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Decreasing rates of cost-related medication non-adherence by age advancement among American generational cohorts 2004–2014: a longitudinal study

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ABSTRACT

Objectives The access barrier to medication has been a persistent and elusive challenge in the US healthcare system and around the globe. Cost-related medication non-adherence (CRN) is an important measure of medication non-adherence behaviours that aim to avoid costs. Longitudinal study of CRN behaviours for the ageing population is rare.

Design Longitudinal study using the Health and Retirement Study to evaluate self-reported CRN biennially.

Setting General population of older Americans.

Participants Three cohorts of Americans aged between 50 and 54 (baby boomers), 65–69 (the silent generation) and 80 or above (the greatest generation) in 2004 who were followed to 2014.

Intervention Observational with no intervention.

Primary and secondary outcome measures Longitudinal CRN rates for three generational cohorts from 2004 to 2014. Population-averaged effects of a broad set of variables including sociodemographics, income, insurance status, limitations in activities of daily living (ADLs) and instrumental activities of daily living (IADLs), and comorbid conditions on CRN were derived using generalised estimating equation by taking into account repeated measurements of CRN over time for the three cohorts, respectively.

Results The three cohorts of baby boomer, the silent generation and the greatest generation with 1925, 2839 and 2666 respondents represented 12.3 million, 8.2 million and 7.7 million people in 2004, respectively. Increasing age was associated with decreasing likelihood of reporting CRN in all three generational cohorts ($p<0.05$), controlling for demographics, income, insurance status, functional status and comorbid conditions. All three generational cohorts had a higher prevalence of diabetes, cancer, heart conditions, stroke, a higher percentage of respondents with Medicare-Medicaid dual eligibility and lower percentage with private insurance in 2014 compared with 2004 ($p<0.05$).

Conclusion The paradox of decreasing CRN rates, independent of disease burden, income and insurance status, suggests populations' CRN behaviours change as Americans age, bearing implications to social policy.

Strengths and limitations of this study

- ⇒ Nationally representative study sample.
- ⇒ Longitudinal follow-up of cost-related medication non-adherence (CRN) (rare in the literature).
- ⇒ Population-averaged effects of a broad set of variables on CRN using the generalised estimating equation.
- ⇒ A rich set of income, insurance status, and disease and functional status variables for risk adjustment.
- ⇒ Does not have information on change in consumption bundle, such as other discretionary spending over time.

INTRODUCTION

The access barrier to medication has been a persistent and elusive challenge in the US healthcare system and around the globe. A recent national poll indicated that among those currently taking prescription drugs, one-fourth of adults (24%) and seniors (23%) have difficulty in affording their prescription drugs including about one in ten (overall and among seniors) saying it is 'very difficult'.[1] Cost-related medication non-adherence (CRN) measures cost-avoiding behaviours and has seen an emerging body of literature on its prevalence internationally. For example, in a study of adults aged 55 and older living in the community in 11 developed countries, the authors found that the USA had a CRN rate of 16.8%, Canada had the second highest national prevalence of CRN at 8.3%, and Australia followed at 6.8%.[2] Many patients engage in strategies to avoid such costs when facing difficult choices between their medication needs and other basic needs, including delaying filling prescriptions, not filling prescriptions, skipping doses and splitting doses. Many behavioural, social, economic, medical and policy-related factors

have been identified as contributing to medication non-adherence.[3–5] Medication non-adherence is associated with increased hospitalisation rates and emergency department visits, higher mortality rates, worse patient outcomes and increased downstream costs that impose heavy, avoidable healthcare costs on society.[6–11] Hence it is pressing for researchers, practitioners and policymakers to gain insight into the key factors that drive the difference in CRN across population strata.

