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Economic Evaluation

The Drug Burden Index and Level of Frailty as Determinants of Healthcare Costs in a Cohort of Older Frail Adults in New Zealand

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ABSTRACT

Objectives: Frailty is common in older people and is associated with increased use of healthcare services and ongoing use of multiple medications. This study provides insights into the healthcare cost structure of a frail group of older adults in Aotearoa, New Zealand. Furthermore, we investigated the relationship between participants' anticholinergic and sedative medication burden and their total healthcare costs to explore the viability of deprescribing interventions within this cohort.

Methods: Healthcare cost analysis was conducted using data collected during a randomized controlled trial within a frail, older cohort. The collected information included participant demographics, medications used, frailty, cost of service use of aged residential care and outpatient hospital services, hospital admissions, and dispensed medications.

Results: Data from 338 study participants recruited between 25 September 2018 and 30 October 2020 with a mean age of 80 years were analyzed. The total cost of healthcare per participant ranged from New Zealand $15 (US dollar $10) to New Zealand $270 681 (US dollar $175 943) over 6 months postrecruitment into the study. Four individuals accounted for 26% of this cohort's total healthcare cost. We found frailty to be associated with increased healthcare costs, whereas the drug burden was only associated with increased pharmaceutical costs, not overall healthcare costs.

Conclusions: With no relationship found between a patient's anticholinergic and sedative medication burden and their total healthcare costs, more research is required to understand how and where to unlock healthcare cost savings within frail, older populations.

Keywords: drug burden index, frailty, healthcare costs, older frail cohort, New Zealand.

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Introduction

Frailty in older adults is common. It reflects the cumulative impact of declining physiological reserves across the human body. Frail adults are more vulnerable to adverse outcomes following otherwise minor health issues.[1] Frailty coincides with an increase in chronic conditions and increased use of medications, frequently resulting in multiple medications being used concurrently. Polypharmacy, the concurrent use of 5 or more medications, is prevalent in older people. Multiple methods to quantify polypharmacy in an individual patient have been developed.[2,3] Of specific relevance in this study is the drug burden index (DBI), which quantifies the total load of an individual's anticholinergic and sedative medications. These medications have known adverse effects in older adults, including falls, confusion, and delirium, which increase as the number and dose of medications in these classes increase.[4–7]

The relationship between higher levels of frailty and increased healthcare costs has been well researched (systematic review and meta-analysis by Chi et al, 2021[8]); however, the association between DBI and healthcare costs has so far not been investigated. Our research explores the relationships between DBI, the level of frailty, and healthcare costs within an older population in Aotearoa, New Zealand.

If a strong relationship between DBI and healthcare costs exists, a deprescribing intervention may be effective at reducing healthcare costs within frail older populations. Research has been conducted to investigate the potential healthcare savings of deprescribing in various healthcare settings (eg, hospitals, aged care, and community), with different target medications and intervention strategies.[9–14] These studies investigated the relationship between polypharmacy (defined differently across studies) and healthcare costs indirectly as they focus on the impact of the deprescribing intervention on healthcare costs. They also included various cost components and results were typically reported as means or medians of the aggregated cost, assuming or implying a known homogeneity of the patient cohort. In contrast, in this study, we investigated the relationship between DBI and healthcare costs directly.

Our objectives were as follows:

1. Describe the structure of costs of health services delivered to a cohort of older adults in New Zealand.
2. Investigate the associations between DBI, the level of frailty, and incurred healthcare costs among older adults in New Zealand.

Within total healthcare costs, we also examined separately the costs of dispensed medicines, outpatient hospital services, hospital admissions, and aged residential care (ARC) admissions.

