



Health promoting and demoting consumption: What accounts for budget share differentials by ethnicity in New Zealand

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ABSTRACT

Background: Health demoting consumption of alcohol and tobacco are some of the most important risk factors for health loss worldwide, however there is limited information on these consumption risk factors in New Zealand (NZ) and whether inequities in the risk factors are ethnically patterned.

Methods: We used three nationally representative Household Economic Survey waves (2006/07, 2009/10, 2012/13) (n = 9030) in NZ to examine household expenditure for key health risk-related components of consumption by ethnicity, and its contributors to the differences using non-parametric, parametric and decomposition methods.

Results: Māori households (NZ indigenous population) were significantly poorer (25% less) than non-Māori households in terms of household per capita expenditure. However, our various econometric estimations suggested that, in relative terms, Māori spent more on tobacco and alcohol, and less on healthcare. The gaps become larger at upper quantiles of the budget share distributions; the composition effect (the gap due to differences in individual and household characteristics between Māori and non-Māori) explains most of the tobacco and alcohol budget share gap between the two groups, and less for healthcare. The structure effect (the gap due to returns to/or effect of individual and household characteristics) contributes very little to the budget share gap for tobacco and drink, but increasingly and predominantly when moving along the distribution of healthcare budget share. The differences between Māori and non-Māori in household ownership, education, and income negatively affect budget share on these health demoting consumption (tobacco and alcohol). The household head's age, education, and employment contributed most to the structure effect.

Conclusions: Our study suggested ethnic inequities in the health risk consumption behaviour are evidenced in NZ. Interventions targeting education and employment that significantly affect household budget shares on risk factors (i.e., harmful consumption) for health loss may help narrow the gaps.

1. Introduction

Tobacco and alcohol use are one of the most important risk factors for non-communicable diseases (NCDs) worldwide, together accountable for 11.4 million premature deaths (20.2%) and the loss of 300 million disability-adjusted life years (DALYs) (11.8% of all global DALYs) in 2019 (Afshin et al., 2019). These risk factors contribute to cardiovascular diseases (CVD) and cancers; which are among the top leading causes of deaths globally (Wang et al., 2016).

In New Zealand (NZ), the NZ Burden of Disease Study shows that tobacco and alcohol use contributes to 13.7% of total health loss (140,000 DALYs). In addition, these diseases are unequally distributed

by ethnicity and socio-economic group, with Māori, Pacific and other disadvantaged socio-economic groups at a higher risk of NCDs (Disney et al., 2017). Much of this health loss and premature death can potentially be prevented by reducing consumption of harmful products and addressing the environment that encourages risky behaviours.

People on a low income might be less equipped with knowledge and tools to limit or avoid tobacco and alcohol, and may over-use these products. Do and Bautista (2015) analysed the associations between tobacco use in low- and middle-income countries found that daily tobacco use was associated with lower household expenditures on education by 8%. In addition, households especially poorer households often face budget constraints, allocating budget to tobacco and alcohol

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also means less available budget for other necessities in low-income households (i.e., the crowding-out effect, [Do & Bautista, 2015](#)). [Husain et al. \(2018\)](#) compared the mean expenditure shares of different types of households using Engel curves and suggested that tobacco user households on average allocated less to education, housing, energy and clothing. Similarly in a high-income country, [Paraje and Araya \(2018\)](#) also found that tobacco consumption is associated with lower budget shares allocated to healthcare, education and housing but higher budget shares for alcohol, especially in low-income households.

Disease prevention can take the form of government interventions targeting individuals or communities at risk of health loss, such as social media to help quit smoking and excise tax on alcohol ([Nghiem et al., 2018](#)). In addition, individuals also need to look after their health and take active measures to reduce their health risks, such as applying sunscreen ([Gage et al., 2018](#)), using regular dental services or seeking professional advice early for their health conditions. These individual prevention measures, however, are normally not publicly funded and can be costly for people on low incomes ([Smith & Thomson, 2017](#)).

Household expenditure surveys are increasingly used to monitor changes in health risk factors internationally, such as dietary patterns, as individual nutrition survey data are lacking and such surveys are expensive ([Coates et al., 2017](#); [Fiedler & Lividini, 2017](#)). The linkage of the Household Economic Survey (HES) data (2006/07, 2009/10, 2012/13) ([Stats, 2019](#)) creates repeated cohorts of nationally representative data, and contains detailed information about alcohol consumption, tobacco consumption, healthcare, household food expenditure, and other household expenditure; and is implemented every three years ([Stats NZ, 2019](#)). There is a strong correlation between what individuals report on individual income in the HES and their actual income recorded in the Inland Revenue data ([Ball & Ormsby, 2017](#)). The HES provides an excellent complementary dataset to analyse health risk factors from a different perspective. Moreover, individual health survey or nutrition survey data only contain consumption data, not expenditure so these data sources are of little value to investigate the whole picture of socio-economic conditions and spending habits of individuals and households in order to target interventions to improve population health.

Recent advances in econometric techniques allow one to decompose the drivers of differences by ethnicity, such as wage gaps or household expenditure gaps in this context, into composition effects (gaps due to individual and household characteristics) and structure effects (gaps due to returns to individual and household characteristics) ([Firpo et al., 2009, 2018](#)). [Doan et al. \(2022\)](#) showed that differences in worker and job characteristics were primarily responsible for the wage gaps between NZ-born and Australian-born workers, and between NZ-born and other English speaking migrants, but differences in returns to worker and job characteristics are mainly responsible for the wage gap between NZ-born and non-English speaking background (NES) migrants in Australia. Barriers to NES migrants remain in the Australian labour market, where there is still significant unequal treatment to NES migrants.

Health inequities in NZ have long been recognized, yet little improvement has been achieved over the last 20 years or more ([Yu et al., 2020](#)). More urgent action and policy interventions beyond the health system are needed to reduce health burdens in marginalized populations ([Yu et al., 2020](#)). Our research investigated various household characteristics for tobacco and alcohol expenditure and decomposed the effects due to composition factors and structural factors to target policy interventions effectively. To the best of our knowledge, none of the studies in New Zealand have studied: (1) the expenditure gaps in different quantiles (not just the mean of the whole budget share distribution) of the household budget share distributions; (2) the composition effect (the gap due to differences in individual and household characteristics between Māori and non-Māori) that explains the gaps in tobacco, alcohol, and healthcare budget shares between the two ethnic groups; and (3) the structure effect (the gap due to returns to/or effect of individual and

household characteristics) contributes to the budget share gap for tobacco, alcohol, and healthcare. These results provide further evidence to shape policy interventions for reducing health inequities in NZ.

