Impact of mid-life trajectories on late life wellbeing: Sequence analysis using Health, Work & Retirement longitudinal cohort data

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Executive Summary

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Circumstances in earlier life shape health and wellbeing in older age. Poorer childhood socioeconomic status has a detrimental effect through mid-life and older age and those with high socioeconomic status in childhood tend to experience a protective effect through mid-life and early old age. However, evidence suggests that conditions and events in mid-life also matter for outcomes in older age.

This report uses Health, Work and Retirement longitudinal study data to identify risks for specific economic and social outcomes and multiple disadvantage in later life. The analysis focuses on the twenty years prior to age 65 to understand the influence of mid-life trajectories on late life wellbeing. Using retrospective data from 787 people aged over 65 years we explored the association of employment status, housing tenure, health and disability status, adverse life events, relationships, number of children, and caring commitments on late life outcomes. Outcome variables were from the HWR 2018 postal survey data and included economic wellbeing, social support, loneliness, depression, self-rated health, and health service use. A measure of multiple disadvantage was also created from combining these outcome variables. Analyses controlled for ethnicity, educational achievement, age, and gender. Sequence analysis and cluster analysis were used to distil mid-life events into clusters and regression analyses were conducted to determine the impact of these mid-life clusters on outcomes in later life.

The mid-life trajectories that had important influences on late life outcomes were employment patterns, health and disability status, and adverse life events. Paid employment in the twenty years before age 65 influenced social outcomes rather than financial outcomes in this research. Those engaged in paid employment were less likely to be lonely and more likely to have social support. Those in education or not looking for work were more likely to be lonely than those in paid employment. People with family centred responsibilities were more likely to have no social support in later life than those who had worked for pay in the 20 years before age 65. Those who were in education between the ages of 45 and 64 reported more disadvantages in later life than those who were working for pay during the same period.

Health was related to several later life outcomes. Participants with health conditions after age 50 were more likely to be in economic hardship, and participants who had multiple health conditions throughout their lives were four times more likely to experience economic hardship compared to participants who were healthy or had recovered. Participants who reported that their health was declining were more likely to report high health system use in later life than those who were healthy. Health was also related to social outcomes; participants who reported their health was declining were more likely to be lonely, to report no social support, and more likely to be depressed in later life. Health decline was significantly associated with multiple disadvantage.

Participants who had experienced assault or abuse were more likely to report being in economic hardship in later life, more likely to be lonely, more likely to be depressed and more

likely to have higher health service use. There was a significant positive relationship between experiences of assault or abuse and multiple disadvantage, with every additional event increasing disadvantage.

Some of the covariates did show significant relationships with the outcome variables. Increasing age was related to higher health service use and to an increased likelihood of multiple disadvantage. Men were more likely than women to report being lonely in later life. Māori participants were twice as likely to report being in economic hardship in later life.

These findings suggest important factors in mid-life that shape economic, health and social outcomes after 65 years. In particular, paid employment is related to better social outcomes in later life. Mid-life health and disability challenges were also important predictors of negative economic and social outcomes. It is likely these trajectories intersect, with health decline shaping employment options. This represents a key opportunity to intervene to improve outcomes for older people. Adequate resources to support recovery from illness and injury are likely to increase attachment to paid work, as well as having direct impacts on late life outcomes. Further research will be useful for suggesting pathways of support through health and employment challenges in mid-life that might enable better outcomes in later life

Background

Background

Circumstances in earlier life shape health and wellbeing in older age. Poorer childhood socioeconomic status has a detrimental effect throughout mid-life and early older age (Arpino et al., 2018; Hempel et al., 2021; Stephens et al., 2022). Experiencing high socioeconomic status in childhood produces a protective effect through mid-life and early old age. Research on early life predictors of late life disadvantage often focuses on the impact of childhood conditions on trajectories of healthy ageing (see Hempel et al., 2021; Stephens et al., 2022). Correspondingly, much of the debate in policy tends to suggest that child poverty alleviation will enable lifelong gains (Breheny, 2023).

However, evidence also suggests that conditions and events in mid-life matter for outcomes in older age (Huisman et al., 2013). Lachman et al. (2015) argue that mid-age is a pivotal period in the life course, with opportunities to intervene to ensure health and wellbeing are sustained into older age. Arpino et al. (2018) found that early life socioeconomic status and childhood health are associated with poorer health in later life; however, the strength of these relationships is weakened when adjusting for education and life course employment, relationship and fertility trajectories.

Findings using the HWR life history data demonstrate that advantages in childhood are not necessarily sustained into later old age. Hempel et al. (2021) found that late life living standards become more important for predicting later life mental and physical health as people age. This has important policy implications; factors in mid-life have the potential to be important for addressing inequities in health and wellbeing for older people. Adverse childhood effects can be offset by later life factors such as education, occupational status and living standards (Pakpahan et al., 2017). Attention to mid-life trajectories and policy attention to supporting people in mid-life are essential in ensuring the ongoing mental and physical health of older people (Hempel et al., 2021).

Life Course Theory

Life course theory suggests that late life outcomes are fundamentally shaped by the conditions and experiences earlier in the life course (Elder, 1994). Life course theory suggests that experiences of both advantage and disadvantage accumulate over the life course (Dannefer, 2003). The specific timing of key events may also be influential. Life course studies show complex relationships. Some life course factors show pathway effects, where early life conditions set people on either advantaged or disadvantaged pathways. However, there are also direct effects where factors experienced in childhood shape late life outcomes even when controlling for mid-life factors. For example, adverse life events may have a lifelong impact if they occur during a critical period of development (Wildman et al., 2018). Unpacking the direct and pathway effects is crucial in understanding the accumulation of disadvantage across the life course.

However, such impacts cannot be separated from the social and political context, which influences the material conditions of people's lives (Elder, 1998). Personal events and social structural factors intersect to shape trajectories of disadvantage in older age. These social structural factors influence people differently depending on their diverse characteristics (Worts

et al., 2013); how they impact outcomes is patterned by sociodemographic factors (Allen & Alpass; 2019) including ethnic group membership and gender (Stephens et al., 2022). For example, life course experiences of disadvantage tend to create further disparities in older age for women and ethnic minorities (Stoller & Gibson, 2000).

