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Variation in the use of medicines by ethnicity during 2006/07 in New Zealand: a preliminary analysis

Scott Metcalfe, George Laking, Jason Arnold

Abstract

Aim To describe variations in dispensing of specific medication groups by ethnicity in New Zealand, adjusting for health need.

Method Preliminary linkage of dispensings of prescription medicines in 2006/07 to age/disease burden proxies of health need for Māori, Pacific peoples (Pasifika)—who are mostly of Samoan, Tongan, Niuean, or Cook Islands descent—in New Zealand, and non-Māori/non-Pasifika. These disease burden proxies combine differences in prevalence, age, morbidity, and mortality. Variations were disaggregated by patients being first dispensed medicines ('access') versus subsequent dispensings ('persistence').

Results Initially, overall age-adjusted incidence of 'scripts' (prescriptions dispensed) to Māori was similar to that of non-Māori. There were differences in therapeutic coverage between Māori and Pasifika, for example greater use of asthma medicines in Māori.

However, further adjustments linking with disease burden showed marked variance for a number of diseases. Differences in dispensing included areas of high health need such as heart disease, infections, diabetes, mental health and respiratory disease. Māori had 19–37% lower dispensings overall than non-Māori, with a net difference of nearly 1 million scripts.

Māori were both less likely to access medicines, and then after first dispensing had fewer subsequent scripts. Patterns for Pasifika appeared similar, although needs-adjusted analysis is awaited for this population.

Conclusions Once adjusting for need, there was variable but sizeable differences in medicines dispensed to Māori compared with non-Māori, and likely differences for Pasifika populations. There are however important limitations to this preliminary analysis.

Crude and age-standardised metrics may be poor predictors of needs-adjusted gaps in medicines use. In this analysis, solely age-standardised rates tended to underestimate differences once adjusting for burden of disease; future analyses of prescribing patterns should consider better adjusting for disease burden.

The Pharmaceutical Management Agency (PHARMAC)'s statutory role in New Zealand is to achieve the best health outcomes from the use of publicly-subsidised medicines within available funding.[1] The health needs of Māori and Pacific people are an important part of PHARMAC's decision-making criteria, alongside the health needs of all New Zealanders.[2] Assessing health need and identifying medicines usage

patterns for populations can provide evidence of disparities and help inform funding decisions and public health activities.

Disparities between Māori and non-Māori health outcomes, and likewise for Pacific peoples (Pasifika) —who are mostly of Samoan, Tongan, Niuean, or Cook Islands descent— in New Zealand, are known to be both large and persistent over multiple issues.[3–12] However, data specific to medicines use in the community have been sparse. Despite good quality information on health disparities and usage patterns for some individual diseases, information has still been insufficient to rank potential health gains across medicines overall.

Analyses of medicines prescription dispensing rates cannot always address confounding from disease burden,[13] where higher needs would be associated with higher use, particularly aggregating for therapeutic groups overall. Such analyses usually require subanalyses comparing proxies for health need (e.g. mortality or hospitalisation) against individual medicines. This is a large task, given there are hundreds of disease entities and medicines, with large overlaps. Moreover, indicators such as hospitalisation, although more relevant for low-mortality / high prevalence diseases such as asthma, can be biased and confounded (see endnote *).[14]

There has been scope for limited analysis by mapping medicines usage against relevant internally-consistent comprehensive needs data. In New Zealand such data have for the past decade been available from the Ministry of Health's New Zealand Burden of Disease Study (NZBDS), first published in 2001,[15] which quantified years of life lost by the New Zealand population in 1996 from premature mortality and disability across a number of individual diseases. The NZBDS included some ethnic-specific data, using prioritised ethnicity

Similarly, information in New Zealand on national use of medicines subsidised in the community (listed in the New Zealand Pharmaceutical Schedule)[16] has been available, disaggregated by ethnic group, since about 2004, at that time being possible to readily link over 90% of prescriptions dispensed with anonymised age, gender and ethnicity data.

The following preliminary analysis therefore provides an overview of medicines dispensed by prescription volumes, category and population dispensing rates for the financial year 2006/07 in Māori, Pasifika and non-Māori/non-Pasifika populations.

The data take into account both (1) age differences within each ethnic group, (2) indicators of health need that combine historical morbidity and mortality, and (3) breakdowns by patient numbers vs. proxies for concordance/adherence. Results to date have helped inform PHARMAC's policy development for medicines funding and access.

Methods

Prescription data—This analysis used anonymised prescription medicines dispensing claims data for the financial year 1 July 2006 to 30 June 2007 contained in the PharmHouse (now Pharmaceuticals Collection) administrative claims database.[17] The PharmHouse/ Pharmaceuticals Collection database links patient-level dispensing of medicines listed on the New Zealand Pharmaceutical Schedule[16] with demographic data, including age and ethnicity, by encrypted National Health Index (NHI)[18] patient identifier numbers.

Encryption is one-way to ensure confidentiality. Endnotes ťand ‡ provide detail on prescription dispensings data collection, NHI numbers and Practitioner's Supply Orders (PSOs). The analysis excluded those medicines dispensed by health practitioners as PSOs and those prescriptions for individual patients otherwise not recording NHI numbers or where the NHI numbering was inconsistent.

During 2006/07 93% of prescriptions dispensed in New Zealand in community pharmacies had an NHI number recorded in PharmHouse; 31,935,268 prescriptions were dispensed, most being for individual patients (not PSOs) and containing NHI numbers. However 2,402,723 scripts were PSO, did not contain NHI numbers, or NHI-related information was unavailable for gender, ethnicity or valid age. To reflect true patient burden, we scaled the remaining 29,532,545 true scripts for individual patients containing NHI numbers and known gender, ethnicity and valid age, to account for those with missing information; this gave a synthesised total of 31,889,448 scaled scripts, used thereafter in this analysis.

Scaling is described in Appendices 1 and 2 – *see all Appendices at* http://journal.nzma.org.nz/journal/126-1384/5869/Appendices.pdf

Box 1. Method of calculation: total script count

Differences in age-standardised incidence rates (ASRs) allowed us to estimate the numerical gaps in prescription items dispensed to Māori people, given their population size, age structure and disease burden.

- For each indication-based group of medicines, we calculated crude rate ratios (RRs) for prescription items comparing crude scripts per 1000 population in M vs. nMnP, P vs. nMnP, M vs. P, and Māori vs. non-Māori ethnicity. We used age-standardised prescription rates (scripts dispensed per unit time) for Māori and non-Māori to calculate age-standardised rate-ratios (ASRRs) for Māori vs. non-Māori. ASRRs were expressed as the ratio of Māori and non-Māori script ASRs, where 'script $ASRR_{M:nM}$' = Māori script ASR ÷ non-Māori script ASR.
- We calculated disease burden ASRRs for Māori vs. non-Māori rates of DALY losses (DALYLs), 'DALYL $ASRR_{M:nM}$'.
- We then adjusted the M:nM script ASRRs for DALYLs. This gave a M:nM 'disease burden-adjusted $ASRR_{M:nM}$' for each indication-based medicines group, using the formula:

DALYL-adjusted prescription ASRR ($adjASRR_{M:nM}$)

= (unadjusted) prescription $ASRR_{M:nM}$ ÷ DALYL $ASRR_{M:nM}$

- We then estimated the difference in Māori medicines use compared with expected non-Māori usage, after accounting for differences in population size, age structure and disease burden. This involved the following:

  (1) calculating differences between Māori and non-Māori DALYL-adjusted prescription ASRs, as numerical shortfalls / excesses in prescriptions per 1000 population; then

  (2) re-expressing (1) as the proportional difference in adjusted Māori prescription ASRs; and then

  (3) multiplying (2) across the absolute counts of Māori prescriptions,

summarised algebraically as the formulae:

gap (DALYL-adjusted shortfall/excess in prescriptions in Māori)

= $(adjASRR_M - ASR_{nM}) \div ASR_M \times$ no. $prescriptions_M$

= $prescriptions_M \div ASR_M \times [ASR_{nM} \times (adjASRR_{M:nM} - 1)]$

where $ASR_{nM} \times (adjRR_{M:nM} - 1) = (adjASR_M - ASR_{nM})$, and

$adjASR_M = ASR_M \times adjASRR_{M:nM} \div ASRR_{M:nM}$

This preliminary analysis did not calculate confidence limits for ASRs and ASRRs.

We grouped medicines according to clinical indication (based on main usage), using therapeutic groupings in the New Zealand Pharmaceutical Schedule (see Appendix 1).

Scaled counts of scripts for these groups were combined with population data (using population estimates categorised by prioritised ethnicity for the 2006/07 year[19]) to derive ethnic-specific crude and age-standardised incidence rates of scaled prescriptions dispensed (counts of scripts, i.e. prescription items that were dispensed during the year, per 1000 population) for the three prioritised ethnic groups Māori (M), Pasifika (P), and non-Māori/non-Pasifika (nMnP). Similar rates were calculated for Māori and non-Māori ('nM', being P+nMnP).