Methods

This article presents an analysis of the determinants of healthcare costs in a cohort of 338 older New Zealanders, focusing specifically on the degree of DBI and the level of frailty. We used data from participants who were enrolled in a previously published randomized controlled trial on deprescribing anticholinergic and sedative drugs in frail older people living in the Canterbury region of New Zealand.[15,16] All participants were stratified by frailty, measured using a cumulative deficit model frailty index (FI),[17] and had their DBI calculated both pre- and post-trial. DBI is a cumulative measure of anticholinergic and sedative medications where each half unit increase in DBI corresponds to the consumption of one medication at its minimum effective dose. It has previously been demonstrated that each additional unit of DBI has similar negative effects as 3 additional physical comorbidities.[4] For details on the development and calculation of the DBI, we refer to comprehensive reports by Hilmer et al[4] and Kouladjian et al.[5] It is important to note that, although this study used rich, individual-level data collected as part of the randomized controlled trial (RCT), we did not focus on the deprescribing intervention itself. We explain and justify this further below.

Inclusion criteria for the RCT were adults 65 years of age or older who had undergone a standardized nterrail Home Care or Contact Assessment and were taking at least 1 anticholinergic or sedative medication. Exclusion criteria were a psychiatric disorder or dementia, having a terminal illness with <6 months of life expectancy, living in an ARC facility, or scoring 0 on the FI. Participants were recruited between 25 September 2018 and 30 October 2020. All gave informed consent. The trial protocol mandated 2 pharmacist-conducted medication reviews 6 months apart. Participants were randomized (1:1) immediately after the first medication review, whereby for the intervention arm, the pharmacist provided the participant's general practitioner (family doctor) with a letter outlining suggestions for deprescribing. In the trial, 172 participants (51%) were randomly allocated to receive the intervention. However, the intervention did not result in a change in DBI overall or in any frailty stratum; therefore, no deprescribing effect was detected. Because of this null result, we considered the cohort as a whole—all 338 participants who completed the full study—for this economic analysis.

Cost Data

Participants were followed for 6 months from their first pharmacist-conducted medication review. We obtained the utilization level of the following medical services and products for each participant: dispensed pharmaceuticals, outpatient hospital services, hospital admissions, and ARC. We used the service/product prices detailed below to determine the overall, individual-specific healthcare cost over the study period. Costs of the RCT intervention itself were excluded. We adjusted all costs for inflation to reflect 2021 prices (refer to Appendix 1 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2023.11.009). The cost incurred by study participants over the 6 months were calculated for the various cost categories. All costs are stated in New Zealand (NZ)$ and exclusive of a 15% Goods and Services Tax.[18] In addition, we show in parentheses the cost in US dollar (USD) using a currency conversion rate representative for the study trial period of 0.65 USD to NZ$.

Pharmaceutical Costs

We measured the quantity of pharmaceuticals dispensed to participants within the study period. Because pharmaceuticals incur costs at the time of dispensing rather than consumption, we focused on dispensed pharmaceuticals and note that no change in dispensing patterns was observed over the study period. Pharmac, the government organization that negotiates prices for all pharmaceuticals in NZ, supplied prices through their Community Pharmaceutical Schedule, including all prescription pharmaceuticals and therapeutic products subsidized by the government. Pharmac uses cost-utility analyses to determine and select pharmaceuticals for supply in New Zealand.[19] We aimed to capture the total healthcare costs to society and thus included the total price of the pharmaceuticals regardless of the level of subsidy because when the government only partially funds a pharmaceutical, the remaining cost fall on the patient.

Reimbursements to pharmacies are paid by the local government health authority and include several components.[20] Pharmacies receive a margin on the subsidized portion of pharmaceuticals to cover the procurement and stockholding of pharmaceuticals. A margin is applied based on the total subsidy value amounting to 3% below $150 and 4% including and above that threshold.[20] In addition, a service fee is provided to pharmacies to cover dispensing and handling of all prescribed products. All pharmaceuticals dispensed to this cohort were included in the community services schedule and incurred a fee of $5.35. This was calculated by multiplying the base service fee of $1.01 per dispensed item by the appropriate multiplier of 5.30.

In our analysis, we took into account for each participant the price of each pharmaceutical, the subsidy margin, and the service fee.