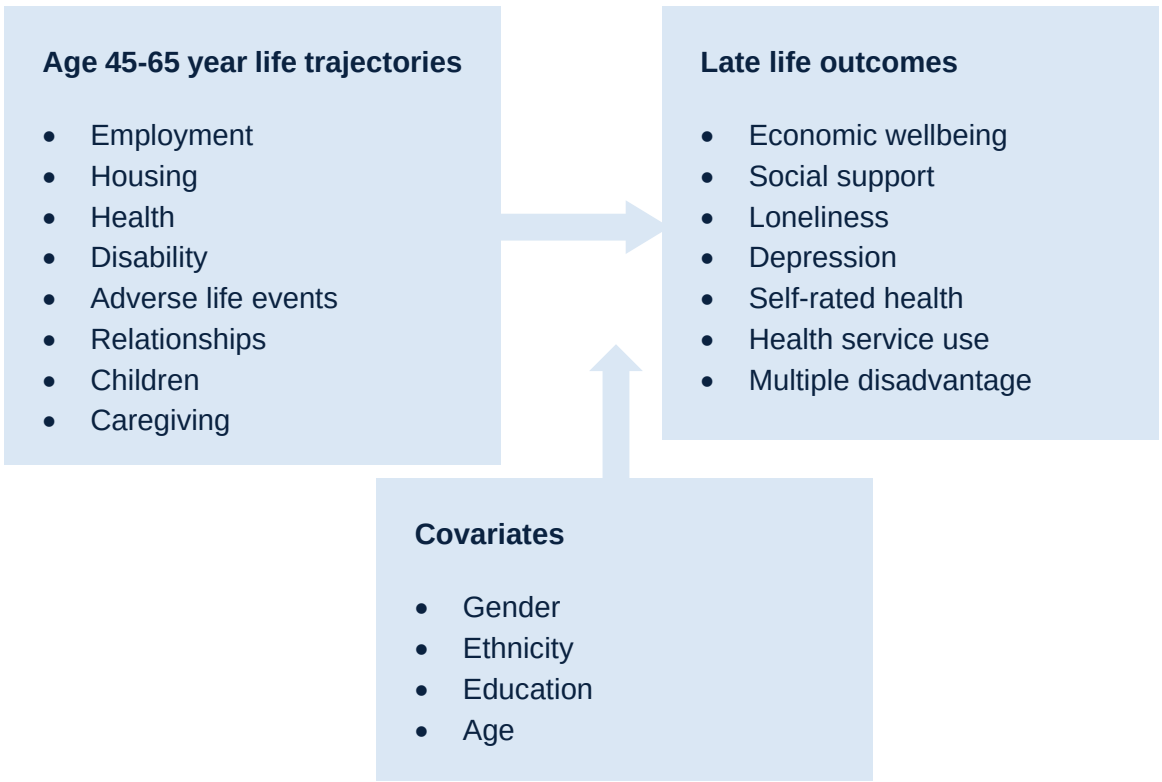
Retrospective Data Collection

To understand how life events shape outcomes in older age, longitudinal studies of ageing internationally have used retrospective data collection. Retrospective data on early and mid-life events can be used to supplement prospective data collected after people are enrolled in longitudinal studies. The HWR retrospective data collection protocol was based on internationally recognised data collections in the English Longitudinal Study of Ageing (Steptoe, et al., 2013) and the SHARELIFE study across thirteen European countries (Pakpahan et al., 2017). Similar data collections have also been used in the Australian Life Histories and Health Survey (Kendig et al., 2014) and the Health and Retirement Study in the United States (Warren et al., 2022). With retrospective assessment of life course information, recall bias is often a concern. Previous research suggests good congruency between retrospective and prospective assessment of socioeconomic circumstances (Jivraj et al., 2020; Warren et al., 2022). This is particularly the case with recalling discrete events and major life transitions.

Research Aim

This research aimed to explore which mid-life trajectories during the period of 45 to 65 years were associated with economic, health, and social wellbeing domains in later life.

Figure 1. Model of relationships between mid-life trajectories and late life outcomes.



Methods

Methods

Health, Work and Retirement Study

Health, Work and Retirement (HWR) longitudinal study data were used to conduct the analyses (see Allen et al., 2023). HWR is a longitudinal cohort study of New Zealanders aged 55 years and older. Data have been collected biennially via postal surveys since 2006. In 2006, using equal probability random sampling, 13,044 adults aged 55-70 years were randomly selected from the New Zealand Electoral Roll. The response rate was 51% resulting in a baseline sample of 6,662 participants in 2006, of which 3,065 agreed to be approached for follow-up surveys every two years. New samples are regularly recruited to the HWR study to mitigate the impacts of attrition on representation and sample size. The use of the national electoral roll as a sampling frame enables over-sampling to ensure representation of Māori and the calculation of survey weights.

Ethical approval was granted by the Massey University Human Ethics Committee. Informed consent was obtained from all participants at the time of response to the questionnaire or interview.

Life history data

Participants

From this HWR 2006 cohort, 1,133 participants still active in the study in 2016 were invited to take part in a structured life history interview data collection. Life history interviews were completed in 2017 with 787 participants, representing a 70% response rate. The technical report shows the demographic characteristics of those who consented to complete the life history interview and those who declined or were unable to be contacted. Of the 787 participants who completed an interview, 520 (66%) had completed all six waves of postal data to date (biennially from 2006 to 2016), and 267 (34%) missed at least one but not more than four waves of postal data collection. Participants were aged 55–70 years when they first entered the study in 2006, aged 65–83 years at the time of the life history interviews, and aged 66-85 at the time of the postal survey used for the outcome measures.

The final analytic sample included 787 participants who provided information on the life history domains. The mean age of the sample was 71.8 years, with participants ranging from 65-81 years. Participants were evenly spread across age ranges (36% aged 65-69; 33% aged 70-74; 31% aged 75-81). Forty-eight percent of the sample were men, and 52% were women. Using prioritised ethnicity, thirty percent of the sample identified as Māori and sixty-six percent as NZ European. Four participants identified as Pacific, two as Asian, and twenty-three as other. The HWR sample overrepresents Māori to enable meaningful subgroup analyses. For comparison, 87% of older people in 2018 identified as European and 7% as Māori (Social Wellbeing Agency, 2023). Twenty-two percent of the sample reported no qualifications, 23% some secondary school qualifications, 35% post-secondary or trade qualifications, and 20% tertiary education.

