Avoidable mortality in New Zealand, 1981-97

Abstract

***Objective*:** To describe avoidable mortality in New Zealand, including trends and variations between groups by age, gender, ethnicity and degree of deprivation.
Method: New Zealand Health Information Service mortality unit records, 1981 to 1997, were classified as 'avoidable' or 'unavoidable' based on a reassessment of ICD9 codes and an upper age limit of 75 years. 'Avoidable' causes of death were further subcategorised according to the level of intervention involved (primary, secondary or tertiary). Deaths were assigned a deprivation score using a Census-based small area deprivation index, the NZDep96. Mortality rates were age standardised by the direct method, with Segi's world population as the reference.
***Results*:** Avoidable mortality declined 38% from 1981 to 1997; unavoidable mortality declined only 9%. In 1996-97 almost 70% of deaths in the 0-74 age range were still considered to be potentially avoidable. Almost 80% of avoidable deaths occur in the 45-74 age group. These deaths are dominated by the emergence of chronic diseases such as ischaemic heart disease, diabetes and smoking-related cancers. In younger age groups, injury (including suicide) dominates avoidable mortality. Males experience a greater burden of avoidable mortality than females – a relative excess of 54% (approximately 2,000) in 1996-97. The gender difference is largely attributable to diseases and injuries amenable to primary prevention, with the largest single contribution coming from ischaemic heart disease. The ethnic gap in avoidable mortality remains wide: rates for Mäori and Pacific people were 2-2½ times higher than European rates in 1996-97. Similar gradients are seen with deprivation.
***Conclusion and implications*:** Avoidable mortality analysis provides a useful tool for evidence-based health needs assessment and health policy development.

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Assessment of a population's capacity for health improvement represents a valuable contribution of epidemiology to health policy.[1] One way of doing this is to analyse the causal structure of mortality (or other health outcomes) at the level of diseases and injuries – the proximal causes of these outcomes. Specifically, such an analysis seeks to distinguish potentially avoidable from unavoidable causes, and depends on two principles:

- the accurate assignment of cause of death; and
- categorical attribution of causes of death as 'avoidable' or 'unavoidable'.

Categorical attribution of diseases and injuries was first proposed by Ruttstein[2] in 1976, and the first widely accepted list of causes of avoidable mortality was assembled by Charlton[3] in 1983. Charlton's list was restricted to deaths at ages 0-64 years, and included only conditions amenable (at that time) to medical or surgical treatment. It was intended to serve as a health care system performance measure, not as an indicator of the scope for population health gain.[4] Variations of Charlton's list have been used in previous studies of avoidable mortality in NZ.[5-7]

For the analysis presented here, Charlton's original list has been updated and extended in several ways:

- An extensive reassessment of the categorical attribution of all ICD 9 codes was undertaken in the light of advances in health care technology since the early 1980s.[8-28]
- The (arbitrary) upper age limit for avoidability was increased from age 65 to age 75, reflecting improvements in life expectancy as well as in coding cause of death for older people.
- The concept of avoidability was extended to cover not only causes of death amenable to therapeutic intervention, but also those responsive to individual and population-based preventive interventions.
- The causes considered to be 'avoidable' were further subcategorised according to the level of intervention, to increase the policy relevance of the analysis.[8-28]

Method

The analysis is based on mortality data for 1981-97 supplied by the New Zealand Health Information Service (NZHIS). ICD coding has been consistent over this period (except for minor changes in 1988 and 1995). Data from 1996 and 1997 were combined for cross-sectional analysis to improve subgroup estimates. Age standardisation was carried out using the direct method, with Segi's world population as the reference. Because ethnicity coding changed significantly in 1995, an ethnic-specific time series cannot be calculated.

The subcategories of avoidable mortality used were:

- *Primary avoidable mortality* (PAM) groups conditions that are preventable, whether through individual behaviour change (i.e. lifestyle modification) or

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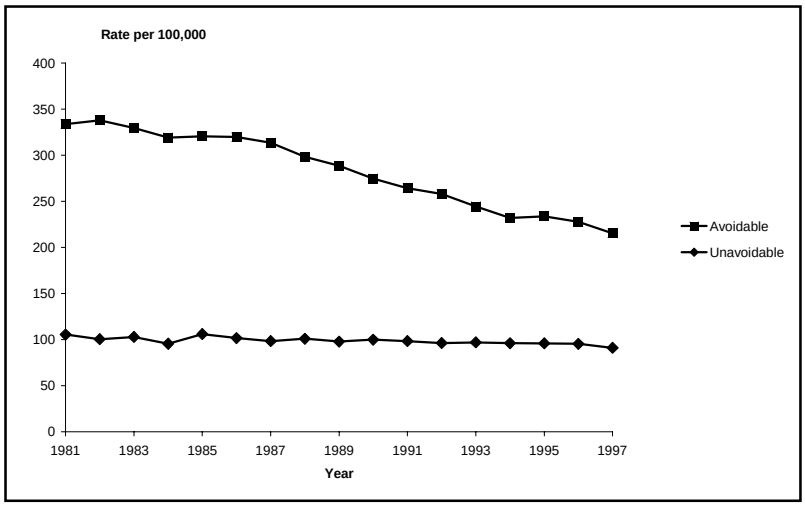

Figure 1: Avoidable and unavoidable mortality, ages 0–74 years, 1981–97. Source of base data: NZHIS

Note: rate is age standardised to Segi's world population.

population level intervention (i.e. healthy public policy). The condition is prevented before it develops by addressing its risk or protective factors: 'primary prevention'.