Among the many risk factors for CRN, age receives little attention even though younger disabled patients have been found to have higher CRN rates among the Medicare population.[12] Age is a complex variable, reflecting multiple dimensions of biological and social factors that can potentially drive up CRN. For example, while older people may have protection from Medicare insurance coverage, including the Part D outpatient prescription drug programme, at the same time they also have lower income and may suffer from multiple chronic conditions that require greater out-of-pocket spending on medications. Thus the tension between their resources and medication needs is comparatively higher. The literature on the effect of the ageing process on CRN is scant, and most reported differences in CRN due to age are examined in the context of cross-sectional studies. These studies make it unclear if the age difference in CRN is due to generational difference (ie, cohort effect) or the ageing process itself and also lack adequate control for the confounding factors. It is important to study the effects of the ageing process on CRN because if older people with fewer economic resources and higher disease burdens report lower CRN rates, ceteris paribus, it may mean they are actually cutting down spending on other basic needs and that therefore social policy may need to be revamped to address this hidden crisis. On the other hand, this is an interesting question about the behavioural change in the ageing process, as it may reflect the change in the assessment of the value of medication (and life) as people progress to more advanced age.

We, therefore, propose to test the hypothesis of changing CRN rates among the older population in the US longitudinally. The longitudinal analysis isolates the cohort effect from its tempering of the age effect, and the broad set of controlling variables (particularly income and insurance variables) further isolate the potential confounding. We used the Health and Retirement Study (HRS),[13] a nationally representative sample of older people (50 years or older), to generate population-averaged effects of age on CRN, controlling for a broad set of sociodemographic, insurance and health variables.

METHODS

Data

Data from HRS from 2004 to 2014 were used for this study. The HRS is a longitudinal panel study that surveys a representative sample of Americans over the age of 50 about their income, employment, health insurance, physical health, functional status and medical conditions.[13] Data for the survey are collected primarily by telephone interview every 2 years. Mortality was recorded if the respondent was deceased during the follow-up.

CRN was measured by asking participants, 'Sometimes people delay taking medication or filling prescriptions because of the cost. At any time since the last interview or in the last 2 years have you ended up taking less medication than was prescribed for you because of the cost?' Participants answered either yes or no, although they had the option to refuse to answer or say that they did not know. For those who refused to answer or say that they did not know, the answer is treated as no CRN was reported.

Cohort creation

We created three generational cohorts of Americans aged between 50 and 54 (baby boomer), 65–69 (the silent generation), and 80 or above (the greatest generation) in 2004, followed them to 2014, and evaluated CRN over time. The reason for creating these three cohorts is to isolate the generational difference in CRN behaviours at baseline, and to compare the trajectory of CRN behaviours in these three cohorts by controlling for other confounding factors. Such a grouping is also consistent with the older population defined by the US Census and policy analysis.[14 15] The narrower band for cohort age further reduces boundary errors among the generations. The reason for the follow-up between 2004 and 2014 is that although the three cohorts experienced the Great Recession starting in 2008, the economy had largely recovered in steady growth by 2014 and hence this period of 10 years provides a clear picture of the trajectory of CRN pre-economic, during and post-economic recession with up to six observations for each correspondent. CRN rates were weighted to reflect the national estimates using 2004 survey weights.

Statistical analysis

Since our data included repeated measurement of CRN on a biannual basis for up to six measures, we developed a generalised estimating equation analysis (GEE) to assess the population-averaged effect of a broad set of risk factors, including advancing age, on CRN, taking into account correlations among repeated observations of the patients, which are quite often unknown.[16] One strength of such an approach is lower variability and thus more efficient comparison, allowing us to detect a difference within socioeconomic strata in a sample with modest size. The GEE model uses a binomial family function, a probit link function, and an exchangeable correlation structure to address the binary outcome variable and correlation among the longitudinal follow-ups of the respondents. There is no particular order effect in the repeated measures in this analysis, as patients can report CRN intermittently, and the research has shown patients are not always persistent in CRN.[17] In this analysis, the value of the age variable increases by 2 years for each respondent for each round of surveys from 2004 to 2014. Our

examination of the population-averaged effect of each risk factor on CRN gives us further evidence about the relationship between age and CRN and about the offsetting effects among other variables held constant.