We therefore aimed to:

- (1) Explore social patterns in NZ household alcohol/tobacco/illicit drug, and healthcare spending using nationally representative linked-data in NZ.
- (2) Decomposing contributing factors to uncover what accounts for the differences in health-risk consumption across ethnic groups.

2. Data and methods

2.1. Data and variables

We used data from three HES waves (2006/07, 2009/10, 2012/13) with a total of 9030 households ([Ball & Ormsby, 2017](#); [Stats NZ, 2019](#)). These samples were randomly drawn from the total NZ population. The HES comprises questionnaires on the household characteristics, income, and expenditure using a 2-week expenditure diary. Household expenditure includes: alcohol, tobacco and e-cigarettes (hereafter tobacco), healthcare, food, transportation, housing, education, recreation and culture, and other goods and services.

The main outcomes of interest are two consumption measures (tobacco and alcohol, and healthcare): (2013 NZ\$, annualised), expenditure as a proportion of total household expenditure (budget share), all obtained from the HES data. We deflated the expenditure to get comparable measurements across HES waves using 2013 price level. We calculated mean expenditure and its standard deviation. Expenditure by income per capita quartile and by self-identified ethnicity (Māori or non-Māori) were also calculated.

Expenditure trends, relative risks and significance levels were estimated using seemingly unrelated regression (SURE), and decomposition adjusting for sample weights.

2.1.1. Household consumption expenditure was classified into (at household level or household expenditure per capita)

- (1) Annual household expenditure (total and per capita): (a) alcohol, tobacco, and illicit drug consumption (note that illicit drugs are illegal consumption), (b) healthcare, (c) foods, and (d) the remaining household expenditure. See [Appendix D and E](#) for the classifications of items (a) and (b), respectively.
- (2) Percentage of (1) out of total household expenditure – this is also called budget share.

2.1.2. Covariates (household's head)

Age (≥ 18 years and ≤ 70), sex (male = 0/female = 1), family type (couples households with or without children = 1; other = 0), ethnicity (Māori = 1; non-Māori = 0), education levels (Bachelors and above, Certificates level 1–5, and no qualifications or others), employment status (FT, PT, and others), main benefit recipient (yes/no), home ownership (owned = 1; rented or others = 0), income level (low, lower-middle, upper-middle, and high income, (ie, income quartile 1, 2, 3, and 4), 5 region dummies (Auckland council, Wellington regional council, other North Island councils, Canterbury regional council, and other South Island councils), and time (year dummies: 2006/07, 2009/10, and 2012/13).

Exclusion criteria: age ≤ 18 and ≥ 70 , household head's characteristics only (removing all observations for other household members except the household's head). We addressed zero consumption issues by replacing zeros with a small random number generated by a uniform distribution between 0.01% and 1%.

[Table 1](#) shows that non-Māori total and per capita household expenditure were significantly higher (by over 30%) than Māori expenditure. They also spent (in dollar terms) more than Māori in all

Table 1
Statistic Summary of Key Variables (pooled sample: 2006, 2009, 2013, per annum).

Variables ^a	Non-Māori		Māori		Non-Māori/Māori difference ^b	
	Mean	SD	Mean	SD	Difference	p-value
Alcohol, tobacco & illicit drug consumption						
Amount (NZ\$)	1,806	2,775	1,629	2,412	144	0.15
Share (%)	3.1%	4.4%	3.4%	4.5%	-0.3%	0.04*
Healthcare spending						
Amount (NZ\$)	1,527	3,285	699	1,476	741	0.00**
Share (%)	2.4%	3.7%	1.5%	2.3%	0.8%	0.00**
Food consumption						
Amount (NZ\$)	11,073	7,221	9,432	7,062	1,476	0.00**
Share (%)	17.7%	8.7%	19.2%	10.3%	-1.1%	0.00**
Other consumption						
Amount (NZ\$)	52,773	38,121	40,011	27,075	11,037	0.00**
Share (%)	77.1%	10.5%	76.4%	11.7%	0.5%	0.21
Total household expenditure						
Amount (NZ\$)	67,182	43,662	51,774	33,123	13,395	0.00**
Share (%)	100.0%	100.0%	100.0%	100.0%		
Average expenditure per capita (NZ\$)	27,390	19,440	20,052	14,556	7,059	0.00**
Average expenditure per capita (in log)	10.03	0.61	9.69	0.67	0.33	0.00**
Household size	2.79	1.39	3.07	1.71	-0.33	0.00**
Household size (ln)	0.90	0.52	0.97	0.57	-0.09	0.00**
Household head's gender (male = 0, female = 1)	0.54	0.50	0.68	0.47	-0.12	0.00**
Household head's age	45.90	13.14	41.44	12.96	4.90	0.00**
Family type (couples family = 1/others = 0)	0.62	0.49	0.46	0.50	0.17	0.00**
Household head's education level (%)						
Bachelors and above	24.8%	43.2%	11.5%	31.9%	13.4%	0.00**
Certificate level 1-5	49.8%	50.0%	57.1%	49.5%	-8.3%	0.00**
Others	25.4%	43.5%	31.4%	46.4%	-5.1%	0.00**
Household head's employment status (%)						
Full-time employed	57.2%	49.5%	50.8%	50.0%	5.8%	0.00**
Part-time employed	26.6%	44.2%	35.4%	47.9%	-8.1%	0.00**
Others	16.2%	36.9%	13.8%	34.5%	2.3%	0.07+
Household's income (NZ\$/year)	96,417	81,351	74,928	52,614	19,239	0.00**
Household income quartile (NZ\$/year)						
High-income	179,085	97,745	155,866	49,193	22,957	0.00**
Upper-middle income	87,373	11,725	86,262	12,549	1,123	0.16
Lower-middle income	52,020	9,346	50,995	9,777	920	0.15
Low-income	22,076	12,755	23,293	8,627	-924	0.27
Household's head main benefit received (yes = 1/no = 0)	0.11	0.31	0.23	0.42	-0.11	0.00**
Home-ownership (owned = 1/others = 0)	0.68	0.47	0.42	0.49	0.26	0.00**
Region (sum of all regions = 100%)						
Auckland	32.3%	46.8%	27.5%	44.7%	2.2%	0.14
Wellington	11.9%	32.4%	8.7%	28.2%	3.3%	0.01**
Other North Island regions	30.2%	45.9%	51.5%	50.0%	-20.3%	0.00**
Canterbury	14.5%	35.3%	6.3%	24.4%	8.6%	0.00**
Other South Island regions	11.0%	31.3%	6.0%	23.7%	6.2%	0.00**
Observations	6740		910			