Linking prescription with disease burden data—We then linked the indication-based medicines groups with relevant disease categories in published burden of disease data for 1996 in the NZBDS.[15] For this we calculated age-standardised rates (ASRs) for disability-adjusted life year (DALY) losses for Māori and non-Māori relevant to indication-based pharmaceutical data, using the year 1996 NZBDS-reported rates of DALYs lost by Māori and non-Māori prioritised ethnicity across its five age-groupings of 0–14, 15–24, 25–44, 45–64, and 65+ years.[15]

The grouper linking indication-based groups with Burden of Disease disease categories is provided in the Annexe to this paper (see http://journal.nzma.org.nz/journal/126-1384/5869/Annexe.pdf). Pharmaceuticals and DALYs were directly age-standardised to Segi's standard world population (as had occurred in the NZBDS), aggregating Segi's 18 5-year age groups into the 5 age group categories reported by the NZBDS.[15]

Gender could not be included in this analysis, as it was not part of the age/ethnic-specific NZBDS 1996 DALY data.

[***Note***: During the production of this paper (in August 2013), the Ministry of Health published the update of the NZBDS for disease burden occurring in 2006.[36,37]]

Differences in the above ASRs allowed us to estimate the numerical differences in scripts dispensed to Māori, given their population size, age structure and disease burden. We used age-standardised rate ratios (ASRRs) for Māori vs. non-Māori for scripts and DALY losses. From these we derived disease burden-adjusted M:nM script ASRRs for each indication-based medicines group.

We then calculated gaps in Māori medicines use compared with expected non-Māori usage. These gaps in effect accounted for differences in population size, age structure and disease burden (as DALYL-adjusted shortfall/excess no. scripts in Māori). Box 1 above details the calculations made.

Access vs. 'persistence'—We estimated the extents to which differential dispensing to Māori could be attributed to access versus 'persistence' (see endnote §). In the context of this analysis:

- *Access* related to differential dispensing to Māori of first prescriptions (index scripts). It was expressed as the variation in numbers of Māori (less or more patients) accessing medicines compared with access in non-Māori after adjusting for population size, age structure and disease burden. We expressed access as the rate ratio of DALYL-adjusted ASRs for 12-month patient period-prevalence ($\text{adjASRR}\mathbf{a}_{\text{M:nM}} = \text{adjASR}\mathbf{a}_{\text{M}} \div \text{adjASR}\mathbf{a}_{\text{nM}}$);
- *Persistence* was the subsequent residual variation in overall numbers of scripts dispensed due to variations in subsequent scripts per index patient, i.e. the individualised frequency of subsequent scripts dispensed to those Māori who had an initial script, expressed as ($\text{persistence}_{\text{M:nM}} = \text{scripts/patient}_{\text{Māori}} \div \text{scripts/patient}_{\text{non-Māori}}$).

Total scripts (prescriptions dispensed) were therefore the product of access (number of patients) and persistence (scripts/patient). This metric of access × persistence was the basis on which we could estimate gaps in dispensing.

The numerical data on prescriptions, patients, and ASRRs allowed us to differentiate between gaps in initial access to scripts and gaps in subsequent persistence with scripts. Gaps with persistence were simply the residual after subtracting gaps in access for total script gaps. Box 2 details these calculations.

Further details of calculation methods are available in Appendix 1, including worked examples.

Box 2. Method of calculation: 'access' and 'persistence'

Numerical gaps in initial access to scripts were calculated similar to gaps in total prescriptions, using the following steps:

1. for each indication-based medicines group, age-standardised incidence rates of index patients dispensed a prescription at any time during the year; notation $ASRa_{M}$, $ASRa_{nM}$, as the unadjusted age-standardised rates of initial dispensing to Māori and non-Māori;
2. then calculating the rate ratio as $ASRRa_{M:nM} = ASRa_{M} \div ASRa_{nM}$,
3. then adjusting for age-standardised DALY losses, as:

access $adjASRRa_{M:nM}$

= (unadjusted) $ASRRa_{M:nM} \div$ DALYL $ASRR_{M:nM}$

4. then using access $adjASRR_{M:nM}$, the age-standardised access rates $ASRa_{M}$ and $ASRa_{nM}$, and absolute counts of patients, to calculate numerical gaps in patients, as:

shortfall/excess $patients_{M}$

= (patient $adjASR_{M}$ – patient ASR_{nM}) ÷ patient ASR_{M} × no. $patients_{M}$

= no. $patients_{M}$ ÷ patient ASR_{M} × [patient ASR_{nM} × (access $adjASRR_{M:nM}$ – 1)]

This was the same as the gap in total numbers of scripts due to access differences (since the ratio of initial scripts to patients must be unity).

Further differences in number of scripts due to variation in subsequent scripts per each patient (persistence) were calculated as the residual, where:

shortfall/excess in subsequent scripts per index patient ($persistence_{M}$)

= overall shortfall/excess $scripts_{M}$ – shortfall/excess $patients_{M}$

Results

Near parity of script counts (prescriptions dispensed) when adjusted for age— During 2006/07 31,935,268 scripts were dispensed in New Zealand, 4,108,107 being PSO scripts and scripts for individuals either without NHI numbers or unknown or invalid age, gender or ethnicity information (comprising 12.9% of all scripts), with non-PSO NHI-containing scripts (including valid gender/ ethnicity/age) scaling to 31,889,448 for this analysis. 3.3 million (scaled) scripts were ascribable to Māori and 1.7 million to Pasifika (detailed in Appendix 2).

These script numbers related to 2.7 million patients with individual NHI numbers, which with scaling for missing NHIs became 2.92 million patients (383,000 Māori, 188,000 Pasifika).

Age-standardised scaled prescription dispensing (script) rates overall for Māori in 2006/07 were 97% of those for non-Māori/non-Pasifika, and for Pasifika were 123% of those for non-Māori/non-Pasifika (Māori 5919.8 scripts per 1000 age-standardised population, Pasifika 7535.8 per 1000, non-Māori/non-Pasifika 6102.1 per 1000). This contrasted with crude 64% scripts overall per capita in Māori compared with non-Māori/non-Pasifika, and 83% for Pasifika compared with non-Māori/non-Pasifika.

The higher usage after adjusting for age is largely explained by the relative youth of Māori and Pasifika; medicine use tends to increase with age and there are proportionately less older Māori and Pasifika (see Appendix 2).

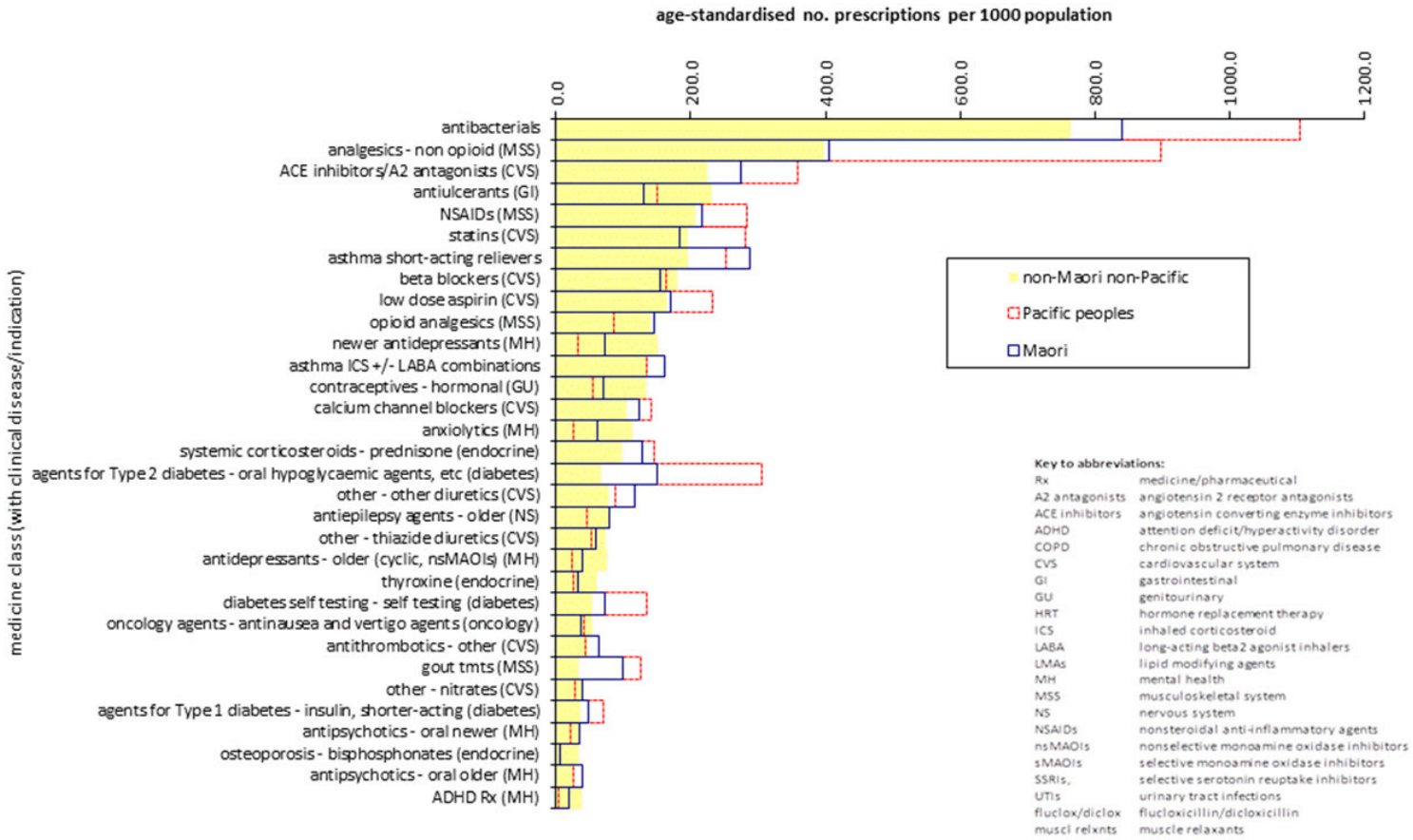
There was a large residual variability in scripts by medicine group after adjusting for age. This was often not obviously related to disease burden. For instance when compared with non-Māori/non-Pasifika, Māori and Pasifika showed lower age-standardised script rates for anti-depressants, contraceptives and inhaled corticosteroids, but higher rates for anti-hepatitis B antivirals, short-acting asthma inhalers, and older and depot injection antipsychotics.