Procedures

Eligible participants were posted an introductory package by mail. This package contained a personalised introductory letter, an information sheet and a life history calendar grid. The life history calendar grid asked participants to note key events in their lives prior to the telephone interview. This was designed to increase the reliability of the data collected. Participants answered structured interview questions presented by a telephone interviewer, who entered the answers directly onto computer assisted telephone interview software. All possible answers and clarification responses were scripted to improve the quality and consistency of the data collected.

Measures

Life course history interviews covered personal histories across several domains, including: caring for children; accommodation; childhood socioeconomic status; employment history; financial history; illness and injury; health care utilisation and health-related behaviours; alcohol consumption; persecution and discrimination experiences; difficult or traumatic life events. The domains of the life history data collection are given in the Technical Report. In some sections, survey questions are looped until a participant indicates that no more instances of the domain applied (i.e., children, partner history, houses lived in, etc.). This allowed a complete housing and employment history to be gained from each participant.

Mid-life trajectories

From the complete set of life history data collection, eight domains were selected for reduction and cluster analysis: employment status, housing tenure, health and disability status, adverse life events, relationship status, number of children, and caring commitments. Further details of these measures are given in the section on cluster analyses.

Outcome variables

Late life outcome variables were from the HWR 2018 postal survey data collection. These late life outcomes map onto the domains of primary interest in the Social Wellbeing Agency's (2023) work on the needs of older people for health, housing, finance, social connections, and access to services.

Economic wellbeing

Using the Economic Living Standards Index (ELSI) items (Jensen et al., 2005), participants were categorised into hardship (8%) or comfortable or better living standards (92%).

Social support

Social support was measured using a short form version of the Social Provisions Scale (SPS10, Cutrona & Russell, 1987; Orpana et al., 2019). This measure includes components of attachment, guidance, social integration, reliable alliance, and reassurance of worth. A score of over 29 indicated that participants had social support. Fifteen percent of the sample were categorised as having no social support, and 85% as having social support.

Loneliness

Using the DeJong Gierveld Loneliness Scale (DeJong Gierveld & Van Tilburg, 2010; De Jong Gierveld & Tilburg, 2006), participants were categorised into lonely (43%) or not lonely (57%).

Depression

Using the Centre for Epidemiologic Studies Depression Scale (Andresen et al., 1994), participants were categorised into experiencing depression (19%) or not experiencing depression (81%).

Self-rated health

An item assessing self-rated health was taken from the SF-12 Health Survey (Frieling et al, 2013). The item was recoded from five response options (poor to excellent health) into two categories, combining fair and poor health (14%) and good to excellent health (86%).

Health service use

There were five indicators used to determine health service use: seen a doctor, hospital visit, hospital admission, emergency department visit, and consulted a health professional (other than the above). Values on each indicator were used to categorise participants into high health service use or lower health service use (see Technical Report).

Multiple disadvantage

Using the five measures with standardised cut-offs and a health service use cut-off for participants reporting high use of any of the health services, a simple sum of the binary indicators was used to generate an index of multiple disadvantage. Each indicator was coded as 0 or 1, with 1 representing higher disadvantage, creating a multiple disadvantage measure with a possible range from 0 to 6. The index had a mean of 1.1 and an SD of 1.3. Almost 1 in five (38%) participants reported experiencing no disadvantages, a third (33%) reported one disadvantage, 16% reported two disadvantages, and 13% reported experiencing three or more disadvantages.

Loneliness was the most common disadvantage experienced by participants (40%) and tended to contribute to the lower end of the scale, while fair or poor economic living standards (ELSI) were the least common (6%) and contributed to the upper end of the scale. The technical report provides details on how the indicator variables are distributed across the total multiple disadvantage score. The other indicators tended to contribute evenly across the scale.

Covariates

Gender, age, ethnicity, and education were included to control for differences in the outcome variables due to these key demographic variables. Gender was also included as an interaction effect to test whether the effect of the independent variables differed for women and men. Age was significantly correlated within the sequence analyses, and the wide participant age-range requires age in the final analyses. Lifetime education was also included as a control variable in the outcome regressions. Gender was included in the regression analyses as a main effect and as an interaction with the identified clusters.

Data Analysis

Sequence analysis (Gabadinho et al., 2011) and cluster analysis (Maechler et al., 2023) were used to develop and characterise profiles of mid-life events to explore their impact on late life health and wellbeing outcomes.

Event sequences

Event sequences were used to explore how key life events over the twenty years before 65 years shaped later life outcomes. Analysing sequences of events is a way to group people into similar profiles over time, rather than focusing on the impact of a single event or averaging exposures over multiple time points (Pacca et al., 2024). Sequence analyses enable researchers to describe the heterogeneity of the life course rather than ignoring variability. The first step in sequence analysis is to code longitudinal processes as trajectories of events for each participant (Pacca et al., 2024). Each participant is assigned a categorical state at each time point in the observation period (Pacca et al., 2024). This produces unique sequences for each participant in terms of the order, duration and timing of these states.

Each year the domain was measured, a domain specific indicator was recorded. For example, the housing sequence involved assigning participants a state (either owned housing with a mortgage, owned housing without a mortgage, renting, or living rent free) for every one of the twenty years before age 65 years. For employment status, participants were recorded as full time employed, part time employed or unemployed. For relationship status, they were single, partnered, separated/divorced for each year. The number of children present was recorded as a cumulative number for each year. Health conditions or experiences of disability were similarly recorded as a cumulative presence of health conditions for as long as participants indicated they were affected; when participants indicated they were no longer affected by that health condition or disability, the total was accordingly reduced from that time-point forward. Caring commitments were recorded as present or absent for each year. Adverse life events were recorded cumulatively for each year. These life course trajectories were then truncated to focus on the twenty years prior to eligibility for New Zealand Superannuation: 45-65 years.

Cluster analysis

Cluster analysis was used to identify and describe dominant event profiles across the life course. The goal of cluster analysis is to reduce the unique individual event profiles to a limited number of groups of life course trajectories that can be meaningfully interpreted (Arpino et al., 2018). This clustering procedure involves calculating a distance measure for pairs of observed sequences in the dataset. This distance or dissimilarity measure is used to identify clusters of participants with similar sequences (Pacca et al., 2024).