Covariates

These covariates included the sociodemographics gender, race and ethnicity. Since insurance status has been found an important predictor for CRN,[18] we included a set of indicator variables for those who were enrolled in Medicare, Medicaid, other types of public insurance, private insurance and no insurance in each round of the survey, which changed over time. Enrolment in Medicaid would indicate that they were at the lowest rung of the economic ladder, since Medicaid is a means-tested, state-sponsored public insurance programme for those who meet the poverty level defined by each state. Research has also shown those with Medicare-Medicaid dual eligibility (dual eligible) can have high CRN rates despite the additional insurance coverage, likely due to the fact that those at the bottom of the economic ladder are highly sensitive to the out-of-pocket payment or to non-monetary factors.[19] Hence we included an indicator variable of Medicare-Medicaid dual eligibility in each round. The inclusion of Medicare, Medicaid, Medicare-Medicaid dual eligibility and other insurance status variables will tease out the enabling effect of health insurance on overcoming resource limitations for the poor. Although not all respondents were eligible for Medicare, and a significant fraction of Medicare beneficiaries had creditable drug coverage and did not enrol in the Medicare Part D outpatient prescription drug programme,[20] we included one additional indicator variable for part D enrolment at each round between 2006 and 2014 to further control potential confounding. We further created an indicator variable for the year of 2004 prior to the institution of part D.

We also included two variables on functional status: limitations in activities of daily living (ADLs), and instrumental activities of daility living (IADLs) in each round of surveys.[21 22] These two variables measure the number of limitations in performing tasks such as dressing, bathing, eating, toileting, getting out of bed and walking (ADLs), and preparing meals, shopping, managing money and taking phone calls (IADLs). Research has also shown that functional status is an important factor influencing CRN.[23] We also included a set of comorbid conditions including diabetes, heart disease, stroke, and cancer in each round of surveys. These conditions are known to have high disease burden for patients in terms of both the need for continuous medical care and the high costs of medication treatments.[18]

HRS has a rich set of questionnaires on sources of income and given that many of the elderly are already in retirement and wage income would have been a poor proxy, we first created one variable for total income, including wages, pensions, unemployment benefits, Social Security (SS) income and income from investments and financial assets for each patient (see online supplemental appendix I for a list of sources of income). Because not every income-related variable is measured on a monthly basis, we extrapolated these variables to its annual amount. Because not all respondents reported income (which is common in social science research),[24] we created one dummy variable indicating those who did not report income.

We compared the demographic variables, insurance status and comorbid conditions for each cohort in 2004 and 2014 respectively, using regression analyses. Specifically, the p values were for the parameter estimates of the year of 2014 compared with the year of 2004, with general linear regressions for continuous variables including age and functional status, and logistic regressions for binary variables including disease conditions and insurance status for time-varying variables. For non-time-variant variables including gender, race and education, χ^2 tests were performed.

Finally, to adjust for Great Recession 2007–2009 which may have had a transient effect on CRN, we created an indicator variable for the years of 2008 and 2010 controlling for this secular event during and immediately after the recession. All analyses were weighted using 2004 sample weight to reflect the highly stratified sample design of HRS and draw inferences to the population. The analyses were conducted using Stata V.14 (StataCorp).

Patient and public involvement

No patient involved.

RESULTS

Table 1 shows the demographics, insurance status, functional status and comorbid conditions at the baseline of 2004 and at the end of follow-up of 2014, for the three cohorts (baby boomers, the silent generation, and the greatest generation, with 1925, 2839 and 2666 respondents representing 12.3 million, 8.2 million and 7.7 million people in 2004, respectively). All three generational cohorts had a higher prevalence of diabetes, cancer, heart conditions, stroke, a higher percentage of respondents with Medicare-Medicaid dual eligibility and lower percentage with private insurance in 2014 compared with 2004 ($p<0.05$). There were higher numbers of limitations in IADL among the silent generation and the greatest generation ($p<0.01$) but not in the baby boomers in 2014 compared with 2004. There was an increase in percentage of people who did not report income among the silent generation and the greatest generation from 2004 to 2014 ($p<0.01$), respectively, although the income reported were not statistically significantly different in the baby boomers and the silent generation, and marginally significant in the greatest generation ($p=0.07$).