Note: Monetary variables were set to 2013 price level. Estimates were adjusted for sample weights unless stated. Statistically significant at 1% (**), 5%(*) and 10%(+). The observations were rounded to comply with the Confidentiality rules by StatsNZ. ^aExpenditure share variables were estimated using sample weights and were not exactly equal to the proportions of expenditure means over the total household expenditure. ^bNo sample weighting.

consumption components. However, in relative terms Māori spent more on alcohol and tobacco and food than non-Māori.

Māori households were different from non-Māori in terms of household and socio-economic conditions. Māori have larger household size, household heads were younger and more likely to be female, have lower education levels, fewer have full-time jobs, household incomes are lower, more receive welfare benefits, and they are less likely to be home owners. Overall, Māori are in lower socio-economic position relative to non-Māori.

2.2. Analysis model

Our outcomes of interest were shares (%) of (1) alcohol, tobacco and illicit drugs, and (2) healthcare expenditure in total annual household expenditure. From a public health perspective, we focused more on these two consumption budget shares: alcohol, tobacco and illicit drugs, and healthcare expenditure as they were expected to have direct impacts on health outcomes. We termed these “consumption health-risk factors”.

The typical approach studying the consumption behaviour

differentials between Māori and non-Māori is to estimate the consumption behaviour equations using *ethnicity* as a dummy in ordinary least squares (OLS) regression or decompose the mean differences between two ethnic groups using a decomposition method (Blinder, 1973; Oaxaca, 1973). Apart from ethnicity, we also considered the contributions of individual and household characteristics affecting the consumption health risk behaviours such as age, sex, education level, employment status (FT/PT/others), welfare benefit recipient (yes/no), home ownership (owned/rented), family type, income levels, region and time (year).

We were also interested in how these factors' roles contribute to the gaps between ethnic groups, we thus employed the Re-centered Influence Function - Decomposition method to decompose the **difference in the consumption health risk factors** (that would lead to ethnic health inequality) across ethnic groups into composition effect (the difference in budget shares due to differences in household characteristics) and structure effect (differences in budget shares due to different returns to the characteristics). This method enables us to further decompose at different points on the budget share distribution as well as the

contribution of each factor (covariate) to the budget share difference (DiNardo et al., 1996; Firpo et al., 2009, 2018).

We started with simple unconditional mean comparison (Table 1), Seemingly Unrelated Regression (SURE),¹ and finally applied the recently developed decomposition methods to decompose the consumption budget share gap into the composition effect and wage structure effect using the Firpo, Fortin and Lemieux² (2009, 2018) decomposition procedure. To make it easy to follow the empirical results from each method, we do not detail methods here rather we discuss each method and its corresponding empirical estimates in the following section.

3. Results

Unconditional estimates of budget shares (mean) on alcohol, tobacco and illicit drug consumption, food and healthcare were presented in Table 1. It shows the mean and standard deviation (SD) of each expenditure share and differences in expenditures between Māori and non-Māori. Because Māori households have a 23% lower total budget on average than non-Māori households, they have lower budgets for all considered budgets in dollar terms. However, Māori households spent more budget shares (in a relative term %) on tobacco and alcohol, but less budget share on healthcare. Figs. 1–3 provide more detailed distributions of the budget shares and the differences in budget shares between the two groups.

Fig. 1 shows that more non-Māori are on the left hand side of the distribution, while there are more Māori on the right hand side (right part) of the distribution (the blue line is above the red-dash line in this area) where the budget share of tobacco and alcohol is higher. In contrast, non-Māori households were more likely on the higher budget share of healthcare (the right part of the distribution) than Māori households.

Fig. 3 shows that Māori spent more budget on food consumption than non-Māori households. The common feature for both budget shares of tobacco and alcohol (Fig. 1), and healthcare (Fig. 2) is that most households spent less than 5% in total budget on these consumptions. However, there were still many households that spent more than 5%,

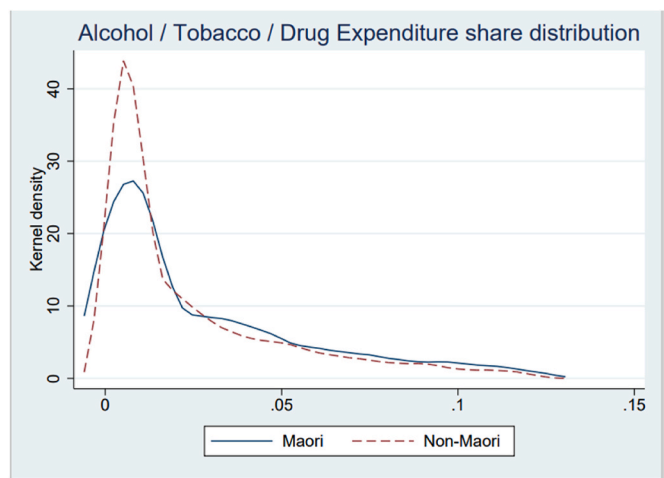


Fig. 1. Distribution of smoking and alcohol drinking budget share by ethnicity.