The differences in therapeutic groups between Māori and Pasifika compared with non-Māori/non-Pasifika were not uniform, as can be seen in Figure A3-3 and Table A3-3 in Appendix 3. For instance, Pasifika were dispensed medicines for attention deficit disorder, Hepatitis C infections and older depot antipsychotics at one fifth the rate of Māori.

Asthma medicines and newer antidepressants were relatively under-dispensed in Pasifika compared with Māori. Conversely, Pasifika were dispensed oral hypoglycaemic medicines for type 2 diabetes and blood glucose test strips, older glaucoma medicines, scabies treatments, and hepatitis B medicines at twice the rate of Māori. Māori and Pasifika age-standardised rates were similar for antibiotics, statins, ACE inhibitors, low dose aspirin, and treatments for gout.

All of these features are detailed in Figure 1 below and in Appendix 3, including tables and further graphs.

Figure 1 Age-standardised prescription dispensing (script) rates 2006/07, by major ethnic group, for leading medicines groups (defined by prescription dispensing volumes)



Lower script counts for Māori when adjusted for health needs—Mapping the NZBDS disease categories to medicines listed on the New Zealand Pharmaceutical Schedule, in order to partly relate medicines use to disease impacts ('health need'), it was possible to link 85% of 2006/07 scripts (prescription dispensings) to relevant NZBDS disease groups. Accordingly, coincidentally 85% of DALY losses in 1996 appeared to be for diseases treatable or preventable by medicines on the Pharmaceutical Schedule.

Hence in 1996 perhaps some 480,000 disability-adjusted years of life (DALYs) were lost by the New Zealand population from diseases treatable by medicines on the Pharmaceutical Schedule (out of 563,000 DALYs lost overall for all diseases)—see Tables A4-1 and A4-2 in Appendix 4.

The generally higher use of medicines by Māori and Pasifika than non-Māori/non-Pasifika must therefore be seen in the context of these populations having general higher health needs. Details of these higher health needs for Māori can be found in Appendix 5.

For conditions treated or prevented by medicines on the Pharmaceutical Schedule, differences in burden of disease could be linked to differences between Māori and non-Māori dispensing rates (see endnote **). This mapping suggests that although total Māori script counts were comparable with non-Māori after adjusting for age, actual dispensing for Māori was much lower than needed to overcome their greater disease burden.

Hence, although Māori in 2006/07 had 97% age-adjusted script counts relative to non-Māori, after further adjusting for historical 45% higher relative DALY losses in Māori this ratio fell to 81% of what it would be for non-Māori.

Moreover, after excluding medicines not covered by the NZBDS diseases the ratio fell further to 63%. Māori had therefore 19–37% lower treatment rates compared with non-Māori (conversely, rates in non-Māori being higher).

The total scripts known to be dispensed to Māori in 2006/7 (excluding PSOs and those otherwise without NHIs, but scaled) was 3.3 million (as stated above), of which 2.7 million linked with NZBDS diseases.

The overall gap in scripts to Māori after standardising for age and adjusting for historical burden of disease amounted to 977,400 fewer scripts. Most medicines had shortfalls rather than excesses. Key shortfalls are summarised in Table 1.

Table 1. Shortfalls in Māori age/DALY-adjusted script counts

Medicine	Shortfall*	Comments
antibiotics	181,500	NZBDS categories of bacterial infections, of which 89,100 for amoxicillins
antiulcerants	60,500	principally 54,300 for proton pump inhibitors (PPIs); may reflect inappropriately high antiuclerant use in non-Māori
statins	53,100	cardiovascular risk (dyslipidaemia); principally simvastatin (45,400)
beta blockers	52,900	primarily for cardiovascular risk and disease
ACE inhibitors/A2 antagonists	48,800	cardiovascular risk and disease, including diabetes
newer antidepressants	46,300	principally selective serotonin reuptake inhibitors (SSRIs) (41,600); also venlafaxine, selective MAOIs
low-dose aspirin	40,100	cardiovascular risk
inhaled corticosteroids ± long-acting beta agonists	22,600	asthma
oral hypoglycaemics	21,300	primarily cardiovascular risk (type 2 diabetes)
diabetes self-testing	19,200	self-management of types 1 and 2 diabetes

*Shortfalls are the differences between actual script counts in Māori and numbers expected were Māori to have the same dispensing as non-Māori, after adjusting for population size, age, and disease burden.

'Access' and 'persistence' similarly less in Māori—Almost half of the above calculated 'need'-adjusted gap in prescriptions dispensed was due to fewer than expected Māori patients accessing medicines (443,900 absent initial dispensings). We estimated access in Māori to be 67% that of non-Māori. The biggest gap from reduced access was for amoxicillins.

The remainder of the gap was due to lower Māori persistence‡ with medicines (533,500 absent subsequent dispensings). Persistence in Māori was calculated as 58% of that in non-Māori. The biggest gaps from reduced persistence were for beta-blockers, PPIs, simvastatin, low-dose aspirin for cardiovascular risk, and SSRIs.

Conversely, the calculated overall difference in scripts for non-Māori (age and disease burden-adjusted) amounted to at least 12.2 million more scripts.

In summary, access and persistence contributed on a similar scale to apparent under-dispensing to Māori. Note however that there were appreciable differences between medicines in the mix of access and persistence. This included examples such as the newer antipsychotics, in which large proportionate shortfall in access was masked by proportionately lesser shortfalls in persistence.

These features are evident in the following graphs (Figures 2 to 5) and are detailed in Table A6.2 in Appendix 6.

To explain Figures 2–5:

- Figure 2 shows shortfalls and excesses in scripts for Māori compared with that expected for non-Māori. This reveals the therapeutic areas suggesting the largest gaps in dispensings.
- Figure 3 shows proportional shortfalls and excesses. This suggests the therapeutic areas with the most divergence in clinical practice from what would be expected in non-Māori, as Māori rates relative to non-Māori. (The data are on a logarithmic scale, so that shortfalls and excesses are distributed symmetrically about a relative rate of 1 (unity), which is the zero line; further explanation is in endnote ‡‡.)
- Figure 4 suggests numerical shortfalls and excesses broken down by access and persistence. This shows these two factors' variable contributions to differential dispensing.
- Figure 5 shows proportional shortfalls and excesses, broken down by access and persistence. As with figure 3, this suggests the therapeutic areas with the most divergence in clinical practice from what would be expected in non-Māori, as Māori rates relative to non-Māori, but then shows how much is due to differences in access versus differences in persistence. (Again as with figure 3, the data are on a logarithmic scale, see endnote ‡‡).

Figures 2 to 5 also include disaggregating of the category 'NSAIDS/gout/analgesics/ muscl relxnts' into component 'Rx for hyperuricaemia & gout' and 'NSAIDS + muscle relaxants' subcategories.