Cost of Outpatient Services

We measured outpatient service utilization using data from the National Non-Admitted Patient Collection provided by the Ministry of Health, including national reference pricing lists for purchase unit codes for the 2018-2019, 2019-2020, and 2020-2021 financial years through Official Information Act requests H201806865 and H202008130. We applied these reference prices to the identified outpatient events and adjusted for inflation to 2021$. Pre-admission and emergency department (ED) visits followed by hospital admission were included under hospital admissions.

Cost of Hospital Admissions

All hospitalization days within the 6-month study period were summed for each participant. To price hospital stays, we sourced national prices per Weighted Inlier Equivalent Separations for each financial year from the Ministry of Health and applied them to corresponding admission cost weights.[21]

Cost of ARC

To calculate the total cost of each participant's ARC, we identified ARC admissions during the study period and counted the length of stay up to the end of the 6-month follow-up. Where

multiple admissions took place, their lengths of stay were added up.

The Canterbury District Health Board reported the prices of ARC facilities within the Canterbury district for the 2018-2019 financial year through Official Information Act request CDHB 10075. We used per bed/day prices for rest homes, hospitals, and dementia aged care facilities.

Statistical Analysis

We present descriptive statistics as n (%), mean ± SD, or median (lower quartile to upper quartile). A multivariable log-linear ordinary least squares (OLS) regression model was constructed to estimate the effect of drug burden and frailty on the cost of participants' healthcare, accounting for age and sex. Where costs showed a strong positive skew, they were transformed into a natural log before inclusion.[22] This was done so that high-cost values did not get excessive weight in the analysis but were still included as legitimate data points. We also estimated Tobit regressions that account for the clustering of costs at 0 in a robustness check. All regression models were controlled for sex, age (and age2), and inclusion in the intervention vs control group. In our main specification, we constructed the following regression model with OLS to estimate participant-level costs (in various categories) accumulated over the 6-month follow-up period (C_i):

$$\mathrm{Ln}(C_i) = \alpha + \beta_1 \times \mathrm{DBIbase} + \beta_2 \times \mathrm{frailty} + \beta_3 \times (\mathrm{DBIbase} \times \mathrm{frailty}) + \beta_4 \times \mathrm{age} + \beta_5 \times \mathrm{age}^2\ \beta_6 \times \mathrm{gender} + \beta_7 \times \mathrm{intervention} + \varepsilon_{i;} \quad \text{(Eq. 1)}$$

in which: *DBIbase* denotes the Drug Burden Index at the time of the first assessment, *frailty* is measured by the aforementioned FI (range 0-1), and the *DBIbase* × *frailty* interaction allows for a differential impact of DBI among participants with different frailty.

When estimating the effects of drug burden and frailty on nonpharmaceutical costs (ie, ARC, outpatient care, and hospital admissions combined), we replaced $0 values with $1 so that a logarithmic transformation could be carried out.

Results

Descriptive Statistics

By design, our sample consisted of frail older adults with high pharmaceutical use (Table 1; participant characteristics). We included 338 participants, 225 (65%) of whom were female. Bergler et al (2021)[15] and Jamieson et al (2022)[16] provide a detailed description of this cohort.

During the 6 months of follow-up, 11 (3%) participants were admitted to ARC, 246 (73%) used outpatient hospital services at least once, and 115 (34%) were hospitalized. The related healthcare costs display high variability, and their distributions are positively skewed (Table 2 and Fig. 1). The average cost of ARC for the 11 admitted patients was $12 673 (USD8237). Overall, 246 participants received outpatient hospital services at an average cost of $1418 (USD922), whereas 115 had hospital stays at an average cost of $17 496 (USD11 372). The maximum hospitalization cost was $253 198 (USD164 579). The total cost of prescribed pharmaceuticals ranged from $15 (USD10) to $43 192 (USD28 075). The high maximum pharmaceutical cost is because of 1 patient who was regularly prescribed a pharmaceutical for cancer called lenalidomide, which can cost between $4700 (USD3055) and $7600 (USD4940), depending on the chemical formulation. Similar to most cost categories, pharmaceutical costs had a positive skew with an average of $1160 (USD754).