- *Secondary avoidable mortality* (SAM) groups conditions that respond to early detection and intervention, typically in a primary health care setting. As well as clinical preventive services such as cancer screening, it includes chronic disease management intended to delay the progression of diseases such as diabetes or the recurrence of events such as heart attacks or strokes (e.g. through the monitoring and management of high blood pressure). This approach constitutes 'secondary prevention'.
- *Tertiary avoidable mortality* (TAM) includes those conditions whose case fatality rate can be significantly reduced by existing medical or surgical treatments (typically, but not necessarily, in a hospital setting), even when the disease process is fully developed. This constitutes 'tertiary prevention'.

ICD codes of 'avoidable' conditions, and the assignment of these codes to the subcategories of PAM, SAM and TAM, are listed in the Appendix. All other causes of mortality are assumed to be 'unavoidable' for the purposes of this analysis. An 'expert consensus' method was used to partition causes among the three subcategories. Initial estimates of the proportions of each cause to be assigned to each subcategory were made by the authors (both public health physicians) based on an extensive review of the relevant literature.[8-28] These estimates were then reviewed and refined by an expert panel comprising clinicians and epidemiologists. The final proportions (weights) used are shown in the Appendix.

The NZDep96 index was used to stratify all avoidable and unavoidable deaths occurring in 1996 and 1997 by level of deprivation (as a proxy for socio-economic status). The NZDep96 score is derived from a principal components analysis of nine socio-economic variables from the 1996 Census, based on small areas with a median of 90 people (meshblocks). The NZDep96 scores were then grouped into deciles. To increase statistical stability and ease data presentation, for some analyses the deciles have been collapsed asymmetrically (reflecting the curvilinear relationship between deprivation and mortality) to create five deprivation strata: deciles 1–4 (least deprived group), deciles 5–6, deciles 7–8, decile 9, and decile 10 (most deprived group).

Results

From 1981 to 1997, all-cause mortality in the 0–74 age group fell 31% (see Figure 1). This was made up of a 9% fall in unavoidable mortality and a 38% fall in avoidable mortality. The 'excess' reduction in avoidable mortality – a fall of 29% over the period or more than 1.5% per year on average – represents the 'added value' of the health system (including health promotion and disease prevention as well as treatment services). In absolute terms this represents a gain of approximately 300 deaths avoided per year, or almost 5,000 fewer deaths in 1997 than expected based on 1981 mortality (adjusting for the underlying trend in unavoidable mortality).

Although the historical trend provides an indicator of progress, the current level of avoidable mortality indicates the scope that still remains for further health gain through health promotion, disease prevention and treatment. In 1996 or 1997, approximately 9,000 potentially avoidable deaths occurred per year – about 70% of all deaths occurring in people under 75 years of age (see Table 1). The majority of these potentially avoidable deaths are preventable (PAM), with early intervention (SAM) and medical treatment (TAM) making smaller contributions. The precise contributions of the three levels of intervention vary with age, gender, ethnicity and socio-economic status.

Variations by age

In each age group under 75 years, between 65% and 81% of all deaths are avoidable (see Table 2). In absolute terms, avoidable mortality is predominantly a feature of middle and (early) old age, with almost 80% of avoidable deaths occurring in people aged 45 years and over (1996-97 average). In all age groups, preventable conditions (PAM) dominate the pattern of avoidable mortality.

Among infants, the standout conditions are SIDS and low birthweight (see Table 3), with maternal smoking being the

Table 1: Avoidable deaths ages 0–74 by gender, average of 1996 and 1997. Source of base data: NZHIS.

	Number of deaths per year[a]			Age standardised rate[b]			Ratio	% of total
	Male	Female	Total	Male	Female	Total	M:F	deaths 0-74 age group
PAM[c]	3,009	1,642	4,741	150	83	116	1.8	37
SAM[c]	1,330	972	2,302	63	48	56	1.3	18
TAM[c]	1,140	842	1,982	57	44	50	1.3	15
Total avoidable mortality	5,569	3,456	9,025	270	175	223	1.5	70
Unavoidable mortality	2,298	1,563	3,861	109	78	94	1.4	30
Total mortality	7,867	5,019	12,886	379	253	316	1.5	100
Avoidable mortality as % all deaths	71	69	70					

Notes:
(a) Number and rate of deaths is the average for 1996 and 1997
(b) Rates are age-standardised to Segi's World population.
(c) PAM = primary avoidable mortality; SAM = secondary avoidable mortality; TAM = tertiary avoidable mortality.

common preventable exposure. Birth defects are sensitive to maternal folate and vitamin consumption, and birth trauma and asphyxia responds to effective obstetric care. Among children and youth, injuries dominate the avoidable mortality picture. Were it not for road traffic injury and suicide, only 20% of (remaining) deaths in the 15-24 age group would have been considered avoidable. Injury remains the leading contributor to avoidable mortality among young adults. Ischaemic heart disease (IHD) emerges for the first time, becoming the leading cause in middle and old age. The common cancers (breast, colorectal and lung) and (smoking related) chronic obstructive respiratory disease (CORD) occupy the remaining high rankings in the adult age groups.