Cluster analysis is agnostic regarding the context or nature of a state; rather, it clusters individuals that move between states in similar ways and is sensitive to change in state rather than the state itself. This means that states that would not necessarily be clustered together a-priori may be grouped together. For example, in the relationship cluster process, being single, divorced or widowed early in life and not forming another relationship after that would likely be grouped together. Because the clustering analysis does not consider the context of the movement between states, the final cluster solution is chosen by assessing groupings for

interpretability. This involves considering the homogeneity within clusters, the heterogeneity between clusters, and the meaningfulness of the clusters. Visual examination of the solutions and the number of participants in distinct clusters was also considered (see Technical Report). For each domain, cluster solutions were selected that represented meaningful patterns of life events and contained sufficient participants within the cluster for meaningful analysis.

Employment and caring trajectory clusters were examined to ensure that they were not markedly different for men and women.

Cluster identification

The results of the cluster process produced the following groupings:

Employment

Employment was categorised as working, looking for work, not looking for work, or education based on their employment situation responses. The five-cluster solution provided the most rational fit. There was clear visual separation between all clusters (see Technical Report).

Around 29% of the sample were continuously employed, and one-in three (31%) were not looking for work. One quarter (24%) were primarily looking for work over the 20 years before the age of 65. Thirteen percent (13%) of participants were mostly in education, with a small proportion transitioning to looking for work or to employment over the twenty years, and three percent (3%) were caring for family. There were no significant gender differences (p=0.97).

Table 1: Employment cluster membership proportions.

Cluster		N	Total
1	In education	104	13 %
2	Not looking for work	243	31 %
3	Working	231	29 %
4	Looking for work	185	24 %
5	Family	24	3 %

Housing

Housing tenure was categorised as either owners, tenants, members of a cooperative or living rent free. Those who owned housing were asked whether there was a mortgage on the property. The five-cluster solution was the most rational fit (See Technical Report). There was clear visual separation between all clusters, with Cluster 4 clearly showing a shift from owning a home with a mortgage to freehold ownership before the age of 60.

Half of the participants (49%) owned their house with a mortgage in the twenty years before age 65 (Table 2), 16% transitioned to being mortgage free in the last twenty years, and 15% had owned their house without a mortgage for all of the last twenty years. Eighteen percent had primarily rented, and 2% reported being in a largely rent-free housing arrangement over

the last twenty years. The rent-free cluster was small (2%) and may include participants living with their children. There were no significant gender differences (p=0.067).

Table 2: Housing cluster membership proportions.

Cluster		N	Total
1	Mortaged	389	49 %
2	Renting	143	18 %
3	Mortage free last 20 yrs	120	15 %
4	Transitioned to mortgage free in last 20 years	123	16 %
5	Rent free	12	2 %

Health

Adult health was categorised using periods of ill health or disability that lasted for more than a year. The five-cluster solution was identified as being the most rational fit. However, the recovered cluster (n=9) was very similar to the healthy cluster and was very small. Accordingly, these two clusters were combined.

The clusters largely reflected groups either in good health or declining across the twenty years before the age of 65 years (Table 3). Almost three-quarters (73%) of participants reported no significant health conditions or illnesses or had reported a single health condition or illness before the age of 60 with all recovering by the age of 60, eleven percent (11%) went from no reported health conditions or illnesses to one after the age of 55, and thirteen percent (13%) reported health declining gradually over the twenty years before the age of 65. Three percent (3%) had multiple and increasing health conditions in this period. There were no significant differences by gender.

Table 3: Health cluster membership proportions.

Cluster recoded			N	Total
1	Healthy	Healthy/ recovered	532	73%
2	Recovered			
3	Health declining after 55 yrs		80	11%
4	Health declining throughout		95	13%
5	Multiple health conditions throughout		26	3%

Disability

Participants were asked whether they had any physical injury leading to any permanent handicap, disability or limitations. Three clear clusters were identified. Most (81%) reported no disability (Table 4), fifteen percent (15%) reported a disability before the age of 50, and four percent (4%) reported a disability after the age of 50. Chi-square indicated that there were

significant gender differences (χ^2=7.04, p=0.03) with men more likely to report a permanent handicap, disability or limitation.

Table 4: Disability cluster membership proportions - three clusters.

Cluster recoded		N	Total
1	No disability	636	81 %
2	Disabled before 50 yrs	118	15 %
3	Disabled after 50 yrs	33	4 %

Adverse life events

Participants completed an adverse life events schedule indicating whether they had experienced a number of events (illness or accident, assault, sexual assault, addiction, witnessed a serious event or death, and natural disaster) and the age each event occurred. To reduce the number of independent variables in the final analyses, initially the cumulative sum of adverse events over time was tested both as a simple total at age 65 and as a part of a sequence analysis. The sequence analysis proved to be a variation of the linear sum and gave no additional explanatory power beyond the sum at age 65. In recognition that some of these variables may co-vary and that simply combining them all may introduce more noise into the analysis, a Principal Component Analysis was used to identify any co-varying variables and to reduce the number of variables in the final analysis. Three clusters were identified, comprising (1) Illness, accident, or disaster event; (2) Assault or addiction; and (3) Witnessed serious accident, violent act, or death (see accompanying technical report for more details). Accordingly, these three clusters were used in the analyses going forward.

The illness, accident, or disaster cluster had a mean of 0.78 and a range 0 – 7, assault or addiction had a mean of 0.55 and a range of 0 – 11, and witnessed serious accident, violent act, or death had a mean of 1.61 and a range of 0 – 14 (see Table 5).

Table 5: Adverse life events descriptives.

Factor	Mean	SD	Range
Illness, accident, or disaster	0.78	1.04	0 - 7
Assault or addiction	0.55	1.15	0 - 11
Witness serious accident, violent act, or death	1.61	1.70	0 - 14

Relationships

Relationships were categorised as partnered, married to divorced, partnered to separated, single, or widowed. The five-cluster solution was a rational fit; however, after initial regression analyses, the cluster describing the trajectory from married through separated to divorced, and the cluster of partnered to separated displayed identical characteristics. Accordingly, these two clusters were combined. Fifty seven percent were partnered (Table 6), with a third

(33%) separated or divorced in the 20 years before the age of 65. Six percent (6%) were widowed by the age of 65, with around half partnered at the age of 45, and the proportion reported being widowed increased until about the age of 60. Chi-square indicated that there were significant gender differences (χ^2=16.68, p<.001) with men more likely to be partnered and women more likely to be widowed.