The combined cost of ARC, outpatient care, and hospital admissions of study participants over the 6-month study period ranged from $0 to $270 266 (USD175 673). When pharmaceutical costs were added, the total costs ranged from $15 (USD10) to $270 681 (USD175 943). The average total cost was $8557 (USD5562), and the distribution was positively skewed. Table 3 details the costs incurred by the 4 patients with the highest total expenditures, whereby in all 4 cases cost of hospital admissions was by far the greatest contributor. When the cohort is viewed in strata incremented by $1000 (USD650) (Fig. 2), the cost for pharmaceuticals shows as the main contributor in the <$1000 (<USD650) stratum.

We analyzed the total cost of health services used by this cohort by summarizing individual costs starting with the lowest-cost and ending with the highest-cost individual and then stratifying the cohort into total cost bins of $1000 (USD650). In Figure 2, we show the resulting Pareto distribution of the cost incurred by this cohort, including a breakdown of the cost type for each stratum. The analysis shows that 4 participants (1.2% of participants; study identifications 360, 183, 64, and 21) accounted for 26% of total costs incurred, and the 15 highest-cost individuals, or 5% of the cohort, accounted for 43% of the total cost incurred. In contrast, 277 participants or 82% of the cohort, incurred individual costs of <$1000 (USD650), contributing just 24% to the total cost.

We then stratified healthcare costs by the level of DBI and the level of frailty to investigate the relationship between DBI, frailty, and associated healthcare costs (Table 4). Higher levels of DBI did not seem to correspond to higher total healthcare costs, whereas higher levels of frailty did. Separating total costs into categories revealed no association between the level of DBI or frailty and ARC costs. A higher level of DBI seemed to be associated with higher outpatient care and pharmaceutical costs but did not correspond with higher hospital admission costs. A higher level of frailty corresponded with higher outpatient care, pharmaceutical, and hospital admission costs.

Regression Analysis

To further analyze the relationships between DBI, frailty, and associated healthcare costs, while controlling for confounders, we utilized regression analyses (Appendices 2 and 3 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2023.11.009). We observed low R^2 values of 0.00 to 0.09 in our

Table 1. Participant characteristics.

Variable at first assessment	Range	Mean (SD)	Median (IQR)
Age (years)	61-98	80 (6.9)	80 (74.51-85.13)
Drug burden index	0.34-5.14	1.19 (0.64)	1.01 (0.70-1.54)
Frailty index	0.02-0.72	0.28 (0.13)	0.27 (0.20-0.35)

IQR indicates interquartile range.