Since 1981, avoidable mortality rates have fallen in every age group (see Table 4). The largest percentage reductions have occurred at both extremes of the 0–74 age range. The lowest reduction has been in the 15–44 age group; indeed, unavoidable causes have declined faster than avoidable causes in this age group. Given the dominance of injury among avoidable causes in those aged 15–44, this pattern reflects the net effect of moderate improvements in road safety offset by worsening suicide rates over this period.

Variations by gender

Males have a higher rate of avoidable mortality than females: age standardised rates of 270 per 100,000 and 175 per 100,000 in 1996-97 respectively. This represents a male excess of 54%, compared with a male disadvantage of 40% in unavoidable mortality. The gender difference in avoidable mortality is largely attributable to a higher rate of preventable deaths (PAM) (see Table 1).

The higher male avoidable mortality rate partly reflects the differential magnitude of the IHD epidemic in the two genders: if males and females had experienced the same IHD mortality rates in 1996 or 1997, approximately 1,200 fewer males (aged less than 75 years) would have died each year. Lung cancer is the next highest disease cause of avoidable death in males, and has a 210 death excess per year over females. Another contributor to the gender inequality in avoidable mortality is injury, males having much higher death rates than females for both suicide (290 excess deaths per year) and road traffic injuries (210 excess deaths).

There has been a faster rate of improvement in avoidable mortality for males than females since 1981 (see Figure 2). These trend differences may reflect the differential timing of the tobacco epidemic in the two genders, with smoking-related mortality falling in males (from a high base) but increasing in females (from a lower base) over the period concerned.

Variations by ethnicity

Mäori and Pacific people aged 0-74 years have much higher

Table 2: Avoidable mortality, by age, 1996-97. Source of base data: NZHIS.

	Number of deaths (and rate)[a]						
	Age: <1	1–14	15–24	25–44	45–64	65–74	Total
Avoidable mortality	325 (581)	139 (18)	393 (73)	926 (84)	3,043 (422)	4,200 (1703)	9,025
PAM[b]	168 (300)	68 (9)	223 (42)	473 (43)	1,564 (217)	2,247 (911)	4,741
SAM[b]	53 (95)	18 (2)	63 (12)	228 (21)	814 (113)	1,125 (456)	2,302
TAM[b]	104 (186)	53 (7)	107 (20)	224 (20)	665 (92)	829 (336)	1,982
Unavoidable mortality	78 (139)	77 (10)	114 (21)	422 (38)	1,334 (185)	1,838 (745)	3,861
Total mortality	403 (721)	216 (28)	506 (95)	1,347 (122)	4,377 (606)	6,038 (2448)	12,886
Avoidable mortality %	81	65	78	69	70	70	70

Notes:
(a) Number and rate of deaths is the average for 1996 and 1997 (age specific rate per 100,000 in brackets).
(b) PAM = primary avoidable mortality; SAM = secondary avoidable mortality; TAM = tertiary avoidable mortality.

rates of avoidable deaths than European/Others (see Table 5): in 1996-97 the Mäori avoidable death rate was 2.5 times and the Pacific rate 1.9 times that of European/Other New Zealanders. Had these rates been the same, Mäori would have experienced 970 fewer deaths and Pacific people 210 fewer deaths each year than actually occurred; this represents 45% and 35% of all Mäori and Pacific deaths in the 0-74 age group respectively.

Since the majority of avoidable deaths in all ethnic groups fall into the PAM subcategory, the scope for health gain – and equity gain – is clearly greatest through primary prevention strategies. Yet the largest *relative* difference is in SAM, where the rates are approximately 2.5 times greater for both Mäori and Pacific people. This subcategory includes conditions such as diabetes, high blood pressure, rheumatic heart disease and screenable cancers, all of which are amenable to early intervention and ongoing management in the primary or integrated care setting.

The major contributor to avoidable mortality in all ethnic groups is IHD (data not shown). Higher smoking rates, poorer diet and lower levels of physical activity all contribute to this ethnic differential. Higher Mäori smoking rates also contribute to other causes of avoidable mortality, including lung cancer and CORD. Diabetes, itself related to diet and physical activity levels, also makes a major contribution to the gap in avoidable mortality (for both Mäori and Pacific people), both as a direct cause of death and indirectly as a risk factor for IHD and stroke. Higher rates of fatal road traffic injuries (70 excess deaths per year in the 0–74 age group), SIDS (50 excess deaths) and rheumatic heart disease (30 excess deaths) also contribute to the high Mäori burden of avoidable mortality.

Variations by socio-economic status

Table 6 and Figure 3 illustrate the strong relationship between deprivation (measured using the NZDep96 index) and both avoidable and unavoidable mortality.