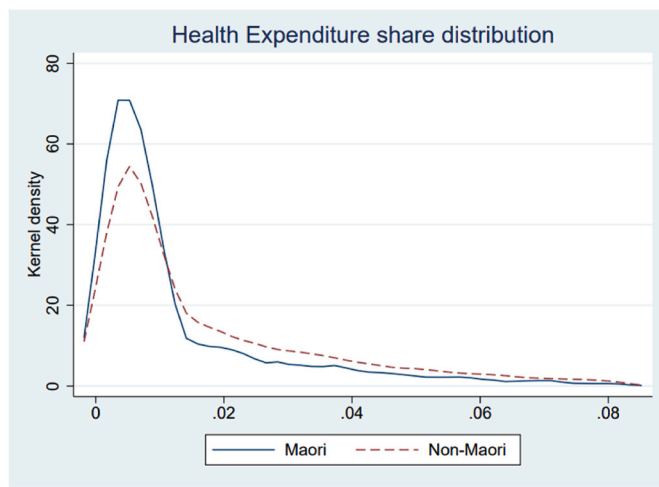


Fig. 2. Distribution of healthcare budget share by ethnicity.

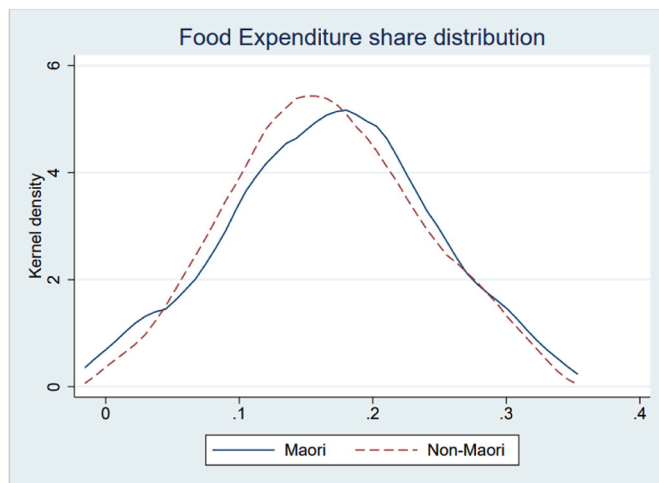


Fig. 3. Distribution of food budget share by ethnicity.

even more than 10% of their budget on health-harmful consumption (tobacco and alcohol) (Fig. 1).

3.1. Seemingly unrelated regression estimator (SURE)

Empirically, consumption expenditure analysis has attracted large attention in household survey analysis; the main purpose of these analyses is to estimate the Engel curve and income elasticity of demand for items of interest (e.g. tobacco and alcohol, and healthcare). Deaton (Deaton, 1997; Deaton & Muellbauer, 1980) provides a useful framework for this direction of the research, the Working-Leser model is employed in this framework (Leser, 1963, 1976; Working, 1943). However, to the best of our knowledge, there is little evidence of employing this framework in public health studies.

The SURE regression is an extension of OLS regression when considering simultaneously all shares of household expenditures. The SURE uses a system of equations (for expenditure shares) rather than estimating each consumption expenditure equation separately. The SURE provides the same estimates of coefficients as the OLS, but is a more efficient estimator than its OLS counterpart because consumption budget share equations are linked by the covariance structure of their disturbances (or error terms) and also tied together by the adding-up restriction; hence the residuals of the equation system are simultaneously correlated (Zellner, 1962). The Working-Leser equation is as

¹ As total budget share is 100%, that is, sum of all budget shares (for tobacco and alcohol, healthcare, food, and other expenditure) will be 100%, the SURE regression is more efficient than estimating separate regression for each budget share using OLS.

² Hereinafter it is called 'FFL'.

follows:

$$w_{ji} = \alpha + \beta_1 \ln(\text{exp}_{ji}) + \beta_2 \ln(\text{hhsz}_{ji}) + \epsilon_{ji} \tag{1}$$

where w_{ji} is the budget share of a particular commodity i to total expenditure of household j , $\ln(\text{exp})$ is the natural logarithm of average expenditure per capita (per capita expenditure is used to take into account consumption behaviour across households i.e., economies of scale (Deaton, 1997; Deaton & Muellbauer, 1980).³ The $\ln(\text{hhsz})$ is the natural logarithm of household size. For food budget share equation for example, if the coefficient of $\ln(\text{hhsz})$ is negative (positive) suggesting that larger households are better-off (worse-off) and reveal the fact by spending a smaller (larger) fraction of their budget on food. This functional form in equation (1) allows the whole sample to be used even though some households may not purchase certain goods, and so that they have zero consumption budget shares (Deaton, 1997).

The effect of ethnicity on the budget share will be examined by including in equation (2) *ethnicity* (Māori = 1; Non-Māori = 0). The regression model is as follows:

$$w_{ji} = \alpha + \beta_1 \ln(\text{exp}_{ji}) + \beta_2 \text{ethnicity}_{ji} + \beta_3 \ln(\text{hhsz}_{ji}) + \beta_4 X_{sji} + \beta_5 \text{region}_{ji} + \beta_6 \text{year}_{ji} + \epsilon_{ji} \tag{2}$$

where X_s are household head's age, sex, education level, employment status (FT/PT/others), welfare benefit recipient (yes/no), family type, home ownership (owned/rented), five regions and time (year). The SURE regression results are presented in Table 2.

Estimates of the contribution of ethnicity on household budget shares are in Table 2. Household expenditure is divided into four groups: alcohol and tobacco, healthcare, food, and the remaining expenditure (named *other*). Due to the adding-up restriction, budget share of any one expenditure group will be excluded from the regressions. We started with basic specification model which controlled for household size in logarithm, expenditure per capita in logarithm, and year and region dummies (left panel of Table 2). The extended specification model controlled for variables in the basic specification, and the household head's gender, education, age, employment status, welfare status, home ownership, family type, and income levels (right panel of Table 2).

Accordingly, Māori households have larger budget shares of alcohol and tobacco, and of food, but a lower budget share of healthcare. In the extended models, the magnitudes of the coefficients reduced but the signs of the coefficients did not change.

