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Using administrative data to look at changes in the level and distribution of out-of-pocket medical expenditure: An example using Medicare data from Australia

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ABSTRACT

Objectives: Australia's universal health insurance system Medicare generates very large amounts of data on out-of-pocket expenditure (OOPE), but only highly aggregated statistics are routinely published. Our primary purpose is to develop indices from the Medicare administrative data to quantify changes in the level and distribution of OOPE on out-of-hospital medical services over time.
Methods: Data were obtained from the Australian Hypertension and Absolute Risk Study, which involved patients aged 55 years and over (n = 2653). Socio-economic and clinical information was collected and linked to Medicare records over a five-year period from March 2008. The Fisher price and quantity indices were used to evaluate year-to-year changes in OOPE. The relative concentration index was used to evaluate the distribution of OOPE across socio-economic strata.
Results: Our price index indicates that overall OOPE were not rising faster than inflation, but there was considerable variation across different types of services (e.g. OOPE on professional attendances rose by 20% over a five-year period, while all other items fell by around 14%). Concentration indices, adjusted for demographic factors and clinical need, indicate that OOPE tends to be higher among those on higher incomes.
Conclusions: A major challenge in utilizing large administrative data sets is to develop reliable and easily interpretable statistics for policy makers. Price, quantity and concentration indices represent statistics that move us beyond the average.

1. Introduction

Changes in the level and distribution of out-of-pocket expenditure (OOPE) for health care goods and services have become an increasing focus for both researchers [1–5] and policy makers [6]. According to the Australian Institute of Health and Welfare (AIHW), total health expenditure in Australia in 2013–2014 was $154.6 billion, of which $27.5 billion came from OOPE from individuals [7]. The total OOPE was more than double the $11 billion spent a decade earlier in 2001–2002 [6]. This trend is not unique to Australia; a US study found that OOPE increased by 39.4% per person from 1996 to 2005, and the growth was not evenly distributed across the population [2]. Similarly, a

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Canadian study showed that from 1997 to 2009, OOPE increased for households in all income quintiles, and the relative increase was greatest among households in lower income quintiles [1].

Previous Australian research on OOPE has had to rely on survey data that are periodically collected by statistical agencies [8,9]. Such data are often costly to collect and only provide a series of snap-shots based on self-reported information from people who live in the general community. In countries with universal health insurance schemes, there is scope for estimating OOPE much more frequently by linking individual administrative payments across the entire population. For example, information on health care utilisation and payments are routinely collected under Australia's national health insurance scheme, Medicare, which covers a wide range of medical services. The Department of Health plans to release a linked 10% sample of administrative data from Medicare (more information on the release of those data can be found at www.data.gov.au), which could be used to routinely generate population level statistics on OOPE in the future.

There is also scope to link health records with other information about individuals such as their socio-economic status. The first example of this in Australia was the probabilistic linkage of mental health services used under Medicare to the 2011 Australian census which contains information on household income [10]. However, there are presently no routinely published statistics on the distribution of OOPE across different socio-economic groups in Australia. The development of statistics to quantify inequality, such as those based on a concentration index [11], would enhance an understanding of the distributional impact of changes in OOPE.

The purpose of this study is to demonstrate how indices can be calculated from routinely collected administrative health care data to quantify changes in the level and distribution of OOPE. We illustrate how this can be done for out-of-hospital OOPE using a national representative survey (the AusHEART study) which has been linked over a five-year period to Medicare data at an individual level. In the first half of our analysis we explore how price indices, which have been widely used to track changes in prices of market based goods, can be used to track changes in out-of-hospital OOPE using a representative basket of health care services. The second half of the paper explores the use of concentration indices to measure changes in the distribution of payments across income classes over time.