The impact of socio-economic inequality on mortality is summarised in Table 7. The size of this impact is noteworthy: if mortality in all socio-economic groups equalled that of the least deprived neighbourhoods (NZDep96 deciles 1–4), approximately 2,850 fewer deaths would have occurred in New Zealand in 1996 or 1997 in the 0–74 age group, including 2,160 fewer 'avoidable' deaths. This represents 18% of unavoidable and 24% of avoidable deaths.

Table 3: Major causes of avoidable mortality, by age, 1996-97.[a] Source of base data: NZHIS.

Age (years)	Condition	Deaths[b]	Percentage[c]
<1	SIDS	89	22
	Low birthweight	67	17
	Congenital anomalies	43	11
	Birth trauma and asphyxia	35	9
1–14	Road traffic injury	44	20
	Leukaemia	16	7
	Congenital anomalies	12	5
	Fire	11	5
15–24	Road traffic injury	169	33
	Suicide	147	29
	Drowning	16	3
25–44	Suicide	242	18
	Road traffic injury	171	13
	Ischaemic heart disease	108	8
	Breast cancer	63	5
45–64	Ischaemic heart disease	947	22
	Lung cancer	383	9
	Colorectal cancer	296	7
	Breast cancer	253	6
65–74	Ischaemic heart disease	1,513	25
	Lung cancer	545	9
	CORD[d]	459	8
	Colorectal cancer	351	6

Notes:
(a) 'Major' cause is a cause accounting for >5% of avoidable deaths in the age group.
(b) Deaths are per year averaged over two years 1996–97.
(c) Percentage is of all deaths (including unavoidable deaths) in that age group.
(d) CORD = chronic obstructive respiratory disease.

With few exceptions (certain cancers such as melanoma, and birth defects), all the conditions included in the 'avoidable mortality' category show a socio-economic gradient in cause specific mortality (data not shown). About half the excess avoidable deaths among people living in deprived areas can be attributed to IHD, stroke, diabetes, lung cancer and CORD. These conditions are common and have steep socio-economic gradients, with at least a two- to threefold difference in age standardised mortality rates between extreme groups

Table 4: Percentage fall in mortality rates, 1981 to 1997, by age and intervention category. Source of base data: NZHIS

	Percentage fall in rates from 1981 to 1997					
	Age: <1	1–14	15–24	25–44	45–64	65–74
PAM[a]	60	39	6	5	44	36
SAM[a]	63	44	60	39	45	41
TAM[a]	44	35	5	28	46	34
Total avoidable mortality	56	39	11	11	44	36
Unavoidable mortality	18	27	28	18	12	1
Total mortality	51	35	15	13	37	28

Notes:
(a) PAM = primary avoidable mortality; SAM = secondary avoidable mortality; TAM = tertiary avoidable mortality.

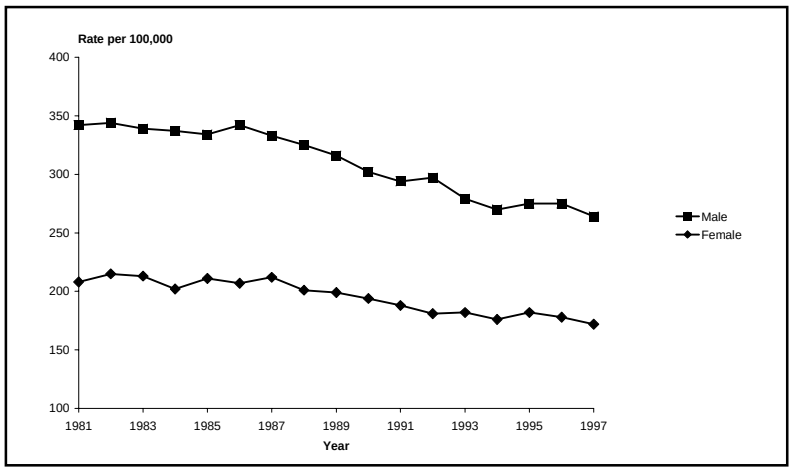

Figure 2: Avoidable mortality, by gender, 1981–97. Source of base data: NZHIS (1997 data are provisional).

Note: rate is age standardised to Segi's world population.

Discussion

Categorical attribution of diseases and injuries (coded as causes of death) as 'avoidable' or 'unavoidable' provides one way to identify the scope for health gain. This categorisation is not meant to imply that every death classed as 'avoidable' could in fact have been avoided – merely that the potential to do so exists. For this analysis, the categorisation of causes has been taken one step further, subdividing avoidable causes into three subcategories, representing different levels of intervention within the health system.

An upper age limit of 75 years is used in this analysis. This does not mean that some deaths involving people older than 75 years could not have been avoided, only that disentangling avoidable from unavoidable causes becomes problematic as the prevalence of co-morbidity increases. Indeed, Rutstein originally proposed avoidable mortality as a subset of premature mortality (since, by definition, only deaths occurring prematurely are potentially avoidable) and employed an arbitrary upper age limit of 65 years. For this analysis, the age limit has been extended to 75 years (roughly, the current New Zealand life expectancy at birth), so allowing a higher proportion of deaths (46% in 1996) to be categorisable.

Thus the concept of 'avoidability' applied here is wider than

Table 5: Avoidable mortality, ages 0–74, by ethnicity, 1996–97. Source of base data: NZHIS.