Apart from the focus on ethnicity, the Working-Leser equation is also used to estimate the income elasticity of demand, which is calculated as follows (White & Masset, 2002):

$$\text{Income elasticity}_i = I + \beta_i (X / Y_i) = I + \beta_i \left(\frac{I}{Y_i/X} \right) = I + \beta_i \frac{I}{\text{budgetshare}_i}$$

where Y_i is annual expenditure for group of good i , β_i is the estimated coefficient from Working-Leser equation (that is β_1), X is monthly (annual) average household expenditure per capita in natural logarithm. The $\text{budgetshare}_i (Y_i/X)$ is the budget share of the corresponding expenditure for group of good i . For example, using values from Tables 1 and 2 (extended model), the income elasticity of demand for alcohol and tobacco for Māori and non-Māori are -0.100 and -0.110 respectively. These are negative suggesting that when average per capita household expenditure increases, both Māori and non-Māori households spend less budget share on tobacco and alcohol. On the contrary, income elasticity of demand for healthcare are 0.160 and 0.100 for Māori and non-Māori households respectively, implying that both Māori and non-Māori would increase budget shares for healthcare when their average per capita expenditure increase (or they are richer), the rise is greater for Māori

³ Regressions on either natural logarithm of average expenditure per capita or natural logarithm of average expenditure result in the same results of all coefficients except that of $\ln(\text{hhsz})$.

households than non-Māori households. For budget share for food, both Māori and non-Māori would reduce budget share for food when their per capita expenditure rises, the income elasticity is -0.254 and -0.276 for Māori and non-Māori households respectively. The decline in food budget share is faster for non-Māori households than Māori households when per capita expenditure increases.

3.2. Budget share gap using RIF decomposition method

In this section, we look at what contributes to differences in the budget shares of tobacco and alcohol, and healthcare between Māori and non-Māori households, and whether the role of the contributors to the budget share differentials varies across points on the distribution. These are our key focuses. Re-centered Influence Function (RIF) decomposition is an appropriate approach to answer these questions. RIF decomposition (Firpo et al., 2018) is a combination of DFL (DiNardo et al., 1996) and FFL (Firpo et al., 2009) that can be applied to various distributional measures. The RIF decomposition involves two stages: the first stage divides distributional changes into the composition effect (explained component) and structure effect (unexplained component) using the reweighting method (DFL, 1996). The second stage further decomposes these two components into contribution of each explanatory variable using the RIF regression (FFL, 2009). In this method, the regressed dependent variable is replaced by the corresponding recentered influence function for the distributional statistics of interest. Barsky et al. (2002) indicated that the Blinder-Oaxaca decomposition provides consistent estimates of the composition and structure effects only under the assumption of linear conditional expectation. This is not the case for the standard quantile regressions. One of the solutions to this problem is to use non-parametric reweighting method (DFL, 1996) to conduct decomposition. However, this method does not enable us to further decompose directly contribution of each covariate to the composition and structure effects. The RIF regression method (FFL, 2018), based on their earlier work (FFL, 2009), is the solution. The RIF regression method in the Oaxaca-type decomposition can provide linear approximation of highly non-linear functional forms such as the quantiles.

The RIF for observation i of quantile q_τ for budget share w can be written as below:

$$\text{RIF}(w_i, q_\tau) = q_\tau + \frac{[\tau - \theta(w_i \leq q_\tau)]}{f(q_\tau)}$$

where $f(\cdot)$ is the density function at q_τ and $\theta(\cdot)$ indicates whether the observed budget share (w) is at or below the quantile q_τ . FFL (2018) shows that when RIF is approximated by a linear function of covariates X , it can be:

$$E[\text{RIF}(w_i, q_\tau) | X_i] = X_i \beta$$

where β is a vector of coefficients of variables X which represents the partial effects using an unconditional quantile regression (UQR), or the marginal effects of covariates X .

The RIF decomposition has three advantages: (i) simple to implement, (ii) possibility of obtaining contributions of each explanatory variable in aggregate decomposition, and (iii) can be applied for any distribution of RIF function. A Stata syntax for Blinder-Oaxaca-style decomposition with a combination of the RIF regression was recently developed by Rios-Avila (2020).

Application of RIF decomposition to investigate budget share gap between Māori and non-Māori involves a two-stage procedure. The first stage constructs *counterfactual budget share distribution* that the Māori would have spent if they had the same characteristics as the non-Māori. The difference between the Māori *actual distribution* and the *counterfactual distribution* is attributable to the differences in characteristics between Māori and non-Māori. This difference in the budget share distribution is the composition effect. The difference between the non-

Table 2
Working-Leser equation by seemingly unrelated regression (SURE).

Variables	Basic model				Extended model specification			
	Tobacco/alcohol	Health	Food	Other	Tobacco/alcohol	Health	Food	Other
Ethnicity (Māori = 1)	0.0030+ (0.0016)	-0.0058** (0.0011)	0.0054** (0.0012)	0.0045 (0.0029)	0.0019 (0.0016)	-0.0045** (0.0013)	0.0012 (0.0030)	-0.0017 (0.0017)
Household size (ln)	-0.0104** (0.0011)	-0.0002 (0.0007)	0.0039** (0.0008)	-0.0103** (0.0020)	-0.0095** (0.0015)	-0.0029* (0.0012)	0.0067* (0.0027)	0.0075** (0.0015)
Expenditure per capita (ln)	-0.0032** (0.0010)	0.0023** (0.0006)	-0.0120** (0.0007)	0.0423** (0.0017)	-0.0034** (0.0012)	0.0024* (0.0010)	-0.0488** (0.0021)	0.0011 (0.0013)
Household head's age					0.0001** (0.0000)	0.0004** (0.0000)	0.0007** (0.0001)	-0.0001** (0.0000)
Head's gender (female = 1)					-0.0044** (0.0011)	0.0017* (0.0009)	-0.0024 (0.0020)	0.0043** (0.0011)
Home-ownership (owned = 1/others = 0)					-0.0038** (0.0013)	0.0031** (0.0010)	0.0062** (0.0023)	0.0039** (0.0013)
Head's benefit status (yes = 1)					0.0018 (0.0017)	-0.0010 (0.0013)	0.0042 (0.0030)	-0.0019 (0.0017)
Education (base group: Others)								
Bachelors and above					-0.0011 (0.0013)	0.0022* (0.0010)	0.0045+ (0.0023)	0.0007 (0.0013)
Certificate level 1-5					-0.0115** (0.0016)	0.0029* (0.0012)	0.0054+ (0.0028)	0.0116** (0.0016)
Employment (base group: Others)								
Full-time employed					-0.0043** (0.0015)	0.0011 (0.0012)	0.0038 (0.0028)	0.0043** (0.0016)
Part-time employed					-0.0016 (0.0014)	0.0050** (0.0011)	-0.0007 (0.0026)	0.0016 (0.0015)
Income (base: Lowest income)								
Lower-middle income (q2)					0.0014 (0.0017)	-0.0011 (0.0013)	0.0014 (0.0030)	-0.0018 (0.0017)
Upper-middle income (q3)					0.0051** (0.0019)	-0.0007 (0.0015)	0.0038 (0.0034)	-0.0055** (0.0020)
Highest income (q4)					0.0072** (0.0022)	-0.0009 (0.0017)	0.0021 (0.0039)	-0.0079** (0.0022)
Family type (couples = 1/others = 0)					-0.0002* (0.0012)	-0.0020 (0.0010)	0.0020* (0.0022)	0.0078** (0.0013)
Constant	0.0678** (0.0106)	0.3534** (0.0089)	0.9492** (0.0074)	0.4193** (0.0179)	0.0702** (0.0130)	-0.0259* (0.0103)	0.6081** (0.0223)	0.9607** (0.0133)
Observations	7650	7650	7650	7650	7650	7650	7650	7650
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Standard errors in parentheses; + significant at 10%; * 5%; ** 1%. Dependent variables are budget shares. Ln(size) is household size (in log); Ln(exp) is monthly expenditure per capita (in log). All model controlled further for region and year dummies.