Figure 2. Numerical differences in script counts for Māori compared with non-Māori, adjusted for age and historical burden of disease

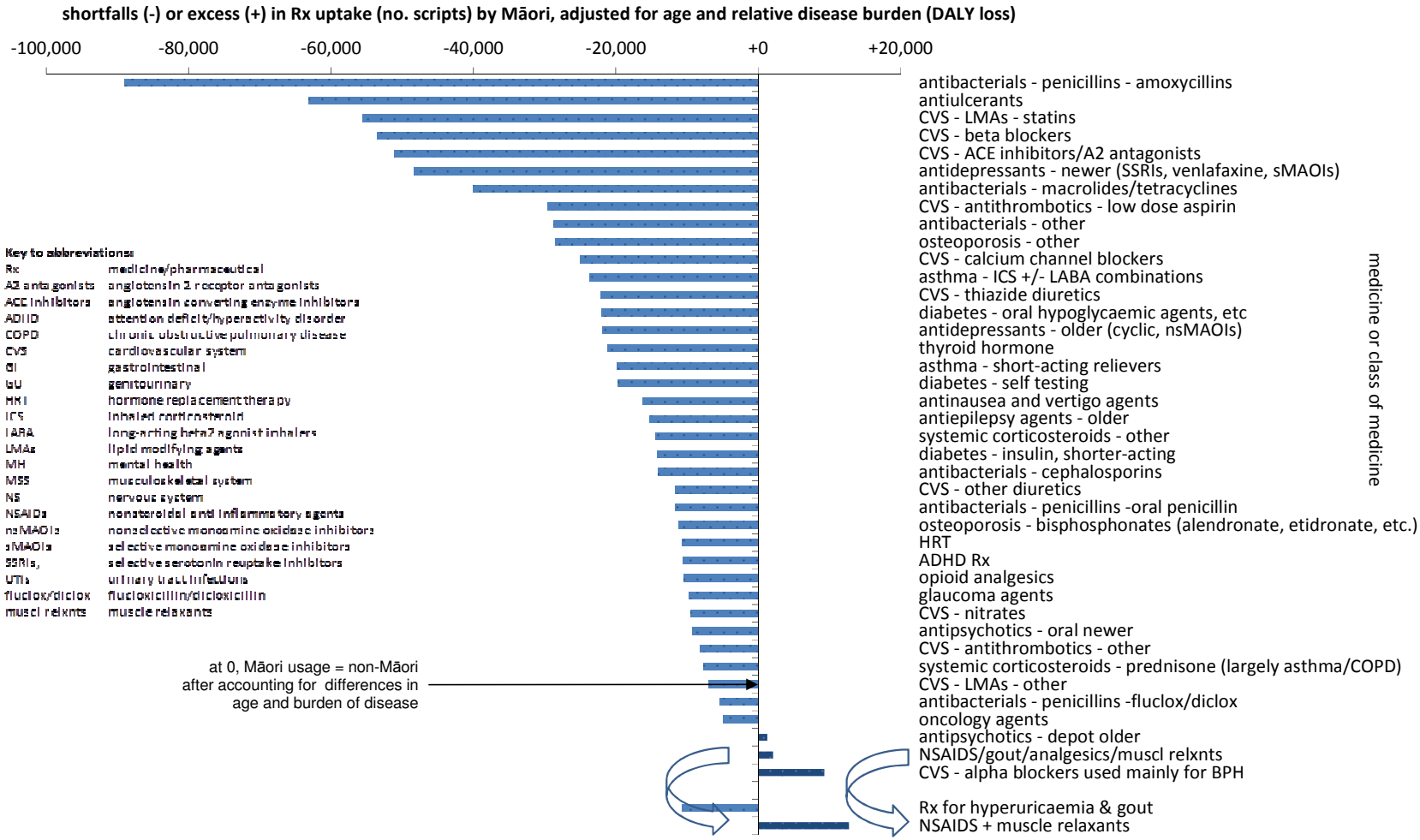


Figure 3. Proportional shortfalls and excesses in script counts for Māori compared with non-Māori (rate ratios), adjusted for age and historical disease burden

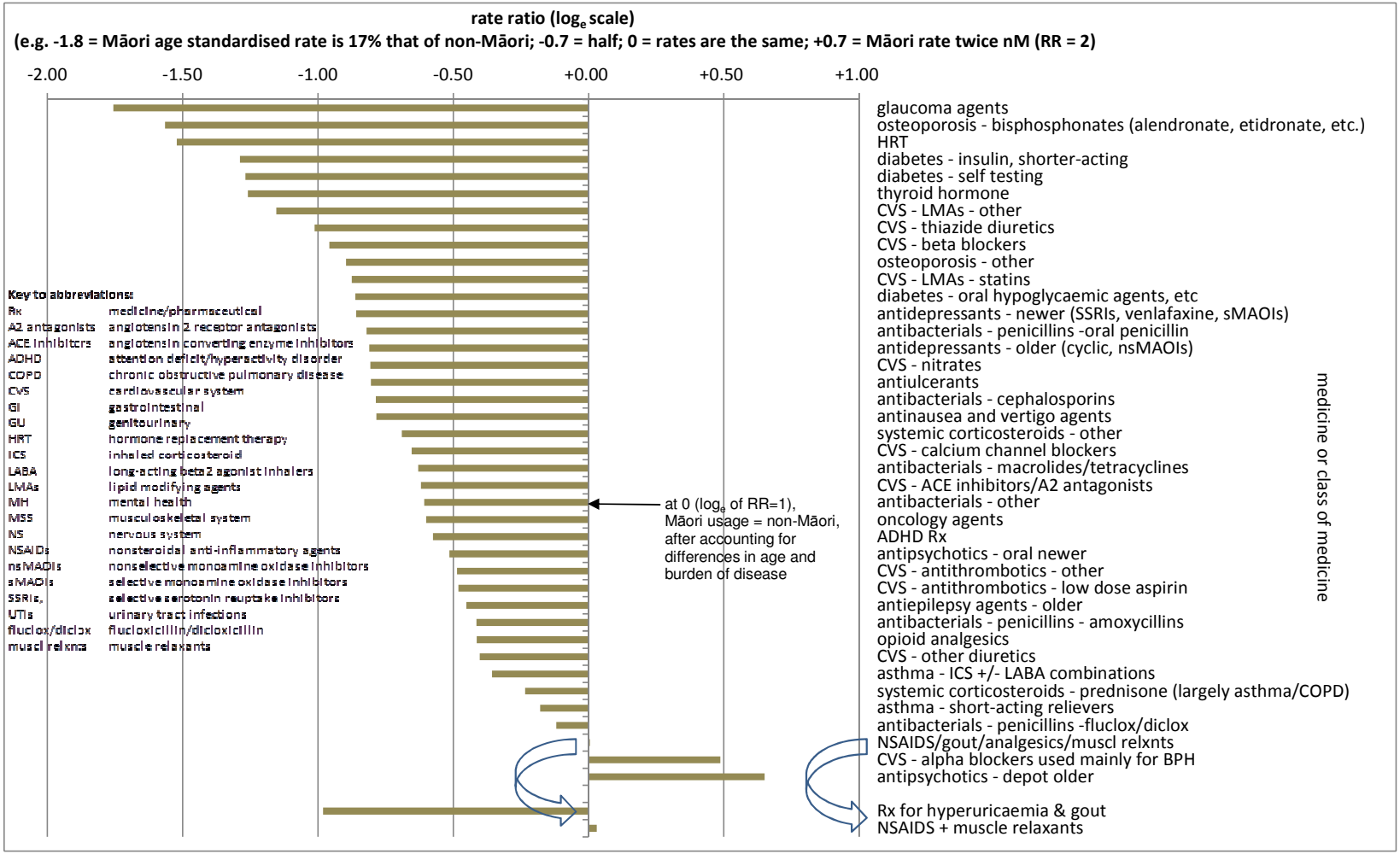


Figure 4. Numerical differences in script counts for Māori compared with non-Māori, adjusted for age and historical disease burden, disaggregated by access and persistence