Table 6: Relationship cluster membership proportions.

Cluster recoded			N	Total
1	Partnered		450	57 %
2	Married, separated to divorced	Partered to separated/divorced	243	33%
3	Partnered to separated			
4	Single		21	3 %
5	Widowed		51	6 %

Children

Participants were asked if they had ever had a biological child or adopted a child as their own. The number of children reported stabilised by age 45 years, with a mean of 2.2 and a SD of 1.3 children by the age of 64. The number of children was used as a continuous variable in any subsequent analyses.

Caregiving

Participants were asked if they had engaged in informal care. The cluster analysis found only one solution, essentially identifying a group that had provided care at some point in their lives and a group that had not. To simplify the analysis and subsequent interpretation, a binary variable was created, which had sixty eight percent indicating no periods of informal care over the twenty years to age 65 and thirty two percent indicating they had provided informal care over this period.

Regression analyses

Following sequence and cluster analyses, the clusters were entered as exposures within a series of regression analyses. This aimed to examine whether these clusters were able to explain differences in late life health outcomes in this cohort. Covariates included in all regression analyses were age, gender, ethnicity and education. A two-way interaction for each of the domains (Employment, Housing, Health, Disability, Adverse Life Events, Relationships, Children, and Caregiving) by gender was also included in the model. Jamovi 2.4 (The jamovi project, 2023) was used for the regression analyses, and Microsoft Excel was used to produce tables and graphs.

A key aspect of the regression analyses was to generate a parsimonious model that could be applied consistently across all seven outcomes. The general form of the regression was Outcome = Domains + Controls + Domain x Gender. Six of the outcomes were binary (economic wellbeing, social support, loneliness, depression, self-rated health, and health

service use) for which a binomial logistic regression was used, while a linear regression was used for the multiple disadvantage index.

Findings

Findings

Pathways to Economic Wellbeing

Examining the role of these eight domains on economic living standards in later life, the model overall explained a significant 22% amount of variance (Model 1 adjusted R^2=0.22, Nagelkerke's $\chi^2(28)=56.01$, p=.001) in the Economic Living Standards Index (ELSI). The main effect model itself was robust, showing no significant multicollinearity (Variance Inflation Factor 1.03 – 1.15).

Participants who reported a permanent handicap, disability or limitation after the age of 50 were 3.5 times more likely to experience economic hardship after the age of 65. Participants who were classified as health declining after the age of 55 were 2.6 times more likely to experience economic hardship, while those participants who had multiple health conditions throughout were 4 times more likely to experience economic hardship after the age of 65 when compared to participants who were healthy or had recovered between the ages of 45 and 65.

Participants who had experienced assault or addiction were also more likely to report being in economic hardship in later life, with every additional event increasing the risk by 1.3 times.

Those who had transitioned from having a mortgage to being mortgage free were 2.4 times more likely than those who had a mortgage to report being in economic hardship in later life.

Māori participants were 2.1 times more likely to report being in economic hardship in later life. The model was run testing for gender interaction effects by cumulative life experiences, which showed no significant additional explanatory power ($\chi^2(22)=17.19$, p=.641). For more details, see the Technical Report.

Table 7. Significant predictors of economic hardship (p<.05).

Predictor	Est	SE	Z	p	OR
Māori – NZ European	**0.72**	**0.36**	**2.00**	**0.045**	**2.06**
Disabled after 50 yrs – No disability	**1.26**	**0.62**	**2.04**	**0.041**	**3.54**
Transitioned to mortgage free – Mortgaged	**0.85**	**0.43**	**2.01**	**0.045**	**2.35**
Assault or addiction	**0.24**	**0.10**	**2.39**	**0.017**	**1.27**
Health declining after 55 yrs – Healthy/recovered	**0.96**	**0.46**	**2.08**	**0.038**	**2.61**
Multiple health conditions throughout – Healthy/recovered	**1.40**	**0.70**	**2.00**	**0.046**	**4.04**

Pathways to Social Support

The model overall explained a significant 10% amount of variance (Model 1 Nagelkerke's R^2=0.10, $\chi^2(28)=47.73$, p=0.011) in social support. The main effect model itself was robust, showing no significant multicollinearity (Variance Inflation Factor 1.02 – 1.12). The model was

run testing for gender interaction effects by cumulative life experiences, which showed no significant additional explanatory power ($\chi^2(20)=22.67$, p=.305).

Those who reported primarily family-centred responsibilities were 3.7 times more likely to have no social support in later life than those who had worked for pay in the 20 years before age 65 years.

Participants who were classified as health declining throughout mid-life or had declined after 55 years were also less likely to have social support in later life than those who were healthy (2.4 and 2.6 times less likely, respectively).

Table 8. Significant predictors of social support (p<.05).

Predictor	Est	SE	Z	p	OR
Family – Working	**1.32**	**0.52**	**2.51**	**0.012**	**3.73**
Health declining after 55 yrs – Healthy/recovered	**0.96**	**0.29**	**3.36**	**< .001**	**2.62**
Health declining throughout – Healthy/recovered	**0.86**	**0.28**	**3.05**	**0.002**	**2.36**

Pathways to Loneliness

The model overall explained a significant 12% amount of variance (Model 1 Nagelkerke's $R^2=0.12$, $\chi^2(28)=48.99$, p<.001) in loneliness. The main effect model itself was robust, showing no significant multicollinearity (Variance Inflation Factor 1.02 – 1.12). The model was run testing for gender interaction effects by cumulative life experiences, which showed no significant additional explanatory power ($\chi^2(20)=24.93$, p=.204).

Participants who reported being in education were two times more likely to be lonely compared to those who were working for pay. Similarly, those not looking for work were 1.7 times more likely to be lonely in later life compared to those who were working in the 20 years before age 65 years.

Participants who were classified as health declining throughout mid-life were 2.1 times more likely to be lonely in later life than those who were healthy.

Participants who had experienced assault or addiction were more likely to be lonely, with every instance of assault or addiction increasing participants risk of being lonely by 1.2 times.

Men were 1.6 times more likely than women to report being lonely in later life.

Table 9. Significant predictors of loneliness (p<.05).