Figure 1 shows the observed CRN rates and their associated 95% CIs by generational cohorts. There is a downward sloping of trend in CRN rates in each cohort over time despite small bumps in 2010 after the Great

Table 1 Socioeconomic and health characteristics of the study sample

	Age 50–54 in 2004 (Baby boomers)			Age 65–69 in 2004 (The silent generation)			Age 80+in 2004 (The greatest generation)		
	2004	2014	P value	2004	2014	P value	2004	2014	P value
Total N: sample (weighted)	1925 (**12 312 762**)	1750 (**11 243 602**)		2839 (**8 189 832**)	2113 (**6 228 691**)		2666 (**7 709 927**)	**529** (**1 865 348**)	
CRN (% of total)	14.38	10.66	<0.01	8.05	5.31	<0.01	4.64	1.93	<0.01
Demographics									
Mean age (SD)	52.29 (1.29)	62.29 (1.29)	<0.01	66.93 (1.42)	76.90 (1.40)	<0.01	84.56 (3.93)	92.80 (2.61)	<0.01
Male N (%)	5 711 903 (46.39)	5 071 821 (45.11)	<0.01	3 750 730 (45.80)	2 708 071 (43.48)	<0.01	2 865 953 (37.17)	549 748 (29.61)	<0.01
Race									
White N (%)	9 546 207 (77.53)	8 770 743 (78.01)	<0.01	6 721 672 (82.07)	5 145 524 (82.61)	<0.01	6 722 307 (87.2)	1 648 583 (88.8)	<0.01
Black N (%)	1 366 186 (11.10)	1 157 880 (10.30)		730 263 (8.92)	501 363 (8.05)		563 630 (7.3)	123 727 (6.7)	
Other N (%)	457 827 (3.72)	431 097 (3.83)		176 414 (2.15)	143 938 (2.31)		82 439 (1.1)	13 734 (0.7)	
Hispanic N (%)	942 542 (7.66)	883 882 (7.86)		561 483 (6.86)	437 866 (7.03)		341 551 (4.4)	70 304 (3.79)	
High school degree N (%)	10 427 873 (85.58)	9 652 366 (86.74)	<0.01	6 004 735 (73.36)	4 800 912 (77.13)	<0.01	5 104 259 (66.2)	1 382 472 (74.5)	<0.01
Income									
Did not report income N (%)	5 613 276 (45.59)	5 727 345 (46.52)	0.48	3 353 191 (40.94)	4 237 951 (51.75)	<0.01	1 700 631 (22.06)	6 366 197 (82.57)	<0.01
Mean total income (SD)	54 945 (117 001)	55 134 (134 558)	0.51	34 756 (73 000)	30 597 (50 565)	0.49	17 825 (69 859)	23 192 (22 520)	0.07
Health insurance status									
Medicare N (%)	719 451 (5.85)	1 873 388 (16.72)	<0.01	7 725 548 (94.54)	6 080 594 (97.94)	<0.01	7 551 255 (98.27)	1 783 088 (96.82)	0.02
Medicaid only N (%)	802 056 (6.53)	907 830 (8.10)	0.09	761 018 (9.32)	633 493 (10.26)	0.32	741 106 (9.68)	376 197 (20.77)	<0.01
Dual eligible N (%)	262 570 (2.14)	447 280 (4.0)	<0.01	668 917 (8.20)	620 016 (10.04)	0.04	697 373 (9.11)	345 825 (19.09)	<0.01
Private insurance N (%)	9 451 878 (76.76)	8.065,905 (71.92)	<0.01	5 136 278 (62.86)	2 797 509 (45.24)	<0.01	5 025 727 (65.64)	797 828 (44.76)	<0.01
Other public insurance N (%)	442 188 (3.60)	594 505 (5.29)	0.03	582 939 (7.13)	473 038 (7.63)	0.55	387 785 (5.05)	118 750 (6.44)	0.27
No insurance N (%)	1 562 386 (12.70)	1 025 268 (8.34)	<0.01	58 174 (0.71)	18 372 (0.22)	0.05	14 157 (0.18)	17 155 (0.22)	0.03
Medicare part D	0 (0)	599 798 (47.22)	–	0 (0)	2 090 310 (52.14)	–	0 (0)	661 142 (35.62)	–
Functional status									
Activities of daily living N (SD) (dress, bath, walk, eat, bed, toilet) limitations	1.02 (1.91)	1.10 (1.94)	0.14	1.14 (1.96)	1.37 (2.05)	<0.01	1.36 (1.94)	2.19 (2.27)	<0.01
Instrumental activities of daily living N (SD) (meal, shop, phone, money) limitations	0.16 (0.50)	0.20 (0.62)	0.60	0.26 (0.66)	0.41 (0.91)	<0.01	0.85 (1.24)	1.82 (1.65)	<0.01
Comorbid condition									
Cancer N (%)	679 167 (5.56)	1 224 613 (10.98)	<0.01	1 250 817 (15.46)	1 390 602 (22.55)	<0.01	1 601 000 (21.1)	463 700 (25.4)	0.05
Diabetes N (%)	1 593 935 (13.04)	2 510 207 (22.50)	<0.01	1 706 534 (21.09)	1 788 997 (29.01)	<0.01	1 268 614 (16.8)	387 277 (21.2)	0.03
Heart condition N (%)	1 399 076 (11.44)	2 052 001 (18.39)	<0.01	1 939 777 (23.97)	2 184 922 (35.42)	<0.01	3 141 721 (41.5)	897 113 (49.21)	<0.01
Stroke N (%)	310 709 (2.54)	542 715 (4.86)	<0.01	436 577 (5.39)	594 572 (9.64)	<0.01	972 042 (12.8)	392 876 (21.6)	<0.01

