for every item for men and women, averages those predictions across the items assigned to each stage, and then standardises the stage values to the same national sex composition. The cell values therefore show posterior median predicted difficulty with 95% credible intervals for the stage, not for any single item.

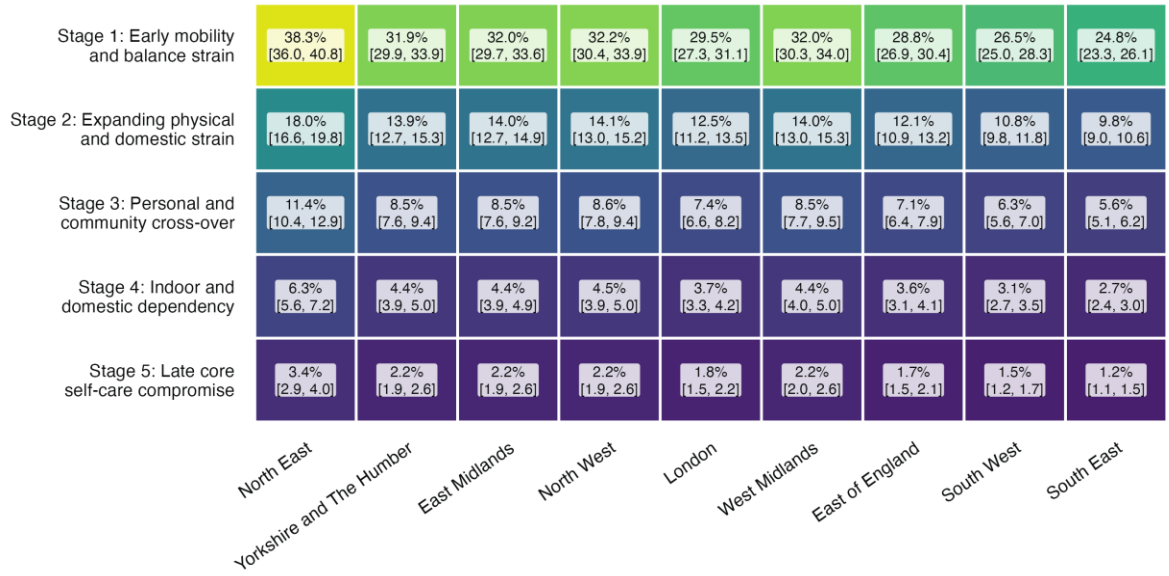


Figure 4A. Posterior predicted regional stage burden at age 65. Each cell shows the posterior median of the mean predicted difficulty across the items assigned to that stage, with 95% credible intervals in brackets; predictions are standardised to the same national sex composition.