Predictor	Est	SE	Z	p	OR
Women/Wahine – Men/Tane	**-0.50**	**0.19**	**-2.64**	**0.008**	**0.61**
In education – Working	**0.67**	**0.31**	**2.2**	**0.028**	**1.96**

Predictor	Est	SE	Z	p	OR
Not looking for work – Working	**0.51**	**0.23**	**2.25**	**0.025**	**1.67**
Health declining throughout – Healthy/recovered	**0.76**	**0.27**	**2.76**	**0.006**	**2.13**
Assault or addiction	**0.16**	**0.08**	**2.05**	**0.040**	**1.17**

Pathways to Depression

The model overall explained a significant 11% amount of variance (Model 1 Nagelkerke's R^2=0.11, $\chi^2(28)$=55.78, p=0.014) in depression. The main effect model itself was robust, showing no significant multicollinearity (Variance Inflation Factor 1.03 – 1.13). The model was run testing for gender interaction effects by cumulative life experiences, which showed no significant additional explanatory power ($\chi^2(20)$=26.45, p=.151).

Participants who were classified as health declining throughout mid-life were 2.9 times more likely to be depressed in later life than those who were healthy, while those who had multiple health conditions throughout were 3 times more likely to report being depressed.

Participants who had experienced assault or addiction were more likely to be depressed, with every instance of assault or addiction increasing participants risk of being depressed by 1.3 times.

Table 10. Significant predictors of depression (p<.05).

Predictor	Est	SE	Z	p	OR
Assault or addiction	**0.22**	**0.08**	**2.72**	**0.006**	**1.25**
Health declining throughout – Healthy/recovered	**1.07**	**0.29**	**3.69**	**< .001**	**2.90**
Multiple health conditions throughout – Healthy/recovered	**1.09**	**0.54**	**2.01**	**0.045**	**2.97**

Pathways to Self-rated Health Status

The initial model had all but one Variance Inflation Factor (VIF) lying between 1.04 and 2.95; however, the health cluster variable had VIFs of 14.3 and 15.12. Accordingly, the model was run again with the health cluster variable removed.

This model overall explained a non-significant 6% amount of variance for the main effects model (Model 1 Nagelkerke's R^2=0.06, $\chi^2(25)$=22.7, p=.595) and 13% when gender-interactions were added (Model 2 Nagelkerke's R^2=0.13, $\chi^2(42)$=46.34, p=.298) in self-rated health. Model 2, which tested for gender interaction effects by cumulative life experiences, showed no significant additional explanatory power ($\chi^2(17)$=23.64, p=0.129). VIF for model 2 ranged between 1.03 and 2.92 (moderate multicollinearity).

Given the model explained no significant variance in self-rated health, no effects are reported.

Pathways to Health Service Use

The model overall explained a significant 15% amount of variance (Model 1 Nagelkerke's R2=0.15, $\chi^2(28)=69.54$, $p<.001$) in health service use. The main effect model itself was robust, showing no significant multicollinearity (Variance Inflation Factor 1.02 – 1.12). Additionally, the model was run testing for gender interaction effects by cumulative life experiences, which showed no significant additional explanatory power ($\chi^2(20)=20.93$, $p=.401$).

Participants who were classified as health declining throughout were 4.1 times more likely to report high health system use in later life than those who were healthy.

Participants who had experienced assault or addiction were more likely to report higher health service use in later life, with every event experienced increasing participants risk of reporting high health system use by 1.3 times.

Increasing age was related to higher health service use, with each additional year after the age of 65 associated with a 1.1 increase in the risk of high health service use in later life.

Table 11. Significant predictors of health service use (p<.05).

Predictor	Est	SE	Z	p	OR
Age16	**0.07**	**0.03**	**2.91**	**0.004**	**1.08**
Assault or addiction	**0.24**	**0.09**	**2.80**	**0.005**	**1.28**
Health declining throughout – Healthy/recovered	**1.42**	**0.29**	**4.84**	**< .001**	**4.14**

Pathways to Multiple Disadvantage

The model itself was robust, showing no significant sign of overfitting (Model 1 adjusted $R^2=0.10$, $F(24,532)=3.48$, $p<.001$) or multicollinearity (Model 1 Durbin–Watson Test=1.87, p=0.132, and Variance Inflation Factor 1.03 – 1.12). The model was run testing for gender interaction effects by cumulative life experiences, which showed no additional explanatory power ($\Delta R^2=.05$, $F(20,512)=1.41$, $p=.111$).

Those who were classified as health declining throughout the ages of 45 and 64 had more reported disadvantages in later life (mean=1.81) compared to those who remained healthy/recovered (mean=0.93). Similarly, those who were classified as health declining after 55 years of age also reported greater disadvantage (1.51), and those who had multiple health conditions throughout reported more disadvantages after 65 years of age compared to those who were healthy or had recovered.

There was a significant positive relationship between assault or addiction and multiple disadvantage, with every additional experience of assault or addiction reported increasing the number of disadvantages experienced by 0.17

Those who were in education between the ages of 45 and 64 reported more disadvantages (1.57) in later life than those who were working for pay (0.95) during the same period.

The number of children participants reported was also significantly related to a reduction in the number of disadvantages experienced, with every child associated with a corresponding decrease of 0.13. This may reflect the structure of the multiple disadvantage measure, where the most common disadvantage was loneliness (see Technical Report).

Increasing age was related to increasing disadvantage (for every year older, there is a 0.3 increase in the number of disadvantages reported (Table 12).

Table 12. Significant predictors of multiple disadvantage (p<.05).

Predictor	Est	SE	t	p
Age	0.03	0.01	2.40	0.017
Number Children	-0.13	0.06	-2.80	0.005
In education - Working	0.48	0.20	2.40	0.017
Assault or addiction	0.17	0.05	3.40	<.001
Health declining after 55 yrs – Healthy/recovered	0.49	0.18	2.69	0.007
Health declining throughout – Healthy/recovered	0.95	0.35	3.03	< .001
Multiple health conditions throughout – Healthy/recovered	1.07	0.35	3.03	0.003

Discussion

Discussion

This report explored mid-life trajectories associated with late life outcomes among participants in the longitudinal Health, Work & Retirement cohort study. Mid-life trajectories and late life outcomes were selected to explore domains aligned with the Social Wellbeing Agency's (2023) work on the needs of older people. Consequently, mid-life trajectories included employment patterns, housing tenure, health and disability status, adverse life events, and personal relationships. Outcome measures were selected to understand diverse social and economic outcomes important to older people: financial wellbeing, mental and physical health, health service access, and were combined to explore multiple disadvantage.