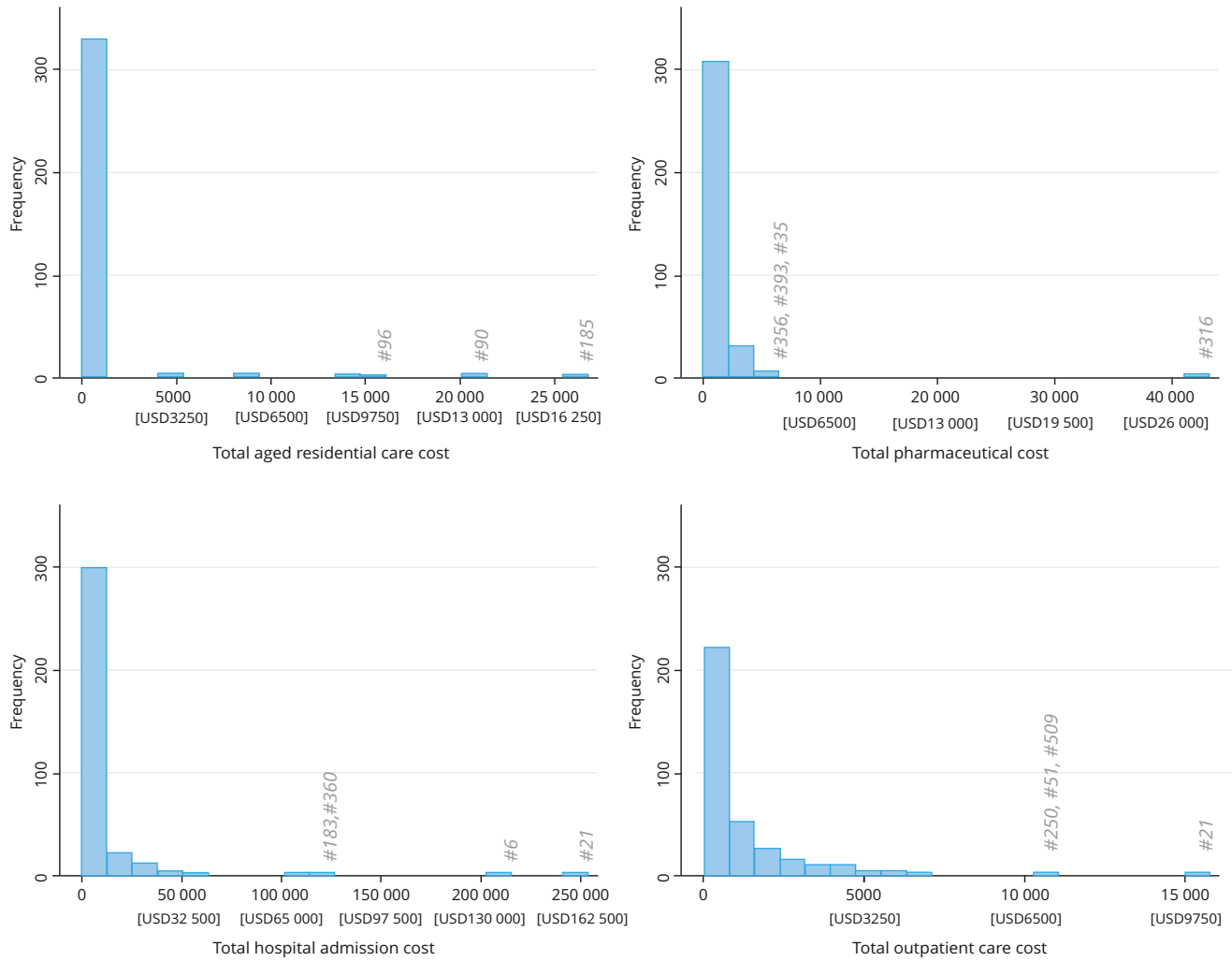
Table 2. Participants' healthcare costs over a 6-month follow-up period, 2021NZ$ (USD).

Cost category	All study participants (N = 338)			Users of healthcare service		
	Range NZ$ (USD)	Mean (SD) NZ$ (USD)	Median (IQR) NZ$ (USD)	n	Mean (SD) NZ$ (USD)	Median (IQR) NZ$ (USD)
Aged residential care	0-26 784 (0-17 410)	412 (2629) (268 [1709])	0 (0)	11	12 673 (7874) (8237 [5118])	14 400 (5184-20 294) (9360 [3370-13 191])
Outpatient services	0-15 772 (0-10 252)	1032 (1749) (671 [1137])	390 (0-1307) (254 [0-850])	246	1418 (1913) (922 [1243])	732 (316-1682) (476 [205-1093])
Hospital admissions	0-253 198 (0-164 579)	5953 (21 275) (3869 [13 829])	0 (0-4204) (0 [0-2733])	115	17 496 (33 680) (11 372 [21 892])	7385 (3909-17 846) (4800 [2541-11 600])
Pharmaceuticals	15-43 192 (10-28 075)	1160 (2470) (754 [1606])	745 (414-1435) (484 [269-933])	338	1160 (2470) (754 [1606])	745 (414-1435) (484 [269-933])
Total cost	15-270 681 (10-175 943)	8557 (23 077) (5562 [15 000])	2109 (756-6951) (1371 [491-4518])	338	8557 (23 077) (5562 [15 000])	2109 (756-6951) (1371 [491-4518])