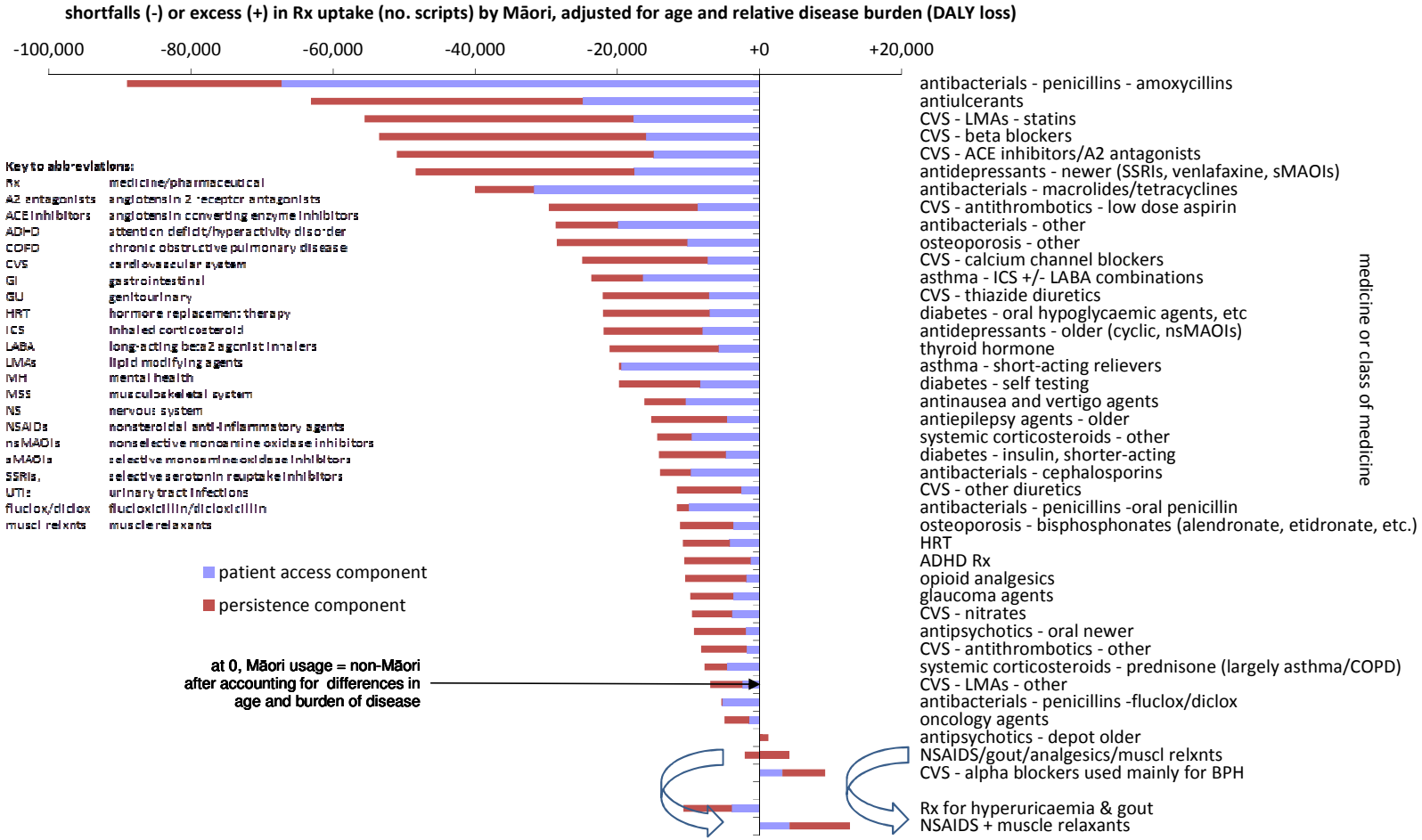
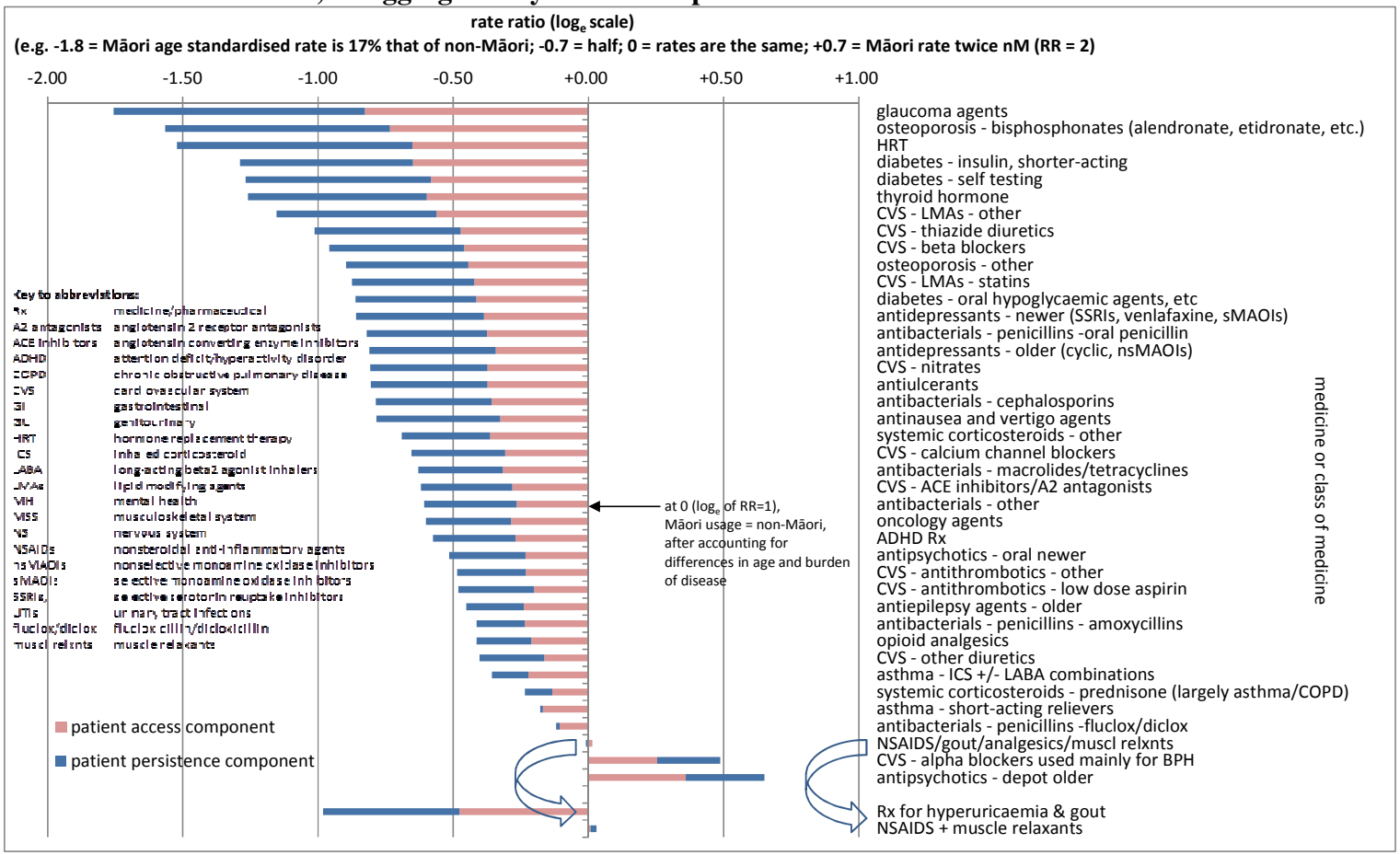


Figure 5. Proportional shortfalls and excesses in script counts for Māori compared with non-Māori (rate ratios), adjusted for age and historical disease burden, disaggregated by access and persistence



Discussion

This analysis links patient-level script count data with population-based estimates of health need. This method can give at best broad indications of trends, for what are complex issues. Interpretation of the results may change after more detailed analysis of individual issues. The ability of access to counteract persistence (as seen with some antipsychotics) is an example of more complex effects that may be lost in population-based data.

Even so, this work reveals a potentially significant issue with likely differences between ethnic groups, and hence potential for health gain or reduced wastage once shortfalls and excesses are addressed. This is apparent in a majority of disease and disability states, and begs the question of suboptimal or excess treatment elsewhere.

Limitations and caveats—There are however important limitations and caveats with the analysis:

- Scripts dispensed are not the same as medicines prescribed. There is evidence that many prescriptions are either not presented or not collected at pharmacies. Reasons for this may include time, cost and transportation. Such factors can affect populations differentially.

  Māori are more likely to have uncollected prescriptions, their non-collection rate being 45% higher than that of non-Māori aged over 15[20,21] (where this statistic stems from 2006/07, when minimum co-payments for the first 20 items were $3 per item; this has since risen to $5). It is not possible to tell from this analysis the extent that failure to dispense represents a systematic failure to prescribe or a systematic failure to ensure that prescriptions are filled. However, this feature may appreciably understate true gaps.

- Dispensing data are restricted to those prescriptions and patient groups that gain subsidies for publicly-funded community dispensed medicines. The data therefore exclude prescriptions that were not subsidised, or items that fell below the $3–$15 prescription co-payments at that time, where pharmacies would have no need to claim (and hence would not be captured in the PharmHouse claims database data). Non-capture of unclaimed medicines use might undercount appreciably overall medicines use and potentially understate gaps in in populations with poorer access to medicines.

- Script counts are an imprecise measure of coverage (days) that medicines are actually provided, being confounded by dispensings/script rates and duration (days' coverage) of dispensings. With scripts versus dispensings, people living in rural areas tend to get longer dispensings (e.g. 3 months, where 1 month would be standard in non-rural setting). Hence, to the extent that Māori are overrepresented in rural populations, the gaps may be overstated to an uncertain extent.

- Some PSOs may be used for targeting populations with poor access to medicines. PSOs are more commonly used in rural areas, where the nearest pharmacy may be some distance, and for certain types of medicines, such as antibiotics. PSOs understate true numbers of people receiving medicines, which may mean gaps are overstated to some extent.

- Gaps in script counts do not necessarily equate with gaps in disease burden and capacity to benefit from effective medicines treatment. Population health gains (expressed for example as quality-adjusted life years (QALYs) gained) reflect not only numbers of patients and script frequencies per patient, but also the effectiveness of medicines in relation to patients' health needs. Hence gaps in health outcomes from patients receiving less medicine are not necessarily the same as gaps in script counts.
- Linking between script counts and diseases can be imprecise where medicines have multiple clinical indications or disease burden covers a broad range of diseases. Problems linking medicines to single disease groups may have important effects on the analysis' results.

  If these factors were to cause bias that is non-differential, such imprecisions from linking could tend to understate true differences in disease burden-adjusted prescriptions. However, this is not a given; it is possible that differential bias could occur, for instance understating of shortfalls in for one disease category meaning falsely ascribing shortfalls in another disease category, which could overstate net true differences.