Across these diverse domains and outcomes, three key patterns emerged. Employment patterns were an important factor in social outcomes for older people. Economic, social and health outcome variables were shaped by health and disability status. Adverse life events had a cumulative impact on economic and mental health outcomes. These key patterns are explored below.

Employment

Employment in the twenty years before age 65 influenced social outcomes rather than financial outcomes in this research. No employment sequences were significant predictors of economic wellbeing in later life. However, older people who had worked for pay in the 20 years before the age of 65 were much more likely to have social support in later life than those with family centred responsibilities. Those engaged in paid employment were also less likely to be lonely or depressed. Those in education or not looking for work during mid-life were more likely to be lonely than those in paid employment during those years.

These findings mirror those found using similar retrospective data collections in the SHARE-LIFE study in Europe. Using sequence analysis techniques, Wahrendorf (2015) found that trajectories associated with detachment from the paid workforce were related to lower quality of life scores for both men and women. These relationships were significant even when controlling for socioeconomic status and in a group of older people with good health. It is likely that paid employment during mid-life creates social networks that increase support and reduce loneliness for older people. Dahlberg et al. (2018) found that forms of social engagement in older age are associated with the same forms of social engagement twenty years earlier. This demonstrates that older people develop social relationships and accumulate resources during mid-life that enable social participation in later life (Dahlberg et al., 2018; Szabó et al., 2024). Employment patterns may be an important component of social participation that requires relatively little effort for people to maintain. When these social networks are not established or are disrupted, it may be highly consequential for older people's social networks and psychological wellbeing.

Previous research suggests that older men are lonelier than older women (Dahlberg & McKee, 2014; Hawkley et al., 2008), and this was also found in the present analysis. Social networks for men may be more likely to be based around employment (Kang et al., 2023), which may produce more marked loneliness when employment is disrupted. This gender interaction was

not found in our analysis, although this is not surprising given the small sample size and that gender and employment were significant main effects.

Health and Disability

Health and disability trajectories in the twenty years from age 45 to 65 were significant predictors of economic, social and health outcome variables. Economic hardship was linked to disability and health decline. This was most pronounced for participants who had multiple health conditions throughout these 20 years. Both health declining after age 55 and health declining throughout mid-life were associated with having no social support. Health declining throughout was associated with loneliness and depression and was significantly associated with the measure of multiple disadvantage. Health and disability outcomes also often intersect with employment options, which are patterned by socioeconomic status and ethnicity. In this study, Māori ethnicity was associated with great economic hardship in later life. There are interlocking systems of discrimination that mean that employment trajectories are often shaped by education, which may be patterned by ethnicity.

This supports previous findings that health and mobility issues influence social outcomes. Dahlberg et al. (2015) found that mobility problems and mobility reduction were significant predictors of loneliness among women. Zhang et al., (2017) found that older people with chronic disease experienced more depressive symptoms, had experienced more negative life events, and experienced lower levels of social support.

Using data from four European studies of ageing, De Breij et al. (2020) found that poor health was more common among workers with lower education, and health status and depression were associated with early work exit. Using data from the longitudinal study of ageing in Copenhagen, Sundstrup et al. (2015) found that physical work is a risk factor for sickness and disability and was associated with early retirement. Although physical labour may be associated with health decline and work exit, Leijten, et al., (2015) found that psychological problems were the strongest predictor of unemployment and earlier retirement. Psychosocial work factors such as greater autonomy and more supportive work environments reduced the risk of exit from the workforce for those with poor health (Leijten, et al., 2015). These findings suggest that work quality can be an important factor in sustaining employment in mid-life. De Breij et al. (2020) found that the health effects on retirement decisions were stronger for those with lower education. They suggest targeted interventions to support the health and wellbeing of lower educated older workers as having the largest impact on sustaining paid work.

The small number of participants in this analysis who suffered health challenges and recovered were no different in outcomes from those without health challenges. Accordingly, these two clusters were combined. With a larger sample size, it might be possible to compare trajectories for those who experience a significant health or disability event without recovery with those who have recovered. This type of analysis would enable the evaluation of financial support and rehabilitation interventions (such as those presently provided through ACC) being made available for illness and disability not caused by accidents. Timely provision of comprehensive rehabilitation programmes may have sustained benefits to economic security and social networks across the lifespan. Future exploration of the factors which shape full recovery from mid-life health challenges would inform interventions to support people to flourish in older age.

Adverse Life Events

Adverse life events include experiencing disaster events, experiencing life-threatening illness or accident, experiences of physical or sexual assault, or witnessing an accident or violent attack. While three adverse life event clusters were entered into every analysis (Illness, accident, or disaster; Assault or addiction; Witness serious accident, violent act, or death) only the assault, sexual assault, or addiction cluster were significantly related to the identified outcomes.

Older people who had experienced assault or addiction were more likely to report being in economic hardship in later life, with a cumulative effect of additional events. Assault or addiction was also associated with loneliness and depression. These findings are supported by evidence from the English Longitudinal Study of Ageing, which found that adverse life events were associated with lower quality of life, lower life satisfaction and higher levels of depression (Richardson et al., 2020). Richardson et al (2020) also found that adverse events were associated with outcomes in a cumulative way. In a meta-analysis on the impact of negative life events on depression, Kraaij et al (2002) found that negative life events had a significant impact on depression scores in older age.

These findings suggest that adverse life events across the life course continue to influence outcomes for older people. Older people in this study were aged from their late sixties to mid-eighties at the time the late life outcome variables were measured. There have been marked cohort shifts in responses to adverse life events over the adult lives of this cohort, and this may have shaped the availability of support for older people to acknowledge and address the impact of these events on their lives. Supporting older people who have experienced challenging and traumatic life experiences, in particular assault, abuse or addiction, may be an important way to promote wellbeing in later life.

Personal Relationships

Three personal relationship factors were explored to examine their impact on late life health and wellbeing outcomes: number of children, relationship trajectories, and caregiving status. Of those, only the number of children had any significant association with any late life outcome. Having a greater number of children was associated with less loneliness and associated with a lower score on the multiple disadvantage measure, most likely because loneliness was the strongest contributor to this score. No trajectories associated with relationships or caregiving were significantly predictive of later life outcomes.

