

Projecting the future burden of lung cancer in Aotearoa New Zealand: informing screening implementation through regional and ethnic projections to 2045

Michael Walsh, Kate Parker, Sue Crengle, Karen Bartholomew

ABSTRACT

AIM: Lung cancer is the leading cause of cancer-related death in Aotearoa New Zealand and a major contributor to health inequities, particularly among Māori and Pacific peoples. Despite declines in smoking prevalence, lung cancer incidence remains high. Detailed projections are needed to inform future cancer service planning and support cancer control strategies.

METHODS: An age-period-cohort Poisson regression model was fitted to national cancer registry data (2001–2022), stratified by sex, prioritised ethnicity, age group and Health New Zealand – Te Whatu Ora region. Time-based weighting and non-parametric bootstrapping were used to derive projections and uncertainty intervals to 2045.

RESULTS: Annual lung cancer cases are projected to increase by 38.3%, from 2,544 in 2020–2022 to 3,519 in 2045 (95% uncertainty interval [UI] 3,275–3,771), despite a decline in the age-standardised rate from 28.2 to 23.6 per 100,000 (95% UI 21.6–25.7). Substantial ethnic inequities persist. Māori cases are projected to rise from 570 to 1,063 (an 86.5% increase), and Pacific cases from 129 to 245 (an 89.9% increase). Although rates are projected to fall across all groups, Māori are expected to continue to experience the highest rates. Regional variation is also evident, with the Northern Region projected to experience the largest increase in case numbers, from 872 to 1,280 by 2045.

CONCLUSION: Although age-standardised incidence rates are expected to decline, rising case numbers indicate growing demand for diagnostic and treatment services. These projections support the need for equitable implementation of lung cancer screening and sustained investment in culturally responsive prevention and cessation support.

Lung cancer remains a pressing public health challenge in Aotearoa New Zealand. It is highly preventable and consistently among the most commonly diagnosed cancers and is the leading cause of cancer-related death, accounting for a large proportion of total cancer mortality.¹ Despite reductions in smoking prevalence, the incidence of lung cancer remains high, with persistent inequities by ethnicity. Māori and Pacific peoples continue to experience disproportionately high rates of lung cancer incidence and mortality along with poorer survival outcomes.^{1,2}

Smoking is the primary risk factor for lung cancer, accounting for approximately two-thirds of all lung cancers worldwide.³ In Aotearoa New Zealand, lung cancer accounts for just over 30% of all smoking attributable deaths; the figure is higher among Māori where it accounts for nearly 38%.⁴ Lung cancer is also a major contributor to the life expectancy gap between Māori and non-

Māori in Aotearoa New Zealand, accounting for nearly 1 year of the gap, the largest contributor among any individual cause of death.⁴

These disparities in lung cancer, particularly among Māori, reflect not only differences in smoking exposure but also later-stage diagnosis, barriers to timely treatment and broader systemic inequities across the cancer care continuum.^{2,5} Addressing the burden of lung cancer is essential for reducing preventable mortality and making meaningful progress in closing the persistent life expectancy gaps.

Despite gains in tobacco control, particularly among younger age groups, the long latency period of lung cancer means that the full benefits of reduced smoking prevalence take some time to be reflected in incidence trends.⁶ The emergence of new nicotine products such as e-cigarettes and heated tobacco, combined with recent legislative changes including the repeal of elements of Aotearoa New

Zealand's Smokefree legislation and recent data showing smoking rates may have plateaued, adds further uncertainty to future trajectories in lung cancer.⁷⁻⁹ This uncertainty is evolving alongside work to progress policy and implementation of a targeted lung cancer screening (LCS) programme designed for the local context.¹⁰ LCS programmes are increasingly recognised as high-impact components of equitable lung cancer control.^{11,12}

In addition to tobacco-related lung cancers, international evidence indicates that lung cancer among people who have never smoked accounts for a growing proportion of the global lung cancer burden. Analyses drawing on Global Cancer Observatory data show that this pattern is most evident in populations with declining smoking prevalence, with adenocarcinoma the dominant subtype.¹³ While smoking status-specific incidence trends are not routinely reported in Aotearoa New Zealand, non-smoking-related pathways may represent an increasingly relevant component of future lung cancer burden.