2. Background

Medicare is a Federal Government-funded universal health insurance scheme which reimburses Australian citizens and some residents [12] for at least part of the cost of a range of out-of-hospital medical services provided by private practitioners on a fee for service basis. The *benefit* a patient receives from Medicare is defined by the Medicare Benefits Schedule (MBS), in which the Government sets the *scheduled fee* for different services [13]. Health consumers can claim 100% of this fee from Medicare as a rebate for general practice (GP) services and 85% of the fee for non-GP services when the services are provided out of hospital [13]. There is no limit on what providers may charge for any service, which means the fee charged can be more than the scheduled fee. OOPE arises whenever the fee charged is above the Medicare rebate. Medical practitioners can also choose to accept the Medicare benefit as full payment for a service (known in Australia as *bulk-billing* [14]). An advantage of bulk-billing from a provider perspective is that it is a way of avoiding bad debts and entails lower administrative costs [15]. Health consumers receiving bulk-billed Medicare services incur no OOPE.

Currently the only routinely published information on OOPE in Australia covers broad categories of medical services (e.g. diagnostic imaging) [16]. The statistics regularly reported for each of these broad categories are: (i) the number of services; (ii) the proportion of services that are bulk-billed (no OOPE); (iii) and the average OOPE for those services where an additional fee was charged.

Using these published statistics, the annual OOPE per person for out-of-hospital services has increased by 75% in nominal terms from $59.60 in 2003 to $104.40 in 2012 and the number of services used has increased from 10.5 to 13.5 during the same period. This rise in OOPE per person could be due to: (i) a rise in the fees charged for existing services; (ii) changes in the level and relative use of services; or (iii) the addition of new items on the MBS schedule.

As we can see from Fig. S1 in Supplementary material, between the financial years 2003–2004 and 2012–2013, there were considerable changes in the average per service OOPE for different categories of services used on the MBS. For example, the average OOPE for pathology services (MBS Item No. 65060-74999) dropped by 55%, while the OOPE for Operations (MBS Item No. 30001-50952) increased by 201%. These changes were due to variations in the rate of bulk-billing, since the bulk-billing trends were very different in different types of services, as well as the fees that were charged above the Medicare rebate. Alongside changes in the average OOPE, there were also changes in the relative quantity of different services. The quantity of operation-related services increased at a much slower rate compared with other MBS categories (see Fig. S1), while the relative OOPE per service increased at a much faster relative rate.

To better understand changes in OOPE and inform policy, there is a need to develop statistics that disentangle changes that are due to the fees charged, from those that are related to the quantity and type of services used. A potentially useful statistic is an index of OOPE which quantifies changes in patient charges over time, in the same way the consumer price index (CPI) tracks general price movements [17]. It is also possible to develop a quantity index that takes into account the relative importance of different types of medical care in terms of their contribution to OOPE [18].

3. Method

3.1. Data

The AusHEART study involved a nationally representative, cluster-stratified, cross-sectional survey in the primary health care setting carried out in 2008 [19]. The GPs who agreed to participate in the study were asked

to provide clinical information on 15–20 consecutively presenting, consenting patients aged 55 years and over, irrespective of their reason for the consultation. All participants were given an option to consent to participate in a second component of the study, in which each participant's health expenditure would be tracked across the next 5 years through linkage with their Medicare number.

The results presented in this paper focus on the Medicare-linked sub-sample (50.1% of the AusHEART participants). To account for the oversampling in rural practices in the AusHEART study [19], weights were generated according to age, sex and remoteness to ensure the sub-sample used in all analyses was representative of the Australian population aged 55 years and over. The method to generate the weights has been described in detail elsewhere [20]. Participants who permanently discontinued use of Medicare services were assumed to have either died or migrated overseas and so were excluded from the analysis for the years in which they had no reported use.

Information collected from the AusHEART questionnaire included participant demographic characteristics, household income and health-related status (smoking, diabetes, cardiovascular disease, kidney disease and self-reported health status). Participants were asked to classify their gross household income into one of seven categories, ranging from negative or nil income to $2000 or more per week. We calculated equivalised income to adjust for differences in household composition by applying the Organisation for Economic Co-operation and Development equivalence weights to the mean of the bounds of the income categories, where a value of 1 was assigned to the head of the household, 0.5 to each additional adult and 0.3 to each child [21].