Note. Accumulated cost in NZ$ over 6 months, starting on the day of the patient's initial assessment; costs stated in NZ$ and converted to (USD) at a foreign exchange rate of 0.65.
IQR, interquartile range; NZ, New Zealand; USD, US dollar.

models, suggesting a low model fit. However, it is important to note that our models studied selected determinants of total healthcare cost in detail rather than trying to include all the determinants of total cost to make predictions. Our models provide inference about a population rather than being predictive of individuals going forward.

Figure 1. Total cost of participants' healthcare categories over 6-month period 2021NZ$ [USD]. Numerical labels identify study IDs of participants with high costs within each category.



ID indicates identification; NZ, New Zealand; USD, US dollar.

Table 3. Participants with the highest costs (2021$).

Study ID	#21	#64	#183	#360
Age (years)	81	80	84	71
Sex	Male	Female	Male	Female
Frailty index	0.27	0.35	0.23	0.47
Cost category	**Participant costs, NZ$ (USD)**			
Aged residential care	1296 (842)	9035 (5873)	14 472 (9407)	0 (0)
Outpatient services	15 772 (10 252)	142 (92)	1833 (1191)	4163 (2706)
Hospital admissions	253 198 (164 579)	207 392 (134 805)	112 941 (73 412)	123 498 (80 274)
Pharmaceuticals	414 (269)	1712 (1113)	1671 (1086)	900 (858)
Total cost	270 681 (175 943)	218 280 (141 882)	130 917 (85 096)	128 561 (83 565)

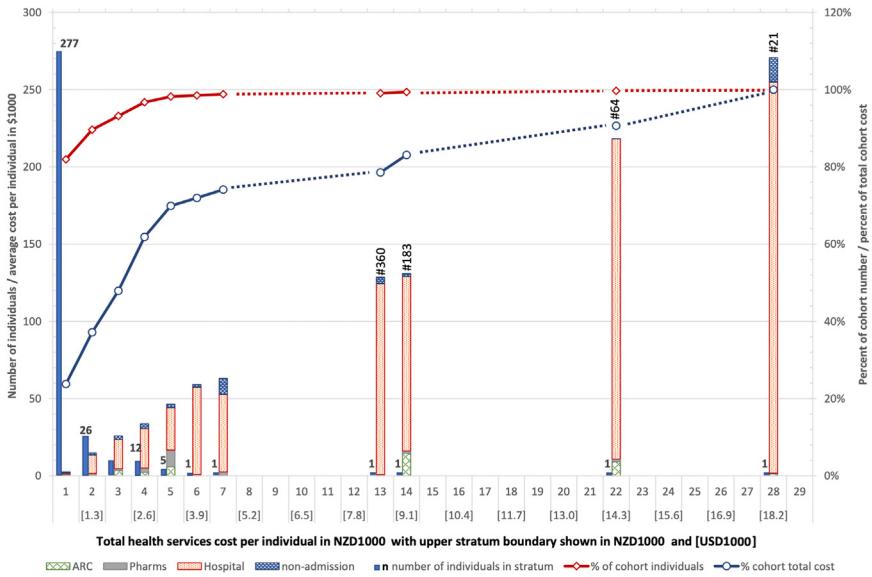
Note. Costs stated in NZ$ and converted to (USD) at a foregin exchange rate of 0.65. Shaded cells represent participants within the top 4 highest costs for a specific cost component.
ID indicates identification; NZ, New Zealand; USD, US dollar.