  An example of probable non-differential bias within a disease category (understating true differences) is that of gout and other musculoskeletal conditions. Medicines for gout (e.g. allopurinol) are bundled into wider NSAIDS etc., because the 1996 NZBDS data combined a number of musculoskeletal conditions, meaning the high excess disease burden for Māori for gout (e.g. their age-standardised hospitalisation rates in 2006/07 being 6–7 times that of non-Māori)[22] was diluted by other musculoskeletal diseases and hence relative disparities were muted. Overall, Māori had a small observed shortfall of DALYL-adjusted scripts for musculoskeletal diseases (-2,000), but this may well have been due to a large shortfall for allopurinol etc. for gout (-10,700 scripts) masking a similarly-sized excess for NSAIDs (+12,700).

  Conversely, an example of the potential for differential bias across disease categories (potentially overstating net true differences) is that of carbamazepine and sodium valproate, which are anti-epilepsy medicines. In the analysis, these were matched to the NZBDS Epilepsy category, and there was a shortfall of 5,900 scripts for Māori (out of 208,900 total scripts). However, carbamazepine and sodium valproate are also commonly used for the control of bipolar disorder, inter alia.

  The lifetime prevalence of bipolar disorder in Māori is double that of the overall population,[23] so it is possible that the shortfall for Māori in the Epilepsy category was understated, and the shortfall for Māori in the NZBDS Mental Health category was overstated, to a greater extent than non-Māori. Such possibilities highlight the impact of mismatching of medicine dispensings and disease categories.

  More specifically, the broad scope of this preliminary analysis does not allow more detailed review of antibiotic use for discrete issues, e.g. the high incidence of acute rheumatic fever in Māori children,[11] which relates specifically to childhood penicillin and amoxicillin use in the treatment of

acute pharyngotonsillitis (sore throat)—where these medicines also treat many other childhood infections.

- Age-standardised rates and rate ratios are aggregates that can obscure wide variation across age groups. This become particularly important where data are missing (e.g. from prescriptions that lack NHI numbers including PSOs), with the potential to mis-state true gaps.

  For example, with the amoxicillins (amoxicillin, amoxicillin clavulanate) there was a shortfall of 89,100 scripts for Māori. Much of that shortfall occurred in children aged 0–14 years, whose relative rates were substantially lower than for older age groups. However, 13% of scripts for amoxicillins did not have NHIs and could in theory all have been on PSO (being double the average 7.5% for scripts overall on PSO).

  If, radically, the many amoxicillin scripts without NHIs were for all Māori children and these in turn had the same relative rates as for older patients, then the shortfall for amoxicillins for Māori children would halve and the overall gap (all ages) would be only 1/5th lower than non-Māori (53,200 script gap). Details including component calculations can be found in endnote ĩĩĩ.

  Amoxicillins accounted for 11% of all non-NHI scripts (204,762 scripts without NHIs numbers, out of 1.6 million amoxicillin etc. scripts and 2.4 million scripts without NHIs), so these medicines are an important part of this information gap.

- Analysis is unavailable for Pasifika. The available Ministry age-specific analysis by ethnic group was confined to comparing Māori with non-Māori, and other relevant disease burden analysis (Ministry of Health 2001b[3]) provided insufficient detail to enable age-specific and age-standardised disease burden estimates for Pasifika, Māori and non-Māori/non-Pasifika. Pasifika people have needs and underuse at least equal to Māori (see Appendix 3), with two consequences:

  Important gaps need to be identified and quantified for Pasifika too;

  Māori vs. non-Māori comparisons if anything may understate the extent of Māori underuse once adjusted for need, as by including Pasifika in the non-Māori group this may dilute the relative effects for Māori.

  Such deficiencies should be addressable in the Ministry's forthcoming updates of the NZBDS.

  [***Note***: The August 2013 published update of the NZBDS[36,37] has not included separate results for Pasifika, only comparing Māori with non-Māori.]

- The use of disease burden estimates based on mortality/morbidity data from 1996 to compare with prescription volumes a decade later may overstate absolute health need, as mortality and morbidity would be expected to have improved overall over that decade (as was certainly the case for life expectancy at birth[24]) but affecting some diseases more than others.

  Such improvement[24] may be due in part to increased access to some medicines since the mid-1990s (e.g. statins), or some medicine classes or medicines or

formulations (e.g. low dose aspirin) subsidised in 2006/07 not so during the mid-1990s, aside from other causes.

In broad terms, this overstating of need a decade later may be substantial, by a factor of 1/10th to 1/3rd overall (see endnote §§), and the extent that individual diseases' burdens had improved is not known. This bias, mismatching medicines use with variably changing needs, would be best addressed by concurrent prescription volume data and burden of disease estimates.[36]

- Analyses that relate medicines utilisation with health outcomes, e.g. using separate hospitalisation and pharmaceutical utilisation databases, are cross-sectional and ecological. Although these can suggest relationships, they cannot adequately resolve causal association. Longitudinal analytical methods, e.g. using linked datasets, can better resolve causation. However, they also are prone to errors such as confounding and selection bias.
- Results can be difficult to interpret without wider contextual information and deeper analysis. Adjusted differences between ethnic groups' medicines use are descriptive only; they can reflect shortfalls in use of needed treatments in one group, excess use of inappropriate treatments in the comparator group, or combinations of these. For instance, for some medicines, low DALYL-adjusted relative dispensings may suggest suboptimal access by Māori, but could equally be due to excess use in non-Māori compared with recommended ideal usage levels, or patient characteristics aside from broad age and disease burden; a number of similar ambiguities are possible.
- Observed associations between dispensings and those disease burden (DALY) measures that incorporate hospitalisation outcomes will probably be subject to confounding from other factors. There are multiple factors leading to hospital admissions, for reasons beyond the simple availability of medicines (endnote *). Relevant factors occupy several different domains, including socio-economic, cultural, and behavioural. This may however not substantially affect the results.
- The NZBDS DALYL estimates for 1996[15] discounted annually at 3%, consistent with the methodology used by the original Global Burden of Disease Study.[25] More recent convention (including with the updated NZBDS)[36] is to not discount future DALYL; PHARMAC's own assessments of health need[26] do not discount future years lost (as distinct from discounting future life years gained in cost-effectiveness analyses, consistent with conventional health economic assessments[27]).

  The discounting of the 1996 DALYLs has two effects:

  1. Patterns of relative absolute disease burdens (total DALYL) across diseases will be distorted by understating disease burden for those diseases with higher proportions of DALY losses occurring later, which especially occurs where premature mortality (high years of life lost, YLLs) dominates DALYL;
  2. Consequent DALYL ASRRs$_{M:nM}$, affecting gap analysis (script differences) and thus consequent rankings, will be distorted for those

disease states where DALYL in Māori occur at quite different times than for non-Māori, especially understating where YLL is particularly high in Māori (where discounting mutes these greater YLL differences).

These disparate effects are best addressed by not discounting DALYL estimates. However this feature is not thought to substantially affect the results of the analysis.

- To prevent numerator-denominator mismatching, ethnicity in all three settings (Pharmhouse prescription data, NZBDS DALYL and population denominators[15]) used ethnicity coded by the 'prioritised output' system adopted by Statistics New Zealand (see endnote ***). Problems with prioritised ethnicity, which Statistics New Zealand no longer supports (recommending since 2004 against its use) nor provides publicly, have been well summarised in the *Journal*.[28] Effects on the analysis' results are difficult to gauge.
- Scaling produces small distortions in absolute script numbers (overall 13% increase), although underlying patterns are unlikely to be affected appreciably.
- Segi's standard world population was used as reference population for age-standardisation, not alternatives such as the World Health Organization (WHO) world population or New Zealand census populations. Used by the original NZBDS[15,3] (and hence a requirement for this analysis), Segi's standard population is younger and hence closer to the Māori population structure, whereas the WHO world population is older and closer to the non-Māori population.[29] This however is unlikely to appreciably affect the results.

  [***Note***: The NZBDS 2013 update[36,37] uses the WHO world population as its reference population for direct age standardisation.[37]]
- Medicines persistence is a systems measure comprising many components, including disease severity, differences in numbers of dispensings per script and/or days' coverage, access to affordable comprehensive ongoing medical and pharmacy care in order to gain and collect subsequent dispensings, and revealed preference (patients electing not to collect further dispensings, beyond issues of pharmacy availability and cost). Again, it is not possible from this preliminary work to ascertain whether and why a patient is not prescribed further dispensings, stops having a medicine dispensed, or later does not use it all once dispensed (concordance/adherence).
- Persistence may be distorted for age/disease/ethnicity groups with marked absolute excess premature death (YLL) in a 12 month period, as early mortality (e.g. Māori) will understate persistence. This however is unlikely to appreciably affect the results.
- This analysis has not included an estimate of uncertainty. In principle, confidence limits could be calculated for ASRs and ASRRs (using the log-transformation method), which would allow standard hypothesis-testing to help filter those gaps explainable by chance. This can be considered for future analysis that uses updated prescription and burden of disease data, provided such analysis was valid (endnote ‡‡‡).

These limitations and caveats will be of varying importance; it is difficult to gauge their overall net impact on the results of the analysis.

The NZBDS update (August 2013) contains more detailed and numerous disease categories, non-prioritised ethnicity (in the form of single and combination ethnic response groups) and does not discount.[36,37]

Interpretation—Despite these limitations, the data still suggest important and potentially remediable differences that need to be addressed.