	Number[a]			Rate[b]			Ratio[c]		Excess[d]	
	Māori	Pacific	Euro	Māori	Pacific	Euro	Māori	Pacific	Māori	Pacific
TAM[e]	346	102	1,534	98	85	44	2.2	1.9	190	50
Total avoidable mortality	1,601	424	7,000	477	374	192	2.5	1.9	970	210
Unavoidable mortality	543	168	3,150	163	148	85	1.9	1.7	260	70
Total all mortality	2,144	592	10,150	640	523	278	2.3	1.9	1,240	280
Avoidable mortality as % all mortality	75	72	69							

Notes:
(a) Number = number of deaths, averaged over 1996 and 1997.
(b) Rate = age standardised rate per 100,000.
(c) Ratio = ratio of rate to Euro (= European and other ethnic groups).
(d) Excess = number of excess deaths in group compared with European/Other group.
(e) TAM = tertiary avoidable mortality.

Table 6: Avoidable mortality, ages 0–74, by NZDep96 decile, 1996–97. Source of base data: NZHIS.

	Number of deaths per year by NZDep96 decile					Rate per 100,000, by NZDep96 decile[a]					Ratio[b]
	1–4	5–6	7–8	9	10	1–4	5–6	7–8	9	10	
PAM[c]	1,403	925	1,080	597	690	92	121	136	165	202	2.2
SAM[c]	697	457	526	267	337	45	58	66	73	98	2.2
TAM[c]	622	388	436	234	277	43	53	57	66	81	1.9
Total avoidable mortality	2,722	1,770	2,042	1,098	1,304	180	232	259	303	382	2.1
Unavoidable mortality	1,269	770	876	419	485	82	99	110	115	141	1.7
Total mortality	3,991	2,539	2,918	1,517	1,789	261	332	369	418	522	2.0
AM as % of all deaths	68	70	70	72	73						

Notes:
(a) Rate is age standardised to Segi's world population.
(b) Ratio is decile 10 to decile 1–4.
(c) PAM = primary avoidable mortality; SAM = secondary avoidable mortality; TAM = tertiary avoidable mortality.

Table 7: Excess deaths from avoidable causes, by NZDep96 decile, 1996–97. Source of base data: NZHIS.

	Excess deaths, by NZDep96 decile[a]					Percentage
	5–6	7–8	9	10	Total	of deaths[b]
PAM[c]	220	350	260	380	1,220	26
SAM[c]	110	170	100	180	560	25
TAM[c]	70	110	80	130	390	20
Total avoidable deaths	400	620	450	690	2,160	24
Unavoidable deaths	140	230	120	200	690	18
Total all deaths	540	850	570	890	2,850	22

Notes:
(a) Excess deaths are relative to least deprived group (deciles 1–4).
(b) Percentage is of all deaths in the category.
(c) PAM = primary avoidable mortality; SAM = secondary avoidable mortality; TAM = tertiary avoidable mortality.

the original conception both in the range of conditions considered potentially avoidable and in the (arbitrary) upper age limit applied to the category. While these extensions are intended to enhance the construct validity of avoidable mortality as an indicator of the scope or potential for future population health gain, such enhancements come at a cost: first, our results cannot be compared with earlier New Zealand studies or international data; second, the usefulness of the indicator as a measure of health care system performance is lost.

The categorisation of causes of death into avoidable/unavoidable was relatively straightforward, and is in line with the literature referenced. The subcategorisation into primary/secondary/tertiary using relative weightings (for which see appendix) was more challenging. An expert consensus process was used in the absence of any more objective method for assigning the weights. Further work in this area is warranted.

The indicator has been constructed to measure the theoretical scope for further population health gain, not what may be considered feasible given current technology, available resources and competing values. For example, road traffic deaths are considered avoidable, even though the total avoidance of such deaths may involve a greater sacrifice of mobility and consumption of health care resources than any society appears willing to make. Breast cancer deaths are considered avoidable, even though one might realistically expect less than a 50% reduction in mortality from this cause were all available interventions applied.

Inclusion of a measure of effectiveness of the intervention(s) involved would yield a more realistic indicator of perhaps greater policy relevance. However, incorporation of such an effectiveness assessment would introduce yet another level of uncertainty into the analysis. As it stands, the indicator provides a reasonably robust measure of the *potential* scope for health gain. Conditions can be selected on this basis, and then examined in terms of the cost effectiveness of the interventions available for them. Such a two-phase analysis could provide a useful input to both health services and research policy.

The results reported here demonstrate that in New Zealand avoidable mortality (expanded definition) in the 0-74 age range declined by 38% from 1981 to 1997, compared with a decline of only 9% in unavoidable mortality. This difference in trend (amounting to approximately 5,000 fewer deaths in 1997 than expected, based on 1981 mortality rates) is a measure of the success of New Zealand society as a whole (including population based interventions, i.e. health promotion/healthy public policy) in reducing fatal outcomes. Even so, in 1996-97 almost 70% of deaths in the 0-74 age range (approximately 9,000 deaths) were still considered to be potentially avoidable.