We found that DBI is associated with higher pharmaceutical costs (Appendix 2 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2023.11.009). One SD higher DBI (0.64) was associated with 18% higher pharmaceutical costs. However, we found no robust relationship between DBI and nonpharmaceutical costs. Frailty was found to be associated with higher healthcare costs. One SD higher FI (0.13) was associated with a 27% rise or $2310 (USD1501) change in total healthcare costs, comprising changes in pharmaceutical costs of 14% ($162; [USD105]) and other (nonpharmaceutical) costs of 46% ($3403; [USD2212]). The evidence for an interaction between frailty and DBI in determining healthcare costs, whether pharmaceutical or other, was weak.

To check the robustness of these results, first a treatment identifier was included as an explanatory variable in our regression analysis to allow for any potential differences in the costs incurred by the intervention vs the control group (Appendix 2 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2023.11.009). Consistent with the null result of the RCT, we found that treatment allocation did not affect the healthcare cost within any regression (*P* value of .16-.99).

Next, we removed the 4 highest-cost patients from our sample and re-run regressions (Appendix 3 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2023.11.009). The results of our OLS regressions remained within respective confidence intervals. The impact of patient characteristics, including the DBI and frailty, became more precisely estimated when we excluded the 4 patients, especially for the Tobit model.

Figure 2. Pareto diagram of cost distribution for the cohort. Bar chart presents cost deciles (by $1000 increments) for overall healthcare costs with portion of costs for each cost category depicted.



ARC indicates aged residential care; NZ, New Zealand; USD, US dollar.

Table 4. Participants' healthcare costs stratified by level of DBI and frailty (NZ2021$).

Cost category	DBI			Frailty		
	Low (0.34-0.84) n = 122	Moderate (0.85-1.34) n = 103	High (1.35+) n = 113	Low (0-0.2) n = 110	Moderate (0.21-0.35) n = 155	High (0.36-0.72) n = 73
	Mean cost (SD), NZ$ (USD)			Mean cost (SD), NZ$ (USD)		
Aged residential care	439 (2506) (285 [1629])	652 (3616) (424 [2350])	165 (1410) (107 [917])	694 (3716) (451 [2415])	246 (1565) (160 [117])	340 (2452) (221 [1594])
Outpatient services	882 (1906) 573 (1239)	1093 (1732) (710 [1126])	1138 (1584) (740 [1.030])	783 (1071) (509 [696])	1054 (2057) (685 [1337])	1360 (1825) (884 [1186])
Hospital admissions	7541 (31 897) (4902 [20 733])	4823 (8485) (3135 [5515])	5268 (13 886) (3424 [9026])	3190 (7533) (2074 [4896])	7211 (28 452) (4687 [18 500])	7444 (16 849) (4839 [10 952])
Pharmaceuticals	874 (835) (568 [543])	1256 (4218) (816 [2742])	1301 (1042) (846 [677])	926 (970) (602 [631])	1209 (3464) (786 [2252])	1286 (1028) (836 [668])
Total cost	9744 (34 189) (6334 [22 223])	7846 (11 259) (5100 [7318])	7923 (14 888) (5150 [9677])	5606 (10 052) (3644 [6534])	9737 (30 601) (6329 [19 891])	10 498 (17 794) (6824 [11 566])

Notes. Costs stated in NZ$ and converted to (USD) at a foreign exchange rate of 0.65. DBI strata separated by 0.5 unit increases from the lowest recorded DBI (as a half unit increase in DBI corresponds to the consumption of 1 medication at its minimum effective dose). Frailty strata guided by Bergler et al (2021)[15] and Jamieson et al (2022).[16]

DBI indicates drug burden index; NZ, New Zealand; USD, US dollar.

Discussion

Our economic evaluation describes the cost of health services delivered to a cohort of older adults in New Zealand. We note strongly skewed Pareto type distribution whereby few individuals account for a large proportion of the total cost incurred. Our results show that 1.2% (n = 4) of participants contributed a disproportionately large part (26%) of the cohort's total healthcare cost primarily driven by the cost of their hospital admissions. Nevertheless, a sensitivity analysis, which removed the 4 outliers with high hospital costs, confirmed our general conclusions.