Estimates of future lung cancer incidence for Aotearoa New Zealand remain limited in scope. Most projections are confined to the national level, offering little insight into regional or ethnic variation, which are important dimensions for effective service planning.¹⁴ In the context of demographic change, healthcare reform and persistent inequities, there is a clear need for more granular projections to enable the recently formed national cancer clinical network Te Aho o Te Kahu – Cancer Control Agency and health service regional planners to better anticipate emerging pressures and support more responsive, equitable care, and implement optimal cancer care pathways.¹⁵

This analysis addresses an evidence gap in understanding the future burden of lung cancer in Aotearoa New Zealand. Results are disaggregated by ethnicity, sex and Health New Zealand – Te Whatu Ora region to better inform service planning, support the detailed work towards the design of a national LCS programme and ensure that efforts to reduce the burden of lung cancer are guided by intentional equity-focussed action.

Methods

Data sources

National cancer registry data for Aotearoa New Zealand were used to model lung cancer incidence trends from 2001 to 2022 and to

generate projections through to 2045. The dataset included all primary lung cancer registrations (International Classification of Diseases, 10th revision [ICD-10] codes C33 and C34), stratified by calendar year, 5-year age group, sex, prioritised ethnicity (Māori, Pacific, Asian, European/Other) in line with Health Information Standards Organisation 10001:2017 protocols¹⁶ and the four Health New Zealand regions. Prioritised ethnicity was applied to ensure mutually exclusive groups, to align with national reporting standards and to enable monitoring of equity across population groups. However, prioritised ethnicity has been shown to undercount and misclassify some groups, and therefore may underestimate the burden for some populations, particularly Māori and Pacific peoples.¹⁷⁻¹⁹ Population estimates for 2001–2022 and official population projections for 2023–2045 with the same stratification were sourced from Statistics New Zealand. These projections were used as denominators in the projection period so that expected future population growth, ageing and ethnicity are reflected in the projected case numbers.

Modelling approach

An age-period-cohort (APC) generalised linear model with a Poisson distribution and log link was fitted to lung cancer registry data. The outcome was the count of incident lung cancer cases, with the natural logarithm of the population included as an offset. Covariates comprised categorical age group, calendar year (period), and birth cohort (derived as year minus age), with main effects for sex, prioritised ethnicity and Health New Zealand region.

The APC structure, incorporating both period (calendar year) and cohort effects alongside age, was based on the modelling approach used in the Nordpred cancer prediction model developed in Norway.²⁰ Although the Nordpred model provides an established foundation for cancer incidence forecasting using APC methods, a new model was developed that aligned better to the characteristics of the Aotearoa New Zealand data and policy context. This included the need for flexible stratification by prioritised ethnicity, region, sex and age group, and the ability to retain small or zero case counts across granular strata.

Despite the collinearity between age, period and cohort, this structure was retained to reflect distinct underlying influences on cancer incidence trends. In this analysis, the overall linear trend in incidence was captured through

the inclusion of period and cohort terms within the APC framework, alongside categorical age groups. As a result, the long-term temporal trend informing projections reflects the combined linear components of period and cohort effects rather than an explicitly constrained drift term.

No interaction terms were included between covariates to reduce the risk of overfitting and maintain model interpretability, particularly in strata with sparse data. Because sex, prioritised ethnicity and region entered the model as main effects without interactions with age, period or cohort, all groups share the same underlying APC temporal pattern, with constant multiplicative differences between groups on the log scale. Small or zero case counts were retained and the use of bootstrapping (discussed below) helped address instability in sparse strata. Population counts were treated as fixed offsets to estimate incidence rates directly. To emphasise recent trend data while retaining longer-term historical patterns, a time-based weighting scheme was applied, using an increasing function of calendar year that up-weighted more recent observations while retaining influence from earlier years. All analyses were undertaken in R (version 4.4.3; R Core Team, 2024).

Bootstrap procedure and projection uncertainty

Uncertainty in the projections was quantified using non-parametric bootstrapping. For each of 1,000 iterations, historical registry records were resampled with replacement within calendar-year strata, preserving the observed mix of age, sex, ethnicity and region within each year while allowing variability in case counts. For each resampled dataset, population denominators were perturbed multiplicatively by independent normal noise with mean 1 and a standard deviation of 0.01, truncated at a minimum of one person. The time-weighted Poisson APC model was then refitted to each bootstrap dataset.