Although the proportion of deaths categorised as avoidable does not vary much across age groups, the exponential rise in mortality with age means that almost 80% of all avoidable deaths occur

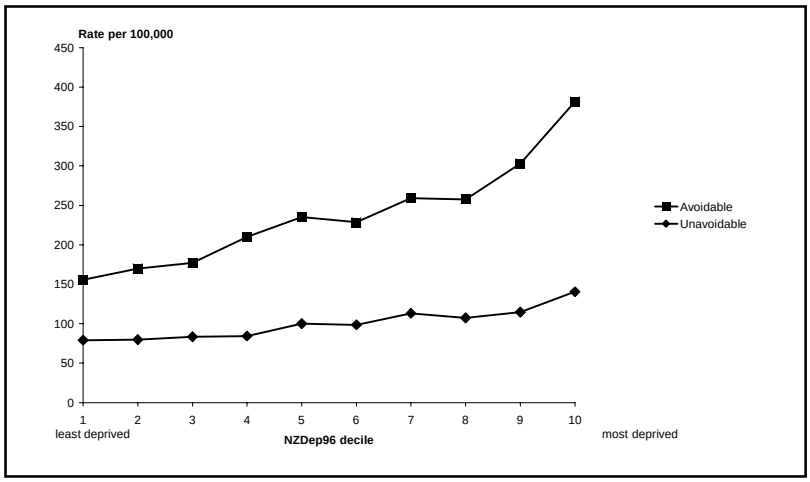

Figure 3: Avoidable and unavoidable mortality, by NZDep96 decile, ages 0–74, 1996–97. Source of base data: NZHIS.

Note: rate is age standardised to Segi's world population.

in the 45-74 age group. These deaths are dominated by the emergence of chronic diseases such as IHD, diabetes and smoking-related cancers. In younger age groups, injury (including suicide) dominates avoidable mortality. Not surprisingly, these age groups have experienced less improvement in avoidable mortality rates over the past one to two decades than have the older age groups.

Both chronic disease and injury (and their respective risk and protective factors) must therefore be targeted by policies designed to reduce the toll of avoidable deaths. While medical treatment could achieve considerable health gain, primary preventive strategies (such as reducing smoking and improving diet and physical activity) and secondary preventive services (such as management of high blood pressure, diabetes and cancer screening) appear to hold the key to substantive reductions in these causes of death.

Males experience a greater burden of avoidable mortality than females – a relative excess of 54% (corresponding to approximately 2,000 excess avoidable deaths) in 1996-97. The gender difference is largely attributable to diseases and injuries amenable to primary prevention, with the largest single contribution coming from ischaemic heart disease. The downward trend in avoidable mortality since 1981 has been steeper for males than females, narrowing the gender differential. This mirrors the changes that have occurred in IHD mortality rates.

The ethnic gap in avoidable mortality remains wide: rates for Mäori and Pacific people were 2-2½ times higher than European rates in 1996-97. In absolute terms, the greatest scope for narrowing the ethnic gap is in primary prevention – reducing disparities in socio-economic status and in lifestyle (smoking, diet, physical activity).

Similar gradients are seen with socio-economic status (SES), using the NZDep96 score as a proxy measure for individual SES. Eliminating the socio-economic gradient in AM would postpone more than 2,000 deaths per year. The gradient is steepest for SAM and flattest for TAM, mirroring the ethnic differences. People with lower SES, and Mäori and Pacific people, appear less able to access preventive/primary health care services. Health education messages may be less relevant or culturally appropriate for these groups; alternatively, the resources needed to respond to these messages may be unavailable. Instead, policies aimed at modifying the social environment (such as policies aimed at income redistribution, labour force participation, school retention and housing need) would appear more likely to contribute to closing the gaps. It is worth noting that policies focusing solely on the most disadvantaged group (a 'high risk' strategy) will have limited effectiveness (see, for example, Figure 3 – more excess deaths emanate from deciles 5-9 than from decile 10 alone). A population-based strategy addressing the whole gradient is likely to have greater impact.

This analysis of avoidable mortality in New Zealand in the mid- to late-1990s has revealed significant scope for the health sector – and for social policy and services more generally – to contribute to population health gain and, in particular, to improvement in equity of outcomes across ethnic and socio-economic groups. Such analyses provide a potentially valuable evidence base on which policy advice relating to specific interventions designed to achieve health gain and close health gaps could be developed. The method developed here may also be of use to the newly established District Health Boards as they seek to assess the health needs of their local communities and set local health targets.

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Appendix: Avoidable causes of mortality