Māori *actual distribution* and the *counterfactual distribution* is the structure effect (or unexplained part). In the second stage, the composition and structure effects are further decomposed into the separate contribution of each explanatory variable. This enables us to gauge the contribution of specific variables to the budget gap between any two groups.

The re-weighting factor is a product of the ratio of Māori to non-Māori in the NZ population and the ratio of two conditional probabilities which can be obtained from a logit regression of ethnicity status on explanatory variables.

Table 3 compares the non-Māori with the Māori budget share for alcohol, tobacco and illicit drug consumption. The difference in budget share between non-Māori and Māori are materially large from the middle to upper parts of the distribution of tobacco and alcohol budget share. The gap increases when moving away from the median to the higher end of the distribution; the non-Māori households have a lower budget share than their Māori counterparts. The composition effect (or explained component) explains *most* of the budget share gap between the two groups, while the structure effect (or unexplained component) contributes less to the budget share gap. However, we should be

Table 3
Oaxaca-RIF decomposition for tobacco and alcohol budget share difference between non-Māori and Māori.

	Q10	Q25	Q50	Q75	Q90
Non-Māori (G ₁)	0.0025** (0.0001)	0.0057** (0.0002)	0.0126** (0.0003)	0.0394** (0.0011)	0.0821** (0.0020)
Counterfactual (G _c)	0.0027** (0.0008)	0.0063** (0.0010)	0.0133** (0.0017)	0.0399** (0.0049)	0.0871** (0.0118)
Māori (G ₂)	0.0024** (0.0004)	0.0058** (0.0006)	0.0151** (0.0015)	0.0478** (0.0038)	0.0911** (0.0053)
Difference (G ₁ -G ₂)	0.0001 (0.0005)	100% (0.0006)	-0.0001 (0.0015)	100% (0.0040)	-0.0089 (0.0057)
Explained (G _c - G ₂)	0.0003 (0.0008)	0.0005 (0.0009)	-0.0018 (0.0016)	72% (0.0044)	-0.0077 (0.0122)
Unexplained (G ₁ - G _c)	-0.0002 (0.0020)	-0.0006 (0.0024)	-0.0007 (0.0042)	28% (0.0118)	-0.0012 (0.0316)

Notes: Robust standard errors in parentheses, **p < 0.01, *p < 0.05, + p < 0.1.

cautious when interpreting the gap for the top quantile (Q90) since the estimate is not statistically significant even if the gap is observed to be the largest relative to estimates at other quantiles. The statistical insignificance implies a large variation in the data (i.e., relatively large estimated standard error). When we looked further into what contributed to the gap that was explained by differences in household characteristics, we observed that most of the contribution to the gap came from household ownership, education, per capita expenditure, and income⁴ (see Appendix A).

Table 4 compares the non-Māori with the Māori budget share for healthcare consumption. The difference in this budget share between non-Māori and Māori are statistically significant at all quantiles except the bottom end quantile (Q10). The gap increases from the lower to higher quantiles of the distribution of healthcare budget share, from negligible (0.05%) to 1.83%. The non-Māori households have spent higher budget share than their Māori counterparts. The composition effect which is attributable to differences in the household and household head's characteristics between the two groups accounts for about half of the total gap in the middle quantile and lower quantiles, but its contribution declines quickly when moving to upper quantiles (43% for Q75, and 8% for Q90). In contrast, the structure effect (i.e., returns to factors or effect of factors such as age, education, gender, home ownership, welfare benefit status, family type, employment status, household income level, and unobserved factors on healthcare consumption behaviour) contributes increasingly to the gap of healthcare budget share from the middle to upper parts of the distribution. We looked further into what contributed to the gap at the quantiles where the gap is statistically significant (i.e., Q25-Q90) and the gap is mainly contributed by the unexplained component, we observed that most of the contribution to the gap came from household head's age, household size, per capita expenditure, income, education, and employment (see Appendix B). The effect of employment or returns to employment helps reduce the gap between Māori and non-Māori households' healthcare budget share, while the higher returns to education for non-Māori in relation to Māori results in widening the gap in healthcare budget share between these two groups (see Appendix B).

For the decomposition of food budget share gap, see Appendix C. Overall, non-Māori households spent less budget share on food than Māori households. The gaps are materially large and statistically significant from the middle to upper quantile. The composition effect accounts for most of the food budget share gap between non-Māori and Māori. Differences in the household and household head's characteristics and differences in household socio-economic conditions between the two demographic groups are mainly responsible for the gap in food budget share.