This study uses Medicare administrative records (including both MBS and Pharmaceutical Benefit Scheme (PBS) data) to report the use of medical services and costs. MBS item number, OOPE and payment type (whether bulk–billed or not) for each MBS record from 1st March 2008 to 28th Feb, 2013 were collected. Attendance services, which are mainly provided by general practitioners, specialists and physicians, were identified items with numbers between 3 and 10948 as *professional attendances* in accordance with the Medicare Benefits Schedule Book [12] and analysed separately as a subgroup.

3.2. Statistical analysis

3.2.1. Price & quantity analysis

A price index is a measure of the average price level based on a basket of goods. Changes in the index allow us to estimate movements in the price over time. As the prices of different goods and services do not all change at the same rate, a price index can only reflect average movements [17]. In this study we employed the Fisher price index which is routinely used to quantify changes in macroeconomic statistics such as movements in consumer prices [22]. We also calculated the Fisher quantity index, which measures the real growth in the use of MBS items per patient over time. The Fisher price index multiplied by the Fisher quantity index represents the ratio of the change in total OOPE [18]. In this study we used this relationship to decompose the per patient OOPE increase into price and quantity changes. More information on the derivation of these indices is contained in Supplementary material.

3.2.2. Equity analysis

We employed the concentration curve and concentration index to evaluate the degree of inequality in the distribution of OOPE spending and quantity of out-of-hospital services from 2008 to 2012 [23]. The concentration curve plots the cumulative percentage of OOPE against the cumulative percentage of the population, ranked by socio-economic status, beginning with the poorest, and ending with the richest [11,24]. In this study, we used equivalised household income as the measure of socio-economic status.

A 45° line of perfect equality reflects a situation in which OOPE or quantity is equally distributed across income. A curve that lies wholly above (or below) the 45° line represents a situation where the expenditure is concentrated amongst those on lower (or higher) incomes. The degree of inequality increases the further the concentration curve is away from the 45° line. The concentration index, which is a relative measure of inequality, represents twice the area between the concentration curve and the line of perfect equality [24–26]. It can range from −1 to 1, with an index of 0 denoting the absence of any systematic correlation, a positive index a pro-rich distribution, and a negative index a pro-poor distribution.

We employed the indirect standardisation method to control for differences in medical need across income groups. We standardised OOPE and quantity of services by need as determined by age, sex, self-reported health and established conditions including diabetes, cardiovascular disease, chronic kidney disease and cancer. The diagnoses of diabetes, cardiovascular disease and chronic kidney disease were collected from the AusHEART study. The diagnosis for cancer was not available in the AusHEART study so we derived an indicator variable for current treatment for cancer using data from the MBS and PBS, including item numbers for chemotherapy, radiation oncology, nuclear medicine procedures and prescriptions for antineoplastic and immune-modulation agents. The detailed method to conduct the standardisation has been documented elsewhere [20]. In brief, we used multiple linear regression to estimate the OOPE/quantity that could not be explained by medical needs for each patient (i.e. the difference between observed and predicted OOPE/quantity), and added this to the average OOPE/quantity of the sample to derive the standardised measures.

3.2.3. Other analyses

We compared the characteristics of the sub-sample for analysis (Medicare-linked sub-sample) with those of the patients in the broader AusHEART study using the *t*-test for the difference of means for continuous variables and the *z*-test for the proportions of binary variables. Annual per patient OOPE and quantity of services were calculated from 2008 to 2012. We compared the changes in the price index for OOPE to the overall CPI to determine how the change in OOPE compares with general price inflation. The 95% confidence intervals for the price, quantity and concentration

Table 1
Annual per patient out-of-pocket expenditure (OOPE) and quantity and Fisher indices[a], out-of-hospital services, 2008–2012.