The numbers were weighted using 2004 HRS sample weight except the first row representing the sample. The p values were for the parameter estimators of the year of 2014 compared with the year of 2004, with general linear regressions for continuous variables and logistic regressions for binary time-varying variables. For time-invariant variables including gender, race and education, χ^2 tests were performed.
CRN, cost-related medication non-adherence.

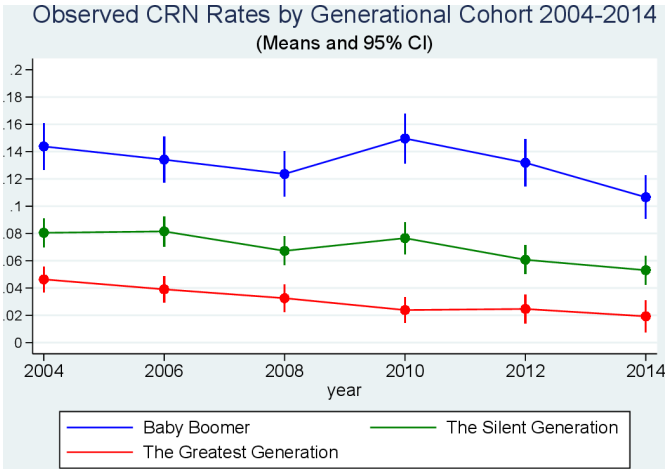

Figure 1 Observed CRN rates by generational cohort 2004–2014. The numbers were weighted using 2004 HRS sample weight. CRN, cost-related medication non-adherence.

Recession. Figure 2 shows the adjusted CRN rates and their associated 95% CIs by three generational cohorts controlling for demographics, health insurance status, disease conditions, functional status and prepart D and great recession indicators. A downward sloping trend in CRN rates prevailed in each cohort over time.

Table 2 shows the population-averaged estimates of age effect along with other risk factors for the three generational cohorts. Since the GEE analyses were based on probit link function and binary outcome, the coefficients can be interpreted as the percentage change in the likelihood of CRN due to a unit of change in the independent variables when the estimates are small. For each 1-year increase in age, the likelihood of reporting CRN decreased 2% (p=0.01), 3% (p<0.01) and 2% (p=0.02) among baby

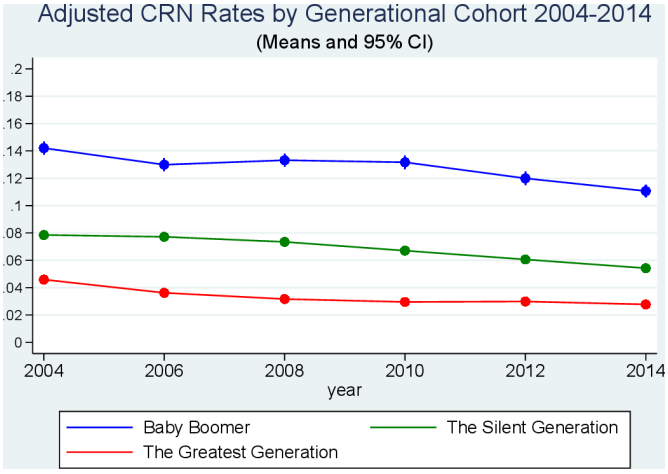

Figure 2 Adjusted CRN rates by generational cohort 2004–2014. The numbers were weighted using 2004 HRS sample weight. The adjusted values of CRN rates were derived from the generalised estimating equations controlling for demographics, health insurance status, disease conditions, functional status, and prepart D and great recession indicators in each generational cohort. CRN, cost-related medication non-adherence.