Potentially avoidable condition	ICD 9 CM range	Conditions involved	Proportion in each category			Primary prevention	Secondary prevention	Tertiary prevention	Refs
			PAM	SAM	TAM				
Enteritis and other diarrhoeal diseases	001–999	Diarrhoeal diseases	0.7	0.1	0.2	Hygiene, overcrowding, food handling, water quality	Case detection, contact tracing	Treatment	4
Tuberculosis	010–018, 137	Tuberculosis	0.6	0.35	0.05	Immunisation, hygiene, overcrowding, housing	Screening, early detection, contact tracing, DOT	Treatment of complications	4
Immunisation – preventable	032–033, 037, 045, 055–056, 3200, 7710, 7713	Diphtheria, whooping cough, tetanus, polio, Hib, measles, rubella	0.9	0.05	0.05	Immunisation	Case detection, contact tracing, isolation	Treatment of complications	4,8
HIV/AIDS	042	HIV/AIDS	0.9	0.05	0.05	Safe sex, safe IV	Case detection, contact tracing, prophylactic medication	Treatment	11
Hepatitis and liver cancer	070, 155	Hepatitis A, B, C, D, E, primary liver cancer	0.7	0.1	0.2	Immunisation, hygiene, sexual behaviour modification, safe IV	Case detection, contact tracing, case monitoring	Anti viral, treatment surgery	11,28
Sexually transmitted diseases	090–099, 6140–6145, 6147–6169, 633	Syphilis, gonorrhoea + other STDs, ectopic pregnancy	0.8	0.1	0.1	Health education, sexual behaviour modification, safe sex	Case detection, contact tracing, prophylactic medication	Treatment	9,11
Skin cancers	140, 172, 173	Lip, melanoma, other skin cancer	0.6	0.1	0.3	Sun smart	Case detection	Surgery, chemo, radiotherapy	4
Colorectal cancer	153–154	Colorectal cancer	0.4	0.5	0.1	Diet, physical activity	Case detection, screening	Surgery, chemo, radiotherapy	12,14, 15,26
Oral cancers	141, 143–6, 148–9, 161	Malignant neoplasm mouth, pharynx, larynx	0.8	0.1	0.1	Smoking, diet, alcohol, tobacco control	Case detection	Surgery, chemo, radiotherapy	14,28
Lung cancer	162	Malignant neoplasm trachea, bronchus, lung	0.95	0	0.05	Tobacco control	–	Surgery, chemo, radiotherapy	4,14
Breast cancer	174	Breast cancer	0.15	0.35	0.5	Diet, physical activity, obesity, alcohol, breast feeding	Mammography, case detection, genetics	Surgery + other treatments	4,14, 26
Nutrition	260–9, 280, 281	Nutritional deficits including anaemia	1	0	0	Health education			8
Alcohol related conditions	291, 303, 3050, 4255, 5353, 5710–3	Psychosis, alcoholism, cardiac, gastric or liver damage due to alcohol	0.9	0	0.1	Primary prevention		Surgery + other treatments	4,11, 28
CORD	490–492, 496	Chronic bronchitis and emphysema	0.8	0.1	0.1	Smoking, immunisation (for influenza)	Prophylactic treatment, oxygen	Treatment of exacerbation, pulm rehab	8
IHD	410–414	Ischaemic heart disease	0.5	0.25	0.25	Smoking, diet, physical activity, etc	Rx hypertension, cholesterol, etc	Acute treatment, surgery	9,10
Stroke	431, 433, 434, 436	Intracerebral haemorrhage or occlusion	0.3	0.5	0.2	Smoking, diet, physical activity, etc	Anti hypertensive treatment	Stroke units, rehabilitation, surgery	4,27
Neural tube defects	740–742	Congenital anomalies of brain and spinal cord	0.6	0.2	0.2	Folate, antenatal care	Obstetric/neonatal care	Obstetric/neonatal care	20
Low birthweight babies	764–765, 769, 7707	Prematurity, low birthweight, respiratory disease from prematurity	0.5	0.1	0.4	Smoking, prenatal care	Antenatal care, use of beta agonist and corticosteroids, obstetric/neonatal care	Obstetric/neonatal care	4
SIDS	7980	SIDS	1	0	0	Sleep position, breastfeeding, tobacco control			11
Road traffic injury	810–829	Road traffic injury	0.6	0	0.4	Driver education, car/ environment safety, alcohol, seat belts, child car seats, bike helmets		Emergency services, treatment	4,11,24
Poisoning	850–869	Poisoning	0.6	0	0.4	Poison safety, child proof caps, education		Treatment	11,24
Swimming pool injury	8830, 9105, 9106	Swimming pool falls and drownings	0.8	0	0.2	Fencing of pools, swimming, education		Treatment	11
Sport injury	8840, 8845, 8860, 9170, 927	Falls from playground equipment, sport injury	0.6	0	0.4	Education, safe equipment, adherence to rules		Treatment	22,23
Fire	890–899	Burns and scalds	0.8	0	0.2	Smoke alarms, fire safety, NZ standards		Emergency services, treatment	11,24
Drowning	910–9104, 9107–9109, 984	Drowning	0.8	0	0.2	Swim safe, life jackets, alcohol safety		Emergency services, treatment	11
Suicide	950–959, 980–989	Suicide	0.6	0.3	0.1	Mental health, employment, social networks, reduction of opportunity	Potential case detection, treatment of depression	Treatment of consequential injury	11