	2008	2009	2010	2011	2012	Diff. between 2012–2008 (95% CI)	p Value of diff.
OOPE, nominal term							
Total	148.7	144.7	159	168.6	164.9	16.2 (1.0, 31.5)	0.036[a]
Attendance	89.5	91	99.9	105.6	106.6	17.1 (8.7, 25.4)	<0.001[a]
Others	59.2	53.7	59.1	63	58.3	−0.8 (−11.2, 9.5)	0.876
Quantity							
Total (bulk-billing rate, %)	33.1 (85.8)	32.5 (86.5)	33.6 (86.6)	35.0 (86.9)	34.8 (88.2)	1.8 (0.2, 3.3)	0.027[a]
Attendance (bulk-billing rate, %)	15.5 (80.0)	15.0 (80.7)	15.2 (80.3)	15.6 (80.8)	15.9 (81.8)	0.3 (−0.4, 1.0)	0.397
Others (bulk-billing rate, %)	17.5 (91.4)	17.5 (92.0)	18.3 (92.3)	19.4 (92.3)	19.0 (93.7)	1.5 (0.4, 2.5)	0.007[a]
Fisher price index							
Total	1.00	1.01	1.03	1.05	1.07	0.07 (0.02, 0.14)	0.011[a]
Attendance	1.00	1.05	1.11	1.15	1.20	0.20 (0.15, 0.26)	<0.001[a]
Others	1.00	0.93	0.91	0.89	0.86	−0.14 (−0.25, −0.03)	0.019[a]
Fisher quantity index							
Total	1.00	0.97	1.04	1.08	1.03	0.03 (−0.01, 0.09)	0.143
Attendance	1.00	0.97	1.01	1.03	0.99	−0.01 (−0.05, 0.03)	0.526
Others	1.00	0.98	1.10	1.20	1.15	0.15 (0.05, 0.25)	0.004[a]

[a] The Fisher indices were built based on all out-of-hospital services, where bulk-billing services were counted as zero OOPE.

indices were generated by 1000 bootstrapped replications. All expenditures are reported in Australian dollars.

All analyses were conducted using Stata 13.1.

4. Results

A total of 5293 patients consented to participate in the AusHEART study; their characteristics have been previously described [20]. 2653 patients were included in our analysis as the sub-sample for which access to linked Medicare data was available. In comparison to those who were dropped from the analysis, the sub-sample had significantly less females and more people living in regional and remote areas (Table S1 in Supplementary material). The sub-sample was further weighted by age, sex and remoteness to make it comparable to the Australian population (Table S1). Data on PBS usage in 2008 was available for 2400 patients, among whom the weighted proportion of concession card holders was 75.4%.

In nominal terms the per patient OOPE for out-of-hospital MBS services increased between 2008 and 2012 by 10.9% from $148.70 to $164.90, with the increase mainly coming from professional attendance services. The number of out-of-hospital MBS services per patient increased from 33.1 to 34.8, the number of attendance services remained unchanged, and the number of other services increased from 17.5 to 19.0 (Table 1).

Fig. 1 and Table 1 display the changes in the Fisher price and Fisher quantity indices over the five-year period. The total price index, which measures the average price evolution of OOPE for all out-of-hospital MBS services (including both bulk-billed and billed services, with bulk-billed services counted as zero OOPE), increased by 7.3% (95% CI: 2.0%, 13.6%) between the beginning and the end of the study period. This change is slightly lower than, but not significantly different from the 10.4% increase in the Australian CPI during that period. However, decomposing the OOPE into attendance and other services reveals a significant divergence in trends for different categories of MBS services. The price index for attendance services increased by 20.2% (95% CI: 15.5%, 25.6%), while the index for all other services dropped by 14.0% (95% CI: −24.7%, −2.8%). The Fisher quantity index shows there has been no change in the use of attendance services between 2008 and 2012, but a 14.5% (95% CI: 5.1%, 25.2%) rise in the use of other types of MBS items.