boomers, the silent generation and the greatest generation, respectively. In addition, women were more likely to report CRN (p<0.01, p<0.01 and p=0.05), respectively; and compared with white respondents, black respondents were more likely to report CRN in all three generational cohorts (p<0.01). Higher income was associated with lower likelihood of reporting CRN among the cohorts of baby boomers and the silent generation (p<0.01, respectively), but not in the greatest generation. There were variabilities among the relationships between CRN and the various insurance statuses by generational cohort, and in general, insurance status was less likely to be statistically significant in the greatest generation. Having diabetes or heart conditions was associated with a higher likelihood of reporting CRN among the baby boomers (p<0.01) and the silent generation (p<0.01), but not the greatest generation. Similarly, a high number of deficiencies in IADLs was associated with a higher likelihood of reporting CRN among the baby boomers (p<0.01) and marginally significant among the silent generation (p=0.09), but not in the greatest generation.

DISCUSSION AND CONCLUSIONS

There was a clear, persistent downward trend in CRN prevalence rates in all three generational cohorts between 2004 and 2014 (figures 1 and 2), despite transient impact by the great recession after 2008. After controlling for other risk factors including gender, race, ethnicity, income, insurance status, comorbid conditions and functional status, ageing was significantly negatively associated with CRN in all three generational cohorts.

Such a steady decrease in CRN rates was accompanied by increasing limitations in functional status in the older age and an increasing prevalence of comorbid conditions, reflecting heightened frailty and disease burden in all three cohorts as they aged. There was an increase in Medicaid enrolment in the greatest generation and Medicare-Medicaid dual eligibility in all three cohorts, which likely provides protection from CRN. However, even after adjusting for Medicaid, dual eligibility and all other insurance variables, there is still a clear pattern of decreasing CRN as the population ages.

This 'paradox' of decreasing CRN rates among old Americans as they age, despite bearing a higher disease burden and requiring a higher consumption of medications along with fixed or decreasing economic resources, seems to be robust, persisting through a series of controls for confounding factors. One possible explanation is that as the population ages and faces a shorter remaining life-span, the value of medication may change, resulting in the population changing their consumption bundle and devoting more resources to medication use. Such a change in their consumption bundle will inevitably constrain their ability to afford other daily needs, such as housing, food and transportation. There is little literature on this aspect of the continued loss of welfare due to longitudinally increasing pressure to pay for medications.

Table 2 Association between age, other risk factors and CRN from generalised estimating equation for generational cohorts from 2004 to 2014