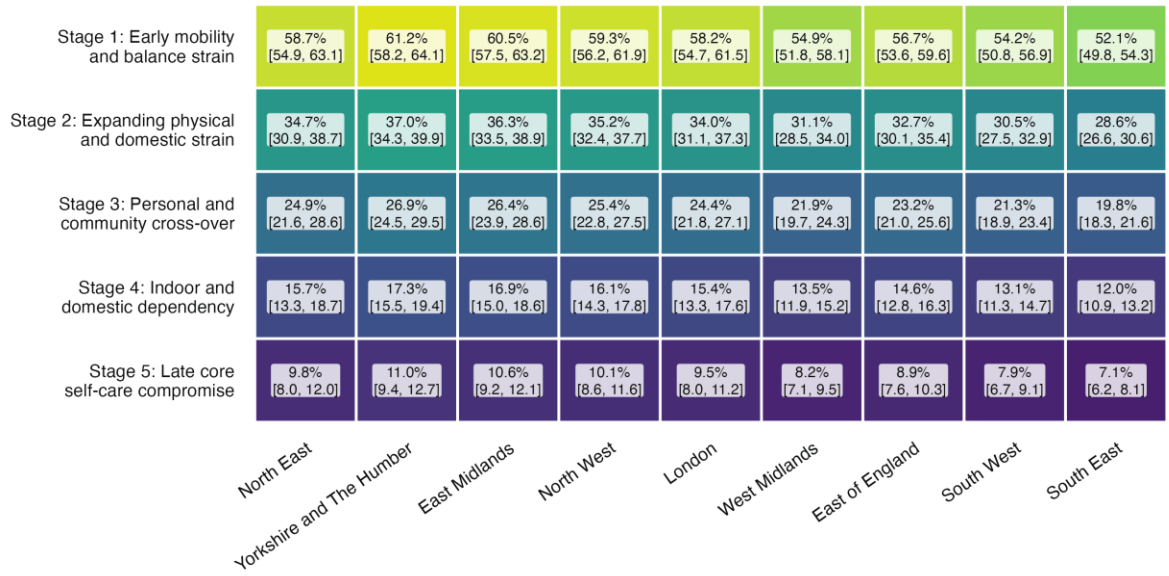


Figure 4B. Posterior predicted regional stage burden at age 85. Each cell shows the posterior median of the mean predicted difficulty across the items assigned to that stage, with 95% credible intervals in brackets; predictions are standardised to the same national sex composition.

The stages follow the same item map used throughout the report. Stage 1, early mobility and balance strain, includes stooping, kneeling or crouching and climbing several flights. Stage 2, expanding physical and domestic strain, includes dressing, lifting or carrying 10lb+, house and garden work, walking 100 yards, pushing or pulling objects, and climbing one flight. Stage 3, cross-over to personal and community function, includes reaching overhead, bathing or showering, and shopping for groceries. Stage 4, established indoor and domestic dependency, includes getting in and out of bed, picking up a coin, preparing a hot meal, using the toilet, and walking across a room. Stage 5, late core self-care compromise, is represented by eating. A Stage 2 regional value is therefore the modelled mean predicted difficulty across all six Stage 2 items.

At age 65, regional separation is already clear in the earlier part of the hierarchy. For stage 1, early mobility and balance strain, the posterior predicted burden was 38.3% in the North East (95% credible interval 36.0% to 40.8%) compared with 24.8% in the South East (23.3% to 26.1%). For stage 2, expanding physical and domestic strain, the corresponding values were 18.0% (16.6% to 19.8%) and 9.8% (9.0% to 10.6%). So, by the mid-60s, regions are already carrying materially different levels of difficulty within the earlier stages of the hierarchy.

By age 85, predicted burden is higher in every region, but the same broad inequality remains. In stage 1, the predicted burden ranged from 52.1% in the South East (49.8% to 54.3%) to 61.2% in Yorkshire and The Humber (58.2% to 64.1%). In stage 2, the range was 28.6% (26.6% to 30.6%) in the South East to 37.0% (34.3% to 39.9%) in Yorkshire and The Humber. Even in stage 5, late core self-care compromise, the predicted burden ranged from 7.1% (6.2% to 8.1%) in the South East to 11.0% (9.4% to 12.7%) in Yorkshire and The Humber. What changes across age is the overall level of burden, not the underlying regional pattern.

Regional concordance with the national ordering is extremely high, with Spearman correlations ranging from 0.980 to 0.995. No item moved by more than two ranks relative to the national order, and the first four items were identical in every region. In that sense, the broad English hierarchy is probabilistically fixed.

Overall, the regional results show a common hierarchy with unequal burden across England.

Discussion

This study supports a common English hierarchy of functional decline, with reserve-heavy mobility and strength tasks at the early end and later indoor and basic self-care tasks at the late end. That broad pattern is consistent with earlier hierarchy work, including the Newcastle 85+ study and later evidence showing that more demanding tasks tend to become difficult before core self-care tasks (7–10).

What the current analysis adds, is a national longitudinal Bayesian account using repeated observations across four recent ELSA waves. This strengthens the evidence base by moving beyond cross-sectional description, quantifying uncertainty in the ordering itself, and testing whether sex and regional inequalities are expressed through different orderings or through different burden on the same broad structure (9,15,16).