We also investigated the associations between DBI, level of frailty, and actual healthcare costs. We found that increased frailty was associated with increased healthcare cost, consistent with previous studies, and DBI was associated with higher pharmaceutical costs. However, we found no relationship between DBI and nonpharmaceutical/overall costs. The driver for this DBI-pharmaceutical cost correlation is unlikely to be the costs of anticholinergic and sedative drugs alone because DBI drugs are relatively inexpensive. The association is more likely to reflect a greater number of pharmaceuticals taken overall. Pharmaceutical cost, although being high cumulatively, was, on average, relatively low per participant. However, this means that the potential for cost savings through deprescribing is in most cases rather low. To create cost savings via deprescribing, individuals with higher healthcare utilization offer a more promising potential to do so, although the clinical background behind each case and associated healthcare costs likely differ. To complicate matters further, deprescribing efforts among those patients with presently low healthcare utilization may reduce later high-cost services being required. Therefore, individual cases and associated costs must be considered before conclusions can be generalized. This, in turn, likely requires more involved consultations and thus costly deprescribing interventions.

Strength and Limitations

This study describes the cost structure of 338 frail older adults using anticholinergic and sedative medications. They represent a specific user group of the health system; however, the findings may not apply to older people in general. We used actual, rather than estimated, costs recorded by different government agencies for the 6 months following a person's initial entry assessment into a deprescribing RCT. This ensures consistency and accuracy of our cost data as incurred by society. Our reported costs and cost structures are specific to the New Zealand health system, including government negotiated drug prices, and may mean that findings are not applicable outside New Zealand.

The COVID-19 pandemic and lockdown measures in New Zealand may have affected pharmaceutical dispensing patterns and resulted in delayed entry into ARC for some participants. Although there is no evidence that the RCT providing our data was negatively affected by COVID-19, our cost estimates for these services may still be influenced.[16]

Despite these limitations, the study is important for several reasons; to our knowledge, for the first time, we provide evidence on how the drug burden and the level of frailty affect healthcare costs in contrast to the published literature, where most cost evaluations are completed on a general population of community-dwelling older adults. Furthermore, this cost evaluation was completed from a societal perspective.

Future Direction

This study points toward the need for specific research that is linked to the economic viability and benefits of deprescribing interventions for frail older people. Our analysis shows that the reduction in the cost of medications is unlikely to contribute substantially to the costs related to implementing the intervention. Further understanding the health-economic impact of deprescribing interventions is important. Future research may focus on what cost components are involved in deprescribing interventions and how they may change as a result of deprescribing. This raises 2 research questions: (1) what is the cost of any specific deprescribing intervention already performed routinely in a healthcare setting, and (2) what cost and cost components may be influenced by means of deprescribing interventions?

The costs of residential care and hospital admission are particularly high and may provide substantive room for cost reduction and pose the risk of cost increases. Declining capabilities experienced by frail older people to support their activities of daily

living while in their own home will lead to an increase in ED visits and hospital stays, incurring costs and taking up capacity.[23] This contrasts with settings where older frail people are well supported in ARC settings. Research is suggested to analyze whether incurring ARC costs may bring about better care and less acute treatment needs, thus reducing ED visits and hospital admissions.

Conclusions

The results of this analysis contribute to a better and more detailed understanding of the cost structure in a cohort of frail older adults. Frailty is associated with the cost of healthcare, and drug burden is associated with a high cost of pharmaceuticals. The distribution of cost in all cost categories is skewed, with few individuals contributing disproportionally to the total cost. More research is required to understand how and where to unlock healthcare cost savings within frail, older populations.

Author Disclosures

Links to the disclosure forms provided by the authors are available here.

Supplemental Material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.vhri.2023.11.009.

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