In summary, Figs. 1–3 help show how budget shares differ (between Māori and non-Māori) across unconditional distributions. Table 2 provides baseline estimates using SURE (like OLS, but it is more efficient as all budget shares are estimated at the same time allowing for the error terms to be correlated across the equations – as each household's total budget share is always 100%). In other words, the sum of all budget shares is 100%. While the SURE estimates provide baseline estimates for initial understanding of how budget shares are different between two groups, our main focus is on RIF decomposition estimates to explore further the differences between two groups to see what contributed to the differences (explained component – the difference due to differences in observed characteristics across groups, and unexplained component – the difference due to effects or returns to the characteristics).

⁴ For categorised variables e.g., education or income level, we added up coefficients of all variable categories before computing the contribution of the variables.

4. Summary and discussion

Māori households spend significantly less than non-Māori households in terms of per capita household expenditure. Māori household per capita expenditure was about 25% lower than non-Māori households. Māori households spent (in dollar terms) less than non-Māori in all consumption components. However, in relative terms Māori spent more on tobacco and alcohol, and food than non-Māori.

The kernel density estimation, SURE regression, and RIF decomposition consistently show that Māori households spent, and RIF decomposition consistently show that Māori households spent more budget share on alcohol and tobacco, but less on healthcare. The gaps become larger when moving from lower quantiles to upper quantiles on the budget share distributions. The higher budget shares on harmful consumptions such as cigarette smoking and alcohol, but less on health promotion such as healthcare may help explain why Māori have more long-term health conditions in relation to non-Māori (Teng et al., 2016).

RIF decomposition also shows that the composition effect (the gap due to differences in individual and household characteristics between Māori and non-Māori) explains most of the budget share gap in tobacco and alcohol between the two groups. The contribution of the composition effect mainly came from household size, per capita expenditure, home ownership, education, and income. The differences between Māori and non-Māori in these factors negatively affect budget share in this health demoting consumption (tobacco and alcohol).

In contrast, non-Māori households spent a higher healthcare budget share than their Māori counterparts. The composition effect accounts for about half of the total gap in the lower to the middle quantile on the distribution, but its contribution declines quickly when moving to upper quantiles. On the contrary, the structure effect (the gap due to returns to/or effect of individual and household characteristics) contributes increasingly to the healthcare budget share gap between non-Māori and Māori households when moving from the middle to the upper parts of the distribution. We looked further into what contributed to the gap at the quantiles where the gap is statistically significant (i.e., Q25-Q90) and the overall gap is mainly contributed by the structure effect, and most of contribution to the gap, which is due to structure effect, is from household head's age, education, and household size and per capita expenditure, employment. The effect of employment or returns on employment helps reduce the gap between Māori and non-Māori households' healthcare budget share, while the higher returns to education for non-Māori in relation to Māori results in widening the gap in healthcare budget share between these two groups.

The findings from the structure effect suggest that being employed is beneficial for Māori people in improving healthcare i.e., reducing the budget share gap in comparison with non-Māori households (assuming that spending more on healthcare is highly correlated to receiving necessary healthcare; however, it is not possible to separate cosmetic health expenditure from medically necessary expenditure for disease prevention and treatment in our data). Employment is not just about raising their income, but also changing their health behaviour and awareness of health-risk factors, and awareness of the importance of investment in health (Colman & Dave, 2018; van der Noordt et al., 2014). Furthermore, higher education and greater returns to education for non-Māori really widened the healthcare spending (budget share) gap between these two demographic groups (Gibson, 2000).

Budget share on health promoting or demoting consumption behaviour is influenced by individual and household characteristics including socio-economic conditions such as income, education, employment, and home ownership. The consumption behaviour e.g., health promoting (healthcare) or health demoting consumption (tobacco and alcohol) will affect health outcomes. Interventions are needed to break, change and create consumption behaviours (Verplanken & Wood, 2006).

Our Working-Leser model suggested that income elasticities of demand for alcohol and tobacco by ethnicity were negative and quite

Table 4
Healthcare budget share difference between non-Māori and Māori.

	Q10		Q25		Q50		Q75		Q90	
Non-Māori (G ₁)	0.0022** (0.0001)		0.0051** (0.0001)		0.0100** (0.0002)		0.0289** (0.0007)		0.0564** (0.0014)	
Counterfactual (G _c)	0.0017* (0.0008)		0.0045** (0.0007)		0.0088** (0.0010)		0.0213** (0.0029)		0.0396** (0.0048)	
Māori (G ₂)	0.0017** (0.0003)		0.0037** (0.0003)		0.0072** (0.0004)		0.0155** (0.0014)		0.0381** (0.0033)	
Difference (G ₁ -G ₂)	0.0005 (0.0003)	100%	0.0014** (0.0003)	100%	0.0028** (0.0004)	100%	0.0134** (0.0015)	100%	0.0183** (0.0035)	100%
Explained (G _c -G ₂)	-0.0000 (0.0007)		0.0008 (0.0007)	57%	0.0017+ (0.0009)	60%	0.0058* (0.0027)	43%	0.0015 (0.0043)	8%
Unexplained (G ₁ -G _c)	0.0005 (0.0019)		0.0006 (0.0018)	43%	0.0012 (0.0025)	40%	0.0076 (0.0070)	57%	0.0168 (0.0116)	92%

Notes: Robust standard errors in parentheses, **p < 0.01, *p < 0.05, + p < 0.1. For full detailed decomposition see [Appendix B](#).

inelastic (around -0.10), suggesting that households are likely to reduce these harmful consumption slightly if their income increase. On the other hand, income elasticity of demand for healthcare was positive and 1.6 times higher for Māori compared to non-Māori households (0.16 vs 0.10), implying that Māori would respond stronger than non-Māori to increase budget shares for healthcare when their income increases. Larger households in this group (those with lower healthcare budget share) would potentially benefit more from an increase in income as they are often from crowded families who face higher risks of disease exposure e.g., communicable diseases; these households have to spend more on healthcare per capita relative to smaller households on the same part of healthcare budget share distribution (i.e., lower quantiles).

Māori households spent significantly less on healthcare than non-Māori households at all quantiles, however, the gap is larger at higher quantiles. We suspect that this is because non-Māori households at upper quantiles invest more in health due to stronger effect of education and employment on households' healthcare budget share. That could also be due to Māori households at similar upper quantiles being younger, hence having lower demand for self-funded healthcare goods and services.