In this analysis, age-standardised rates (without further adjustments for disease burden etc) tended to understate true gaps in needs-adjusted access. Confining analysis to crude and age-standardised script rate ratios may equate poorly with needs-adjusted gaps in access to medicines; the reporting of prescription volumes should consider the effects of burden of disease.

Needs-adjusted Māori and non-Māori dispensings during 2006/07 were about equal in a small number of areas—for example, substance use disorders, hepatitis B/C treatments, and anti-rheumatoid agents. But there were major differences in some areas of key importance to Māori health.

For example, in 2006/07 around 286,000 fewer prescriptions for cardiovascular medicines were dispensed than would have been expected for a comparable non-Māori population (and thereby more than expected scripts in non-Māori). Other key areas of large underuse in Māori (and/or overuse in non-Māori) included antibiotics for infections (which will include preventing rheumatic fever), newer antidepressants, oral hypoglycaemic agents for type 2 diabetes, and inhaled corticosteroids and/or long acting beta agonists for asthma.

Conversely, the small surplus in Māori for non-steroidal anti-inflammatory drugs (NSAIDs)/gout medicines /analgesics/muscle relaxants included 12,700 excess prescriptions dispensed to Māori for NSAIDs. NSAIDs pose significant cardiovascular, renal and gastrointestinal hazards. The relatively high NSAID usage by Māori may reflect underdispensing of other treatments such as allopurinol for gout (10,700 script shortfall), a disease where Māori and Pasifika suffer disproportionately.[30]

More detailed analysis required—Ambiguities could in part be addressed by estimating concurrent ideal needs-adjusted usage for populations across the range of medicines within specific disease categories, and then comparing access and persistence by demographic characteristics across those medicines across time. This might also improve measurement of progress within ethnic groups over time (intra-ethnic group comparison).[31]

Examples of such groupings of different medicines include treating schizophrenia and related psychoses with newer and older oral and depot antipsychotic medicines; treating asthma with short-acting relievers, inhaled corticosteroids (ICSs) and long-acting beta-agonists (LABAs) in various combinations; or glycaemic control in diabetes with rapid vs. long-acting insulins, sulphonylureas, other oral hypoglycaemics, diet alone, blood glucose monitoring test strip to manage diabetes.

For instance, in 2006/07 excess script counts (similar to NSAIDS etc. above) occurred for Māori with antipsychotic medicines overall. However, within that overall pattern

there were important areas of relative excess for Māori, in particular older depot agents (twice the rate in Māori than non-Māori), but with shortfalls for oral antipsychotics, especially newer oral agents, when compared with non-Māori. These patterns are seen in Table 2 below.

This means, for instance, that Māori had three times the usage of long-acting injection (depot) older antipsychotics than would be expected after adjusting for historic disease burden, age, population and lower usage of oral newer (atypical) antipsychotics. The high disease burden and documented disparities in Māori from schizophrenia etc.[32] would make it valuable to know the trends in ratios over time.

Table 3. Proportional disparities in script counts for prescriptions of antipsychotic medicines dispensed to Māori, adjusted for age and burden of disease*, by type (older/newer) and formulation (depot, oral, orodispersible)

scripts,M/nM RR

	depot	oral	orodispersible	total	**oral/depot**
older antipsychotics	1.92	0.72		0.85	0.37
newer antipsychotics	1.47	0.60	1.14	0.62	0.41
total	1.81	0.64	1.14	0.70	0.35
newer/older	0.77	0.83		0.74	

ratio of depot older antipsychotics to oral newer antipsychotics = 3.2 (1.92 / 0.60)

* DALYL-adjusted age-standardised M:nM rate ratios for prescription dispensings (scripts)

Updated analysis should include new medicines and new groups of medicines listed on the Pharmaceutical Schedule since 2006/07, including vaccines for some childhood infectious diseases.

Policy implications—These data, spanning many medicines and diseases, simply reveal differences between what was dispensed to Māori and non-Māori, after adjusting for differing populations and need. However, they raise again the possibilities of structural discrimination[33] with systemic inequity[4-12] in New Zealand's prescribing practice at the time.

Any inequity and/or wastage, if ongoing, can only undermine key public policy objectives of securing access to medicines for all eligible New Zealanders.[1] If confirmed, their redress could provide opportunities for substantial population health gains and expenditure savings—by reducing shortfalls in needed medicines use, with fewer costly hospitalisations, fewer premature deaths and improved quality of life and patient satisfaction, and/or reducing inappropriate medicines excesses. This however requires further analysis.

The data relate to the 2006/07 year, now seven years ago, and given changes to Health Sector since then they cannot necessarily be considered to still be representative. This will require updating including concurrent burden of disease data and matching indications. However, to our knowledge this preliminary work is the sole such gap analysis available to date that compares across all community medicines.

Conclusion

Population-based linkage studies of this kind can be an important tool to inform equitable policies and funding decisions. These preliminary data suggest important variation in medication access and persistence across different medicines and ethnic groups. Both lower accessibility and 'persistence' appear important, but their relative influence varies across therapeutic settings; this can inform the priorities set for health sector efforts to improve access to medicines and public health activities for their optimal use.

The limitations to this preliminary analysis mean that more research will help better understand reasons for differential dispensing. An early update is required, to account for change in NZBDS disease categories, non-prioritised ethnicity, new estimates of DALY losses,[36] and different medicines and indications funded in the years since 2006/07. Such work could include age/disease burden-adjusted gap estimates for Pasifika and non-Māori/non-Pasifika using non-prioritised ethnicity, gaps for other sociodemographic variables (e.g. location, deprivation), and tracking change in shortfalls/excess of medicines over time,[31] using a treatment-year metric.

Meantime, age-standardised ethnic rates of medicine use that do not adjust for need may carry a high risk of understating true gaps in needs-adjusted access. Analyses of prescription data by ethnicity should consider whether to more extensively adjust for health need and methods to separate access from persistence.

Appendices and annexe

Appendices

1. Methods
2. Crude rates of prescription dispensings by ethnic group, and effects of age structures and thus age standardisation on prescription dispensing patterns for ethnic groups
3. Detail of variability in prescription dispensing rates for Māori and Pasifika compared with non-Māori/non-Pasifika
4. Medicines use related to New Zealand Burden of Disease Study disease needs
5. Excess disease burden in Māori and non-Māori
6. Gaps in Māori use of medicines, adjusted for age and disease burden (need)

Annexe

Grouper linking pharmaceuticals 2006/07 with DALYs 1996

Endnotes:

* Thresholds to hospital admission are determined only in part by the severity of disease or similar need ('demand'). Many factors can lead to hospital admissions, for reasons beyond the simple availability of medicines. These include variation in bed supply; diagnostic shift and miscoding in hospitalisation data; and the differential effects of double counting of readmissions and of inter-hospital transfers as 'new' admissions. Supply factors include bed availability, which can vary by time and place; alternative service provision (outpatient services, assessment wards in Emergency Departments); clinical protocols; and competing illnesses (e.g. the winter surge in cardiorespiratory admissions).

ťIn New Zealand, patient-level data is collected from dispensing pharmacies when they claim for dispensing fees. Although the original prescription does carry patient details, the only detail recorded into the database is a patient identifier called a National Health Identification (NHI) code, which is encrypted to ensure confidentiality. This unique NHI number is issued to any patient using any public hospital or enrolled in any Primary Healthcare Organisation (PHO) in New Zealand. Virtually every primary care clinician in New Zealand has computerised patient records, and prescriptions have the NHI number automatically printed on them. Similarly, the majority of hospital out-patient prescriptions are likely to be issued with an adhesive label giving the patient identification and the NHI number. (The one confounding factor in the information chain is likely to be private specialists who have no incentive to write the NHI number on their scripts. This is only a small proportion of prescriptions however, and there is no particular reason to think that the trend in private practice would work against what is recorded in public.)

In addition to the NHI number attached to hospital records, the NHI register contains the individual's date of birth, ethnicity, deprivation index (based on socioeconomic variables in national household census data relating to domicile), and other demographic data.

In PharmHouse/the Pharmaceuticals Collection, 'scripts' (i.e. prescription items dispensed) count initial dispensings alone, authorised by a doctor's etc. prescription, without including repeat dispensings, while 'dispensings' combine initial dispensings with any repeats (authorised by the same prescription). A script is flagged in the database the first time a patient is dispensed a medicine on a given prescription. Therefore the count of scripts (prescription items) a person has for a given medicine is the count of initial dispensings they receive over a given period of time.

This analysis relates to dispensing data for any of those medicines listed on the New Zealand Pharmaceutical Schedule[16] between 1 July 2006 and 30 June 2007.

Analysis includes only dispensing claims for prescriptions written individual patients, and excludes Practitioner's Supply Orders (PSOs). PSOs help prescribers obtain subsidised medicines for emergency use, and teaching and demonstration purposes (a PSO being a written order made by a prescribing Practitioner (doctor, dentist, dietician, midwife, nurse prescriber, optometrist, pharmacist) for the supply of community pharmaceuticals to the practitioner, which the practitioner requires *inter alia* for emergency use and providing to patients where individual prescriptions are impractical).