Table 2 presents the concentration indices for annual MBS out-of-hospital utilisation and OOPE between 2008 and 2012. Overall, MBS out-of-hospital services were used more frequently by people with lower household incomes, as indicated by the concentration index of −0.07 (95% CI: −0.09, −0.04) in 2012. However, this inequality disappeared after controlling for medical need (age, sex, self-reported health and established conditions) with a need-adjusted concentration index of −0.01 (95% CI; −0.03, 0.01) in the same year (Fig. 2). We further explored income-related inequality in the out-of-hospital utilisation of bulk-billed and non-bulk-billed service. In 2012, for bulk-billed services (no OOPE incurred) the need-adjusted concentration index was −0.04 (95% CI: −0.06, −0.02), compared to −0.10 (95% CI: −0.12, −0.08) for the unadjusted concentration index. For non-bulk-billed services and OOPE, the need-adjusted concentration indices were 0.20 (95% CI: 0.16, 0.24) and 0.22 (95% CI: 0.18, 0.26) respectively, which were similar to the unadjusted indices. Similar patterns of inequality were found when considering attendance and other services only (see Supplementary material).

5. Discussion

This study has explored the change in OOPE of MBS out-of-hospital medical services by calculating statistics that represent changes in both the price and the volume of services as well as the distribution of expenditure across different income groups. The results show that from 2008 to 2012 the per patient OOPE of out-of-hospital medical services increased by 10.9%, which can be decomposed into

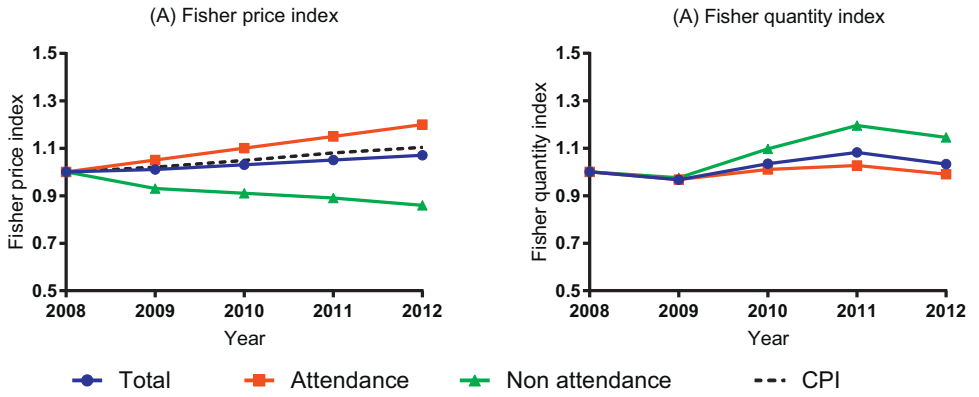

Fig. 1. Fisher price and quantity index for annual out-of-pocket expenditure, 2008–2012. Notes: attendance were identified as with services item numbers between 3 and 10948 (all items under category 1—professional attendances in the Medicare Benefits Schedule Book).

Table 2
Concentration indices for out-of-pocket expenditure (OOPE) and quantity, out-of-hospital services, 2008–2012.

	2008	2009	2010	2011	2012	Diff. 2012–2008 (95% CI)	p Value of diff.
Unadjusted concentration index							
Quantity	−0.08	−0.08	−0.08	−0.07	−0.07	0.01 (−0.01, 0.03)	0.225
Bulk-billing quantity	−0.12	−0.13	−0.12	−0.11	−0.10	0.02 (−0.01, 0.04)	0.125
Non bulk-billing quantity	0.15	0.18	0.18	0.16	0.19	0.03 (−0.01, 0.07)	0.105
OOPE	0.20	0.21	0.23	0.20	0.22	0.02 (−0.03, 0.07)	0.358
Need-adjusted concentration index							
Quantity	−0.02^	−0.03^	−0.02^	−0.02^	−0.01^	0.01 (−0.01, 0.03)	0.367
Bulk-billing quantity	−0.05	−0.06	−0.06	−0.05	−0.04	0.01 (−0.01, 0.03)	0.315
Non bulk-billing quantity	0.16	0.18	0.19	0.17	0.20	0.04 (0.00, 0.08)	0.039*
OOPE	0.18	0.20	0.22	0.19	0.22	0.04 (−0.01, 0.09)	0.133

* Statistically significant at the 5% level of significance.
^ No significant difference from 0 at the 5% level of significance.