4.1. Strengths, limitations and further study

The strength of our study was that we used the national representative HES data, which is repeated every three years and representative of the whole NZ population, offering rich data on household consumption including 2-week diary of household expenditure covering all household consumption.

In this study, we addressed health demoting consumption of tobacco and alcohol, which are some of the most important risk factors for health loss worldwide. Indigenous population Māori are over-represented in low-income, low-education, low employment rate and high health burden groups in NZ. However there is limited information on these consumption risk factors, in particular the structural and the composition effects of these factors in NZ. Our results can have policy implications for other high-income countries with diverse population groups and health inequities, such as Australia, the USA and Canada.

However, this paper focused more on tobacco and alcohol, and healthcare budget share, but did not look at the component of food consumption e.g., healthy food, unhealthy food such as fast food or sugar-sweetened beverages. This gap would be a potential avenue for future study. This paper also focused on total budget spent on tobacco and alcohol, as proxies for health-harming consumption, but our study was unable to capture the amount of cigarettes or alcohol consumed as that was not available in the survey data. Similarly, the healthcare spending in the survey data recorded only out-of-pocket healthcare costs which excluded the contribution from government healthcare subsidies and private health insurance companies. Given that access to healthcare services, treatment and medicine is affected by health knowledge, accessibility and affordability, which are not homogenous across ethnic

groups, the gap in healthcare budget share between Māori and non-Māori households without the government subsidies would be different.

The current study used the budget shares as health investment and hence proxies for health outcomes. In future research, one may link individual health outcomes with budget share data to investigate the relationship between health promoting and demoting consumption (budget shares) with individual health outcomes.

Finally, we did not address the possible response bias in this HES for out-of-pocket expenditure. For example, targeted participants having significant recent expenditure on healthcare would probably not respond to the survey due to illness and/or time constraints. And as it is only a two-week diary, which is not a limitation with alcohol and tobacco that tends to have a consistent spend throughout the year, it may not capture rare, very large healthcare expenditure items (e.g., operations). However, the survey should capture the regular healthcare items (e.g., GP visits, drugs, and physiotherapist visits etc).

Although we used three waves of the HES survey, our models are all pooled (or cross sectional) models in which we also adjusted for year (wave) dummy variable. Because we did not aim to investigate the dynamics of the budget shares (e.g., how budget shares change over time) so we did not use any longitudinal models in our analyses. If longer time period data are available, one may want to look at consumption behaviours change over time. Unfortunately, the change in survey composition in current waves of the HES survey (i.e., recruiting more low-income households) makes it less comparable across earlier waves and current waves.

4.2. Policy implications

Our results suggested that improving Māori household income, education and employment may help to reduce their expenditure on harmful goods and increase expenditure on healthcare, with Māori (especially those in larger households with a lower healthcare budget share) benefiting more. In addition, interventions targeting home ownership for Māori may help to reduce household expenditure on alcohol and tobacco.

Current NZ government policy analyses suggest that improving income, education, employment and home ownership for Māori can help with increasing Māori economic resilience ([Ministry of Māori Development, 2020](#)), and this area is a priority for the Māori action plan. It is recognized that Māori recover at a much slower rate than non-Māori from the impacts of economic shocks, such as Covid-19. This disproportionate recovery enables the systemic inequities that are already large between Māori and non-Māori to worsen.

Improving Māori employment and household income means they have (more) disposable income to invest in healthcare, and as a result, can reduce future health burden. For example having the funds and time to take their children to the GP, when they might have a group A streptococcal pharyngitis or skin infection, which if left untreated may

lead to rheumatic fever and ultimately rheumatic heart disease.

Education helps to equip Māori households with more health knowledge and health risk prevention, and hence, can encourage them to invest more in healthcare upfront, and less on harmful goods. For example, if diabetic, (i) being aware that quitting smoking decreases their risk of CVD, stroke and circulatory problems, and (ii) seeking regular podiatric care to reduce the risk of amputation. Deaton (2002), who in 2015 was awarded the Nobel Memorial Prize in Economic Sciences, suggests that unlike in developing countries, health policy in high-income countries should target education. There is evidence in high-income countries that an additional year of education reduces mortality rates by about 8%.

It is also well-established that Māori with low levels of income, education and being unemployed can have poor health outcomes (Blakely et al., 2018; Nghiem & Wilson, 2021). Together with interventions reducing supply of unhealthy and/or harmful products (Nghiem et al., 2018, 2019) it may be more effective to simultaneously target households and individuals' demand of these products through improving employment opportunities, improving education, and then income.

5. Conclusions

Our study suggested that ethnic inequities in health-demoting consumptions are evidenced in NZ, with Māori spending relatively more on tobacco and alcohol, and less on healthcare. The main drivers for the gap in health-demoting consumption between Māori and non-Māori households are differences in individual and household characteristics, and the key contributors to the gap in health-promoting consumption between Māori and non-Māori households are differences in returns to (or effect of) individual and household characteristics on the healthcare spending. Interventions targeting education, employment, and income may help narrow the gaps between the two groups.

Author contributions

NN: developing ideas, literature review, data analysis and modelling, drafting up the paper, and providing discussion. WL: reviewing results, contributing to the writing, and discussion of the paper. TD: method development, data modelling advice, interpretation of the results, paper drafting, and discussion.

Ethics approval

Ethics Committee reference number HD19/057 by University of Otago, New Zealand.

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Availability of data and material

Access to the anonymised data used in this study was provided by Stats NZ under the security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation, and the results in this paper have been confidentialised to protect these groups from identification and to keep their data safe.

Code availability

Code available upon request but note that data for running this code are only available in a strict confidential environment managed by Stats NZ (New Zealand).

Disclaimer

The results in this paper are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI), managed by Stats New Zealand.

The opinions, findings, recommendations, and conclusions expressed in this paper are those of the authors, not Statistics NZ, the University of Otago or individual data suppliers.

Careful consideration has been given to the privacy, security, and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

Consent for publication

Results for this work were checked and released by Stats NZ (New Zealand).

Declaration of competing interest

The authors have no conflict of interests.

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2022.101204>.

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