The sex results suggest not a separate female hierarchy but unequal burden within a broadly shared structure. Women showed higher predicted difficulty on most items at ages 65 and 85, with the clearest separation in stair-related, strength-heavy and heavier domestic tasks. Dressing remains important because it behaves differently: within this modelled national structure it sits earlier than conventional intuition might suggest, but it does not show the same degree of sex inequality as the physically demanding items.

The age-profile results help clarify why the earlier part of the hierarchy deserves attention. The curves for climbing several flights and lifting or carrying 10lb+ turn upwards well before later indoor or basic-function markers become common. That does not by itself prove the effectiveness of any specific intervention, but it does show that rising difficulty becomes visible earlier than later ADL frameworks imply. Because the sentinel items mark broader zones of the hierarchy, they may help structure a brief functional review around where difficulty is beginning to concentrate, although that use would still need formal validation in service settings (25,26).

The regional findings tell a different but complementary story. English government office regions did not show meaningfully different hierarchies; instead, they showed different amounts of burden carried on the same broad structure. This is consistent with wider evidence that healthy life expectancy and pressures on care and support are socially and geographically patterned across England (27).

There is also an economic reason to pay attention earlier in the process. UK evidence shows that muscle weakness is associated with substantial excess annual health and social care costs, with a large share falling on informal care, while recent evidence on hip fracture shows how rapidly social care costs escalate once mobility loss results in major events (28,29). The Scottish national LifeCurve survey points in the same direction, suggesting that later functional stages are associated with sharply higher service costs and that support often arrives late (25).

These findings support earlier identification and may help target community response more clearly, especially in the mobility- and strength-related part of the hierarchy, but they do not on their own prove that any single service template will alter trajectories. That caution is consistent with the intervention literature, which suggests that some community-based complex interventions are more promising than others but that effects remain mixed (14). In strategic terms, the findings are most relevant to the three shifts in the 10 Year Health Plan for England: hospital to community, because difficulty becomes visible before later dependency

is established; analogue to digital, because structured functional ability recording could make rising risk more visible; and sickness to prevention, because the hierarchy highlights an earlier part of the process than later personal-care markers alone (14,30).

Strengths and limitations

This study has several strengths. It uses nationally representative English longitudinal data across four recent ELSA waves, a 17-item hierarchy spanning mobility, IADL and ADL domains, and a Bayesian item-response framework that provides full posterior uncertainty rather than only point estimates (7,17). The use of an unbalanced panel for the main analysis also avoids making the primary results conditional on remaining observed at all four waves.

The limitations are also important. First, the time-related findings remain conditional on observed respondents and do not remove selective survival, mortality or informative attrition as sources of bias in later-life analyses. Second, the age curves are model-based summaries of age-related change in latent ability rather than directly observed transition times for each person. Third, the five zones used in this report are interpretive groupings placed over the fitted hierarchy, not latent classes estimated by the model. Fourth, the regional burden figures are stage-level averages of posterior item predictions rather than separate fully fitted regional hierarchies. Finally, this analysis does not yet include diseases, cognitive impairment, socioeconomic position, housing or environmental exposures, all of which may shape when people enter the hierarchy and how quickly they move through it (6,12).

Future directions

The next analytical step is to explain not only the order of functional decline, but also why different people appear to enter the hierarchy at different ages and move through it at different speeds. In practical terms, that means extending the current framework to incorporate disease burden, socioeconomic position, housing, and wider environmental context. Those factors may shape both the age at which people join the hierarchy and the speed with which difficulty accumulates once decline has begun (13). A fuller model of this kind would help distinguish whether inequality arises mainly through earlier entry, faster progression, different clustering of functional losses, or some combination of these processes.

Conclusion

In conclusion, the report supports a consistent English functional hierarchy in which decline appears first in tasks that depend heavily on reserve, strength and balance and only later in indoor basic function and core self-care. Women and men broadly share this structure, but not the same burden within it, and English regions share the same broad ordering while differing in the load carried at each point. The main implication is not that later personal-care markers are unimportant. It is that by the time they happen, much of the disablement process is and has already been experienced. A hierarchy-based approach therefore offers a clearer basis for earlier identification, interpretation of inequality, more targeted support and healthier ageing futures.

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