	Age 50–54 in 2004 (Baby boomers)				Age 65–69 in 2004 (The silent generation)				Age 80+in 2004 (The greatest generation)			
	Coef.	p>z	95% conf.		Coef.	p>z	95% conf.		Coef.	p>z	95% conf.	
Age	−0.02	0.01	−0.03	0	−0.03	<0.01	−0.04	−0.02	−0.02	0.02	−0.04	0
Female	0.32	<0.01	0.21	0.43	0.26	<0.01	0.16	0.36	0.16	0.05	0	0.32
White	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Black	0.23	<0.01	0.10	0.36	0.24	<0.01	0.11	0.37	0.41	<0.01	0.20	0.62
Other race	0.04	0.80	−0.25	0.33	−0.10	0.53	−0.42	0.22	−0.53	0.19	−1.32	0.25
Hispanic	−0.10	0.21	−0.26	0.06	0.12	0.17	−0.05	0.28	0.18	0.16	−0.07	0.44
Income	−0.03	<0.01	−0.06	−0.01	−0.05	<0.01	−0.07	−0.03	−0.01	0.84	−0.06	0.05
Not reporting income	−0.28	<0.01	−0.40	−0.15	−0.21	<0.01	−0.32	−0.10	−0.16	0.08	−0.34	0.02
High school	−0.36	<0.01	−0.51	−0.21	−0.13	0.02	−0.24	−0.02	−0.05	0.53	−0.20	0.10
Medicare	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Medicaid	−0.15	0.19	−0.38	0.07	−0.20	0.39	−0.65	0.26	0.35	0.13	−0.10	0.79
Dual eligibility	−0.25	0.07	−0.52	0.02	0.12	0.61	−0.34	0.58	−0.40	0.09	−0.87	0.06
Uninsured	0.27	<0.01	0.09	0.46	0.19	0.34	−0.20	0.57	0.13	0.74	−0.63	0.88
Private insurance	−0.15	0.07	−0.33	0.02	−0.11	0.01	−0.19	−0.02	−0.11	0.10	−0.25	0.02
Other public insurance	−0.16	0.24	−0.42	0.11	−0.42	<0.01	−0.63	−0.21	−0.29	0.13	−0.66	0.08
Part D	0.22	0.04	0.01	0.43	0.10	0.02	0.01	0.19	0.06	0.46	−0.09	0.20
Diabetes	0.35	<0.01	0.24	0.46	0.19	<0.01	0.07	0.30	0.02	0.88	−0.19	0.23
Cancer	−0.03	0.74	−0.18	0.13	0.10	0.09	−0.02	0.21	−0.04	0.63	−0.20	0.12
Heart	0.25	<0.01	0.13	0.37	0.20	<0.01	0.10	0.30	0.11	0.10	−0.02	0.25
Stroke	−0.03	0.83	−0.30	0.24	0.07	0.41	−0.09	0.23	0.14	0.14	−0.05	0.32
ADL deficiency	0	0.93	−0.02	0.02	0.03	<0.01	0.01	0.04	0.01	0.46	−0.02	0.04
IADL deficiency	0.16	<0.01	0.09	0.22	0.04	0.09	−0.01	0.09	0.02	0.60	−0.04	0.07
Before part D	0.04	0.43	−0.07	0.16	0.03	0.64	−0.08	0.13	0.12	0.14	−0.04	0.27
Great recession	0.05	0.16	−0.02	0.12	0.02	0.54	−0.05	0.09	−0.03	0.61	−0.15	0.09

Results from generalised estimating equation with CRN as binary outcome and weighted using 2004 HRS sample weight.
Income was rescaled to US$10 000.
ADL, activities of daily living; CRN, cost-related medication non-adherence; HRS, Health and Retirement Study; IADL, instrumental activities of daily living.

More research is greatly needed to evaluate the adequacy of social policy to help the elderly cope with increasing demand for medications as they age. When CRN was examined longitudinally, one recent study suggested that younger age is a risk factor for persistent CRN.[17] The evidence from this study corroborates the supposition that patients' behaviour may evolve as they age.

In this study, we included all observations of CRN by the respondents regardless of mortality during the follow-up. Clearly there was sample attrition due to mortality for the older generations. Preserving the observations of those CRN respondents who died during follow-up provided a richer data set, reflecting more fully the prevalence of CRN as the population ages. Nevertheless, those who were deceased might have had increased tension between medical needs and other needs for daily living, and future research should be directed at examining coping strategies by the elderly when they are faced with greater certainty of death.

This study is limited by the fact that the HRS does not have data to examine the subjective evaluation of consumption bundles in order to derive the exact cause of decreasing CRN despite increasing disease burden and increased enrolment in Medicaid and dual Medicare-Medicaid. Nor does the HRS allows an exhaustive examination of consumption by goods and services. Future research should be directed to examine these issues and to further illuminate the changing consumption patterns of the elderly. Such changes may be forced on them when faced with exhausting their life savings while their disease burden increases. Further understanding of the coping mechanisms and trade-offs faced by the elderly may have profound implications for social policy that aims to protect them.

CONCLUSION

In summary, we presented a clear case of decreasing CRN rates among three American generational cohorts independent of disease burden, frailty, income and insurance status. This may suggest a hidden gap in social policy as the elderly cope with increased burdens by reducing consumption of other goods and services, which may reduce their overall well-being. More research is greatly needed to understand this phenomenon and improve social policy for our ageing population.

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