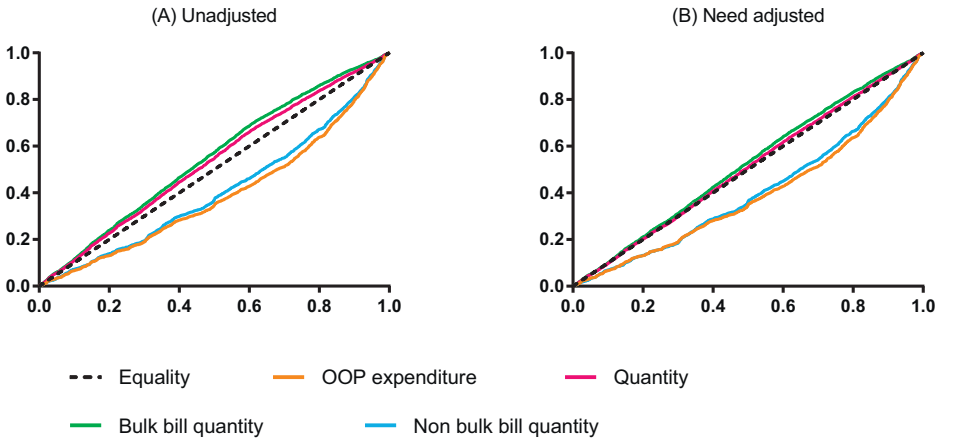

Fig. 2. Concentration curves for annual out-of-pocket expenditure and services in 2012, without and with need adjusted (by age, sex, self-reported health and established conditions including diabetes, cardiovascular disease, chronic kidney disease and treatment for cancer).

a 7.3% price increase with the remainder from increases in the quantity of services used. The price of attendance services increased faster than average, but the use of these services was stable over the period. By contrast, the price of the totality of all other categories of out-of-hospital services declined, but with an increase in the use of these services over the study period. After taking into account differences in medical needs, the utilisation of medical services was distributed equally across different income groups and OOPE was distributed pro-rich indicating that higher income groups paid a higher proportion of above Medicare scheduled fees than lower income groups.

While the AIHW does produce an annual price index for health care goods and services, it only reports changes in the fees for medical services, without separating hospital from non-hospital services or OOPE from the Medicare scheduled fee [27]. Further, the health price index produced by the AIHW is released annually with an 18-month

time lag, which is much less frequent than other price series such as the CPI [28]. These delays make it difficult to use these data for monitoring the impact of policy changes on price and quantity used of medical services.

The former Prime Minister of Australia Edward Gough Whitlam noted in a speech given in the Australian Parliament almost 50 years ago that "one of the problems in discussing health policy in Australia is the lack of reliable official information" [29]. It is not clear why index statistics for OOPE could not be produced in a more timely fashion to allow them to be used in contemporary policy formation. The development and routine reporting of statistics with much shorter time lags (e.g. the consumer price index which in Australia is reported with only a 3 month lag [28]) is central to informing other aspects of government policy (e.g. macro-economic policy settings), as well as generating public debate. It is surprising that while OOPE has received much political attention, such as a recent report by a committee of the Australian Senate [6], there have been no recent efforts to improve the reporting of OOPE statistics in Australia. The increased availability of linked administrative data should enable this to be undertaken using national level data in the near future.

A good example of where a regularly updated index of OOPE would be illuminating is the proposed changes to a previous policy of providing incentives to pathologists to provide bulk-billing services, which would have the effect of reducing the scheduled fees for some items such as MRI services [30]. The regular release of price and concentration indices would enable the potential impact of such changes in policy to be more accurately modelled prospectively. Further the regular publication of price and concentration indices is a way of transparently monitoring the impact of policy changes on the extent as well as the distribution of OOPE across socio-economic groups.