Potentially avoidable condition	ICD 9 CM range	Conditions involved	Proportion in each category PAM	SAM	TAM	Primary prevention	Secondary prevention	Tertiary prevention	Refs
Other infections	023–031, 034–036, 084, 320, 3201–3209, 7700, 7711–2, 7714–9	Brucellosis + other zoonoses, streptococcus, malaria, meningitis, congenital	0.3	0.4	0.3	Hygiene, overcrowding, food handling, water, animal handling/ treatment	Case detection, contact tracing	Treatment	8
Cervical cancer	180	Cervical cancer	0.3	0.5	0.2	Sexual behaviour modification, smoking	Screening, cytology	Surgery + other treatments	4
Thyroid disease	240–242, 244	Goitre, thyrotoxicosis, hypothyroidism	0.1	0.7	0.2	Iodine	Case detection, thyroxine	Surgery + other treatments	9
Newborn screening conditions	243, 2552, 2701, 2711	Congenital hypothyroidism, CAH, PKU, galatosaemia	0	0.8	0.2		Newborn screening	Treatment	16
Diabetes	250	Diabetes	0.3	0.6	0.1	Obesity, diet, physical activity	Case detection, treatment, monitoring	Treatment of complications	9
Epilepsy	345	Epilepsy	0	0.9	0.1		Prophylactic treatment	Treatment of seizures	9
Ear infections	381–383	Otitis media and mastoiditis	0.1	0.7	0.2	Hygiene, overcrowding, housing	Case detection, early treatment avoiding complications	Treatment of complications, e.g. grommets	8
Rheumatic fever/ heart disease	390–398	Acute rheumatic fever, heart disease	0.3	0.6	0.1	Hygiene, overcrowding, housing	Case detection, Rx of Strep, penicillin prophylaxis	Treatment, cardiac surgery	4
Hypertensive disease	401–405, 4372	Hypertensive disease	0.3	0.65	0.05	Obesity, diet, physical activity	Case detection, anti hypertensive medication	Treatment of complications	4
Respiratory infections	460–466, 480–487	Respiratory infections including pneumonia and influenza	0.4	0.5	0.1	Hygiene, overcrowding, housing, smoking	Immunisation, case detection, early treatment avoiding complications	Treatment of complications	8
Asthma	493	Asthma	0.1	0.7	0.2	Housing, smoking, allergen avoidance	Prophylactic treatment, care pathways	ED care, emergency treatment	4
Peptic ulcer	531–534	Gastric and duodenal ulcers	0.05	0.75	0.2	Diet	Diagnosis, preventive treatment	Treatment of complications, surgery	4
Pregnancy complications	630–632, 634–676	Complications of pregnancy	0.2	0.5	0.3	Smoking, alcohol/drug	Antenatal care, obstetric care	Obstetric care	4
Musculoskeletal infections	680–686, 711, 730	Skin, bone and joint infections	0.2	0.5	0.3	Hygiene, overcrowding, housing	Case detection, early treatment avoiding complications	Treatment of complications, surgery	8
Stomach cancer	151	Stomach cancer	0.4	0.2	0.4	Food care, diet, refrigeration	Case detection	Surgery, other treatments	26
Cancer of uterus	182, 179	Cancer of uterus	0.1	0.4	0.5	Sexual behaviour modification, obesity	Case detection	Surgery, chemo / radiotherapy	8
Cancer of testis	186	Cancer of testis	0	0.3	0.7		Case detection	Surgery, chemo / radiotherapy	4,28
Eye cancer	190	Eye cancer	0	0	1		Case detection	Surgery, chemo /	13
Thyroid cancer	193	Thyroid cancer	0.1	0.2	0.7	Iodine	Case detection	Surgery, chemo / radiotherapy	21
Hodgkin's disease	201	Hodgkin's disease	0	0.1	0.9		Case detection	Surgery, chemo / radiotherapy	4,28
Leukaemia	204	Lymphoid leukaemias	0.05	0.05	0.9	Infection avoidance(?)	Case detection	Chemo /radio therapy, bone marrow transplant	4,17
Benign cancers	210–234	Benign & *in situ* cancers	0	0	1		Case detection	Surgery	
Appendicitis	540–543	Appendicitis	0	0	1			Diagnosis, surgery	4
Intestinal obstruction and hernia	550–553, 560	Intestinal obstruction and hernia	0	0	1			Diagnosis, surgery	4
Gallbladder disease	574–57699	Gallbladder disease	0.2	0	0.8	Diet, obesity		Diagnosis, surgery	4
Acute renal failure	584	Acute renal failure	0.1	0.2	0.7	Avoidance of NSAIDs and other causes of renal disease	Preventive treatment of renal diseases	Dialysis	19
Congenital anomalies	743–7466, 7468–7479, 749–757	Congenital cardiac, digestive, genito-urinary, musculoskeletal anomalies	0.1	0.2	0.7	Prenatal care – avoidance of teratogens	Antenatal care, obstetric/neonatal care	Surgery	4,25
Birth trauma and asphyxia	767–768, 7701, 7720, 7723	Birth trauma and asphyxia	0.1	0.4	0.5	Smoking, prenatal care	Antenatal care, obstetric/ neonatal care	Obstetric/ neonatal care	4
Other perinatal conditions	766, 769, 7702–6, 7708–9, 7721–2, 7724–9,773–779	Respiratory disease, haemolytic disease, jaundice, etc	0.3	0.2	0.5	Smoking, prenatal care	Antenatal care, obstetric/ neonatal care	Obstetric/ neonatal care	4
Iatrogenic conditions	870–879	Complications of treatment	0	0.2	0.8	Clinical safety, standards, governance		Recognition and treatment of complications, clinical safety	18