‡ This was an observational study (being an audit observing outcomes without controlling study variables or having an intervention) with the secondary use of data for quality assurance/outcome analysis/resource review undertaken by people employed by the service provider holding the information and where participants remain anonymous. It did not meet criteria for requiring ethics committee review.[34]

§ In the context of this analysis, 'persistence' is the frequency of subsequent prescriptions dispensed for each individual index patient dispensed a first prescription of a medicine during the year. This is distinct from rates of dispensings across a population (which combine both access rates (index patients dispensed any amount of a medicine) and persistence (subsequent prescriptions dispensed/patient). Persistence is predicated on, *ceteris paribus* (all other things being equal), there being no particular reason why some groups would have lower subsequent prescription dispensing frequencies than other groups needing the medicine.

Medicines persistence is a systems measure comprising many components, including disease severity, differences in numbers of dispensings per script and/or days' coverage, access to affordable comprehensive ongoing medical and pharmacy care in order to gain and collect subsequent dispensings, and revealed preference (patients electing not to collect further dispensings, beyond issues of pharmacy availability and cost). Any choice not to collect further dispensings (*ceteris paribus*) may

have similar underlying causes of incomplete concordance once a medicine is collected. Concordance /adherence by patients is merely a subset of persistence.

** Unfortunately the available Ministry analysis by ethnic group was confined to comparing Māori with non-Māori (Ministry of Health 2001a[15]); other relevant disease burden in 1996 analysis (Ministry of Health 2001b[3]) did not provide sufficient detail to enable age-specific and age-standardised disease burden estimates for Pasifika, Māori and non-Māori/non-Pasifika. Māori vs. non-Māori comparison if anything understates the extent of Māori underuse once adjusted for need, as the non-Māori group includes Pasifika who have needs and underuse at least equal to Māori—hence diluting the relative effects for Māori. The Ministry analysis was also outdated, using data from 1996, for which some conditions the Māori:non-Māori differences will have changed (but at the time of writing we could not efficiently determine for which and the extent). The Ministry has now updated and enhanced the 2001 published work.[36]

ϯϯ (% Māori access cf non-Māori) × (% Māori persistence cf non-Māori) = % Māori overall prescription volumes cf non-Māori, where scripts = access× persistence.

‡‡ To help interpret Figures 3 and 5, note that, because the scale is logarithmic, it is the zero line where Māori usage is equal to non-Māori after accounting for differences in population size, age and burden of disease (i.e. 0, where when Māori usage rates equate to non-Māori the ratio of the rates is 1, and then the natural logarithm ($\log_e$) of 1 is 0). Values are spread out when Māori usage was less than non-Māori, and clumped when Māori usage was relatively higher, so for example at -1.7 the Māori age standardised rate was 18% that of non-Māori; -0.7 was half that of non-Māori; 0 means rates were the same; 0.7 means the Māori rate was twice that of non-Māori.

§§ The ethnic gap in life expectancy at birth (Māori versus non-Māori) in 1996 was 9.7 and 9.8 years for males and females, declining in 2006 to ~7.6 and 7.0 years, respectively;[24] this was an approximate 25% relative decrease in the gap improvement [(average of (9.7 −7.6, 9.8 −7.0)) −1]. Recent life expectancy updates[35] suggest recent further narrowing, with the gap between Māori and non-Māori life expectancy at birth being 7.3 years (based on death rates in 2010-12), compared with gaps of 9.1 years for 1995-97, 8.5 years for 2000-02, and 8.2 years for 2005-07; this gave a 10% relative reduction in the gap over the decade 1995-97 to 2005-07:

Differences between non-Māori and Māori life expectancy at birth (years)

Tobias et al 2009	1996	2006	difference	%2006/1996	relative change	gap overstated*
male	9.7	7.6	2.1	78%	-22%	28%
female	9.8	7.0	2.8	71%	-29%	40%
all	9.8	7.3	2.5	75%	-25%	34%

StatsNZ life tables	1995-97	2005-07	difference	%2006/1996	relative change	gap overstated*
all	9.1	8.2	0.9	90%	-10%	11%

*= the extent that the gap in life expectancy (LE) in 1996 overstates the gap in LE in 2006

Hence the 1996 NZBDS data may overstate Māori versus non-Māori health gaps for the 2006/07 population by perhaps 11 to 34%, for death at least.

This however is a crude comparison that is broadly indicative only, where some diseases will be affected more than others. In addition, the absolute gap in life expectancy at birth remains large: Māori life expectancy in 2006 was similar to that achieved by non-Māori 30 years previously (1976) for females and 20 years previously (1986) for males.

Analysis of the NZBDS update, for disease burden during 2006,[36] would address these concerns.

*** With the 'prioritised output' system adopted by Statistics New Zealand, each person is identified as belong to just one ethnic group, prioritised by Māori first, etc. (i.e. all individuals identifying as Māori (including those also identifying with other ethnic groups) are coded as Māori; all those identifying as Pasifika, other than those also identifying as Māori, are coded as Pasifika; etc.) Analysing ethnic variation using total response would mean that one person could be represented in multiple ethnic groups. While ethnic prioritisation provides a true denominator, where each person equals one count, total response would allow richer information around ethnic data, particularly for people who identify as both Māori and Pasifika, and increased accuracy around non-Māori and non-Pasifika comparisons. The advantage of using prioritised ethnic analyses is to continue previous time trend comparisons using a consistent methodology.

Initial summary material has been available on PHARMAC's Te Whaioranga website (http://www.tewhaioranga.co.nz/Health-professionals/Research-and-articles/Analysis) since 2009, and was provided in bpac$_{nz}$'s Best Practice Journal in 2012.[38] These initial data however understated overall disparities by one third, due to numerator-denominator bias evident on preparing detailed data for formal publication.

ŧŧŧ With the amoxicillins (amoxicillin, amoxicillin clavulanate), there was a shortfall of 89,100 scripts for Māori, being 1/3rd less than expected after adjusting for population, age and disease burden (disease burden-adjusted AS RR of 0.66). 73% of that shortfall occurred in children aged 0-14 years, whose adjusted rate ratio of 0.55 was substantially less than the average 0.81 RR for older age groups.

However, 13% of scripts for amoxicillins did not have NHIs and could in theory all have been on PSO; this is double the average 7.5% for scripts overall. Amoxicillins accounted for 11% of all non-NHI scripts (204,762 scripts without NHIs, out of 1.6 million amoxicillin etc scripts and 2.4 million scripts without NHIs).

If, radically, the 204,762 amoxicillin scripts without NHIs were for all Māori children and these in turn were to have the same script M:nM adjusted RRs as for older patients, then the shortfall for amoxicillins for Māori children would halve and the overall shortfall in Māori would decrease by 40% to become 53,200—see the following table.

agegroup		0-14	15-24	25-44	45-64	65+	total
no. scripts	Māori	150,699	30,233	45,790	42,229	18,190	287,141
(excl PSO)	non-Māori	503,297	121,455	174,982	273,396	241,609	1,314,739
	total	653,996	151,688	220,772	315,625	259,799	1,601,880
ASR	M	696.8	257.3	270.6	425.1	691.8	459.3
	nM	749.4	246.9	173.4	300.0	489.8	410.7
	RR, scripts	0.93	1.04	1.56	1.42	1.41	1.12
RR, DALYL		1.7	1.7	1.7	1.7	1.7	1.7
adj RR scripts		0.55	0.62	0.92	0.84	0.83	0.66
difference rates M - nM		-52.6	10.5	97.3	125.1	201.9	48.7
shortfall (scripts)		-65,115	-11,135	-3,407	-6,585	-2,887	-89,130
% age/all for shortfall		73%	12%	4%	7%	3%	100%
% shortfall/all Maori for age		-43%	-37%	-7%	-16%	-16%	-31%
% shortfall/all pts for age		-10%	-7%	-2%	-2%	-1%	-6%
if scripts without NHIs were for Maori children with same M:nM script RR as for older patients							
(no. scripts, Māori)		150,699	30,233	45,790	42,229	18,190	287,141
RR, scripts		1.36	1.04	1.56	1.42	1.41	1.36
adj RR scripts		0.81	0.62	0.92	0.84	0.83	0.81
shortfall (scripts)		-29,205	-11,135	-3,407	-6,585	-2,887	-53,220
% change in shortfall*		55%	0%	0%	0%	0%	40%

*if scripts without NHIs were for Maori children with same M:nM script RR as for older patients

‡‡‡ The use of confidence limits in this setting may confuse precision with validity, when this was a preliminary pilot exercise whose validity required due peer scrutiny.

Competing interests: The authors are PHARMAC staff or advisors.

Author information: Scott Metcalfe, Chief Advisor Population Medicine/Deputy Medical Director (Epidemiology), PHARMAC, Wellington; George Laking, Medical Oncologist/Health Economist, Auckland—Member, Pharmacology and Therapeutics Advisory Committee (PTAC)—Member, Māori Caucus, PHARMAC, Wellington; Jason Arnold, Team Leader Analysis, PHARMAC, Wellington

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Correspondence: Dr Scott Metcalfe, PHARMAC, PO Box 10254, Wellington, New Zealand. Email: scott.metcalfe@pharmac.govt.nz

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