Using the price index we are able to separate the effect of changes in the fees charged from the quantity of Medicare items used. However, like other price indices, our statistics cannot account for changes in quality (e.g. improvement in diagnostic accuracy of tests) and technological change that may produce changes in the items included on the MBS schedule. Quality adjustments for price indices have been previously discussed [31] in the context of goods with a high rate of technology improvement or substitution, such as personal computers [32], apparel [33] and telecommunications [34]. While technological change is unlikely to be a major factor over the period of the few years employed in our study, it is worth exploring the impact of technological change on the OOPE index if it is to be routinely estimated over longer periods.

Several previous studies have explored the equitable distribution of OOPE and health care utilisation in Australia, using self-reported data from the Australian Household Expenditure Surveys and the National Health Surveys [8,9,35]. The results of these studies showed that the direct payment (OOPE plus private health insurance premiums) for the Australian health care system is pro-rich [8,9], which is similar to the results in this study. In this study, we linked the AusHEART survey data with the original MBS records to analyse equity in the utilisation and OOPE of out-of-hospital services. This approach allowed us to include all services in the analysis and avoided uncertainty around estimates of medical use and spending which may arise due to recall bias potentially present in self-reported data. The results of this study show that after adjusting for medical need, although people in different income levels tend to use the same number of total services, people in poor income groups use more bulk-billed services that do not incur an OOPE. This results in OOPE having a pro-rich distribution. Possible reasons include patients from lower income groups seeking out bulk-billing services and providers restricting eligibility for bulk-billing to those with a health-care concession card (which are predominantly from lower income groups). Previous studies have shown that both general practitioners and physicians tend to charge higher fees for their high income patients in the Australian market setting [36,37]. The use of the statistics proposed in this study would facilitate assessment of policy changes on the progressivity of OOPE.

There has been a wide discussion of how large administrative data sets such as those generated through Medicare can best be used to inform research and policy [38–41]. The difficulty in fully exploiting such "big data" often lies in the scatter of custodianship across different institutions and the lack of a national unique patient identifier to link them [42]. In this study, we explored the potential of utilizing large administrative data sets on OOPE analyses with the Australian Medicare administrative data, which generates large amounts of updated health utilisation and expenditure data, covering the entire Medicare eligible Australian population, and can potentially be linked to other data sources (like the AusHEART survey in this case). We have shown that the calculation of indices of OOPE is feasible, and that releasing individual de-identified Medicare data to researchers has great potential value. The routine estimation of a concentration index would however require additional linkage of Medicare data with information on income from sources such as tax data.

This study has several limitations. First, we had to restrict our analyses to out-of-hospital services, because private insurance information is not available in our dataset. To explore OOPE for in hospital services, further linkage is required to determine the degree to which OOPE is covered by voluntary private health insurance. Second, although we have reweighted our data according to age, sex and remoteness to ensure the sub-sample used in all analyses was representative of the Australian population aged 55 years and over, there is a potential overestimation of the health utilisation since the study's mode of recruitment involved patients attending a general practitioner. Finally, we only have information on self-reported income instead of actual income, and this was grouped into categorical bands. Actual income is hard to get as the linkage to income tax records is not available in Australia at this stage.

6. Conclusion

In conclusion, in this study we explored the OOPE of out-of-hospital health services in Australia by linking the Medicare administrative records with a nationally representative health survey-AusHEART. The result shows that

in this broadly representative cohort of older Australians, the amount of OOPE was not increasing faster than inflation between 2008 to 2012, and OOPE tends to be higher among those on higher incomes. Beyond these results, this study has highlighted that when it comes to understanding trends in OOPE, statistics such as price, quantity and concentration indices can provide a much greater degree of insight than the measures that are routinely reported in Australia and in many other countries.

Conflicts of interest

None to declare.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.healthpol.2017.02.003.

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