Relationship disruptions have been found to be important predictors of late life economic wellbeing in other studies, with married women experiencing greater income loss than men following relationship breakdown (Fisher & Low, 2015). Although there are international differences in economic outcomes, and differences in the availability of welfare support following relationship dissolution, Mortelmans (2020) concludes that in every country, women appear to be economically disadvantaged following relationship dissolution compared to men. Men tend to experience little to no financial consequences. Differences have been found in the economic consequences of ending a marriage compared to ending other cohabiting relationships for women (Fisher & Low, 2015). Larger sample sizes might enable a more nuanced analysis of the economic outcomes of relationship cessation.

Although the number of children was protective against loneliness, having a family centred employment trajectory was associated with inadequate social support. This is supported by evidence on social networks that suggests that family dependent networks are associated with poorer outcomes for older people (Stephens et al., 2011). Future cohorts of older women are likely to have experienced greater attachment to paid employment over their lives (Worts et al., 2013). This may provide gains in social support in later life as well as greater economic resources for women.

Considerations

Only one housing trajectory was significantly related to late life outcomes; those who transitioned to being mortgage free in the twenty years before age 65 were more likely to report being in economic hardship than those who were still mortgaged. This finding that transitioning to mortgage free status within the twenty years before age 65 was associated with poorer outcomes is counter-intuitive. However, it may be that such trajectories are associated with factors that indicate lower socioeconomic status overall. Many in retirement have fixed incomes that tend to be lower than their income from employment. Therefore, transitioning to mortgage free housing in mid-life may be due to downsizing housing to reduce mortgage costs in response to loss of employment or health challenges. A larger data set may enable closer examination of the interrelated patterns of employment, health and housing.

Sequence analyses can consider trajectories as a whole and so accommodate processes that evolve over time (Pacca et al., 2024). Similar trajectories are clustered together whilst also allowing the examination of distinct pathways to health outcomes. Although sequence analyses are useful to explore patterns of events across groups, they may not be the most useful way to explore intersectionality and its relationship with multiple disadvantage in later life because of the comparatively small number of people in each group. In particular, trajectories that lead to poor outcomes in later life may be less common and therefore discerning the impact of key timings and durations for these trajectories may be difficult. A larger data set may enable closer examination of the interrelated patterns of employment, health and housing.

Although administrative data may be useful to overcome issues with small group sizes in intersectional analyses, they are often constrained by having limited data on social or mental health outcomes (Holman & Walker, 2021). Combining institutional data with high quality cohort study data is a productive way to combine the statistical power of institutional data collection with the robust psychometric properties of measures included in large scale cohort studies, such as the HWR longitudinal study. For example, the multiple disadvantage index showed promise as an outcome measure, given the availability of detailed psychometric data in the NZHWR study. It is useful as a guide to determine how cumulative life experiences have contributed to later life disadvantage. The measures used in the construction of the index are unlikely to be available using administrative data, highlighting the value of in-depth social and psychological measurement of outcomes.

Limitations

Participants in this study were limited to those who survived to at least 66 years of age. Given that mortality is patterned by socioeconomic status and ethnicity, it is likely that the

relationships between these life course trajectories and outcome variables are attenuated by survival bias (Hempel et al., 2020).

Some clusters are small but represent groups that experience multiple disadvantages. In the HWR study, we have identified a small proportion of the study sample (8.7%) who have vulnerable health (Stephens et al., 2019). These participants have very poor physical and mental health, and low social provisions. Although they only represent a small percentage of the total sample, they have the lowest scores on environmental resources and enter older age with the poorest health (Stephens et al., 2019). Similarly, using growth mixture modelling we have identified ten percent of the HWR sample with low and declining quality of life scores (Szabó et al., 2021). The Social Wellbeing Agency (2023) used institutional data on multiple disadvantages and found 13% of older people experience vulnerability across two or more domains. These studies show the importance of modelling predictors for the small proportion of older people who experience the poorest outcomes in later life. Planned life history data collections with larger cohorts from the HWR sample will enable more detailed analyses of mid-life trajectories. In addition, more detailed within person analytic techniques may be most suitable for examining life course impacts for those who experience the poorest outcomes. Such approaches enable the detailed examination of comprehensive life history data for small numbers of participants (Singer et al., 1998). They involve moving between nuanced details of individual lives and summaries of groups of people. These analytic techniques may enable examination of the processes and resources that contribute outcomes in later life.

Employment and relationship patterns are highly patterned by age and cohort intersections. Consequently, analyses of mid-life trajectories need to be contextualised to be meaningful. For example, there are both clear gendered shifts in employment and relationship profiles at a population level and increasing divergence between people (Worts et al., 2013). There is some evidence that this divergence has expanded opportunities for some women rather than necessarily providing social advantages for all women (Worts et al., 2013). Previous research has also suggested that many older people may now be in precarious employment situations (Kang et al., 2023). Increasing income precarity may be unevenly distributed; older Māori in particular may have experienced structural disadvantages that lead to challenges securing high quality work in later life (Allen & Irwin, 2023). More detailed analyses of employment patterns may uncover pathways through which employment influences social outcomes. All life course analytic data needs to be considered in a social and historical context to be useful for policy makers.

Conclusions

Employment trajectories, health and disability status, and adverse life events were important predictors of late life social and economic outcomes. Older people who experienced good health in mid-life experienced better mental health, more social support and better economic resources. Older people who maintained paid work had better social support, were less likely to be lonely or depressed. Adverse life events experienced in mid-life, particularly assault or abuse, continued to influence economic and social wellbeing. These findings point to the importance of these mid-life years and provide the foundation for outcomes in later life.

Along with evidence from other international studies of ageing, this points to the intersection of health, disability and employment trajectories. Those who are able to maintain paid work until age 65 (and beyond) benefit socially. Those who experience the onset or the increase in health conditions or impairments in mid-life experience economic and social impacts, and these increase as they age.

These findings suggest that supporting people to recover from illness and to live well with disability during mid-life will have ongoing benefits. Support for people to contend with adverse life events may also provide opportunities for improved wellbeing in later life. Although paid employment was associated with increased social wellbeing, recommendations to improve rates of paid work in mid-life need to consider the mental and physical health challenges that some experience and focus on the availability of high-quality employment that is suitable for people as they age.

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