For the projection period, population denominators were similarly perturbed multiplicatively by independent normal noise with mean 1, with the standard deviation increasing across the projection horizon (0.005 for 2023–2025, 0.010 for 2026–2030, 0.015 for 2031–2035, 0.020 for 2036–2040 and 0.025 for 2041–2045) to reflect growing uncertainty in population forecasts. Across the 1,000 bootstrap replicates, the median projected case count and the 2.5th and 97.5th percentiles were used as the point estimate and 95% uncertainty

interval (UI) respectively.

Age-standardised rates (ASRs)

ASRs were calculated for both observed and projected data from 2001 to 2045. Rates were stratified by year, Health New Zealand region, sex and prioritised ethnicity. All rates used a consistent age-group structure aligned with the modelling dataset. The 2001 World Health Organization population standard was used as the standard population.

Study approval

This study was considered low risk and was out of scope for the Health and Disability Ethics committee. Locality authorisation including Māori research review was granted by Health New Zealand – Waitematā District, Research & Knowledge Centre (approval code: WAI20420).

Results

National and regional projections

Nationally, lung cancer cases are projected to increase from 2,544 in 2020–2022 to over 3,500 annually by 2045 (95% UI 3,275–3,771), representing a 38.3% rise in total cases (Table 1). Despite this increase in case numbers, the ASR is projected to decline from 28.2 per 100,000 (95% confidence interval [CI] 27.6–28.9) to 23.6 (95% UI 21.6–25.7), a relative decrease of 16.3%.

In the Northern Region, total lung cancer cases are projected to grow from 872 to 1,280 by 2045 (95% UI 1,187–1,379), an increase of 46.8%. The ASR is projected to decrease from 29.2 (95% CI 28.0–30.3) to 23.3 (95% UI 21.3–25.5), a 20.2% decline. Increases are observed for both sexes, with female cases rising from 444 to 639 and male cases from 427 to 640 (Table 2). However, ASRs for both groups are projected to decline.

In Te Manawa Taki, total cases are projected to rise from 573 to 803 (95% UI 743–866), a 40.1% increase. The ASR is projected to fall from 30.3 (95% CI 28.8–31.8) to 25.9 (95% UI 23.6–28.4), a relative drop of 14.5%. Among females, case numbers are projected to increase from 299 to 402 by 2045, with ASRs declining from 30.4 to 24.3. For males, cases are expected to rise from 274 to 401, and ASRs to decline from 30.5 to 27.7.

In the Central Region, lung cancer cases are projected to grow from 488 to 640 (95% UI 589–689) by 2045, marking a 31.1% increase. The ASR is projected to drop from 27.3 (95% CI 25.9–28.8) to 24.0 (95% UI 21.9–26.3), a 12.1% decline.

Table 1: National lung cancer projections—total population.

	National	Northern	Te Manawa Taki	Central	Te Waipounamu
2020–2022					
Observed ^a	2,544	872	573	488	611
ASR ^b	28.2 (27.6–28.9)	29.2 (28.0–30.3)	30.3 (28.8–31.8)	27.3 (25.9–28.8)	26.1 (24.9–27.3)
Population ^h	5,110,975	1,923,710	1,012,335	970,830	1,204,100
2035					
Projected ^c	3,239 (3,082–3,397)	1,148 (1,089–1,210)	739 (697–781)	602 (568–636)	751 (709–793)
ASR ^d	25.5 (23.9–27.3)	25.6 (23.9–27.4)	27.9 (25.9–30.0)	25.6 (23.8–27.5)	23.4 (21.8–25.1)
% Change in cases ^e	27.3%	31.7%	29.0%	23.4%	22.9%
Population ^h	5,852,415	2,289,580	1,160,290	1,048,910	1,353,635
2045					
Projected ^c	3,519 (3,275–3,771)	1,280 (1,187–1,379)	803 (743–866)	640 (589–689)	798 (738–861)
ASR ^d	23.6 (21.6–25.7)	23.3 (21.3–25.5)	25.9 (23.6–28.4)	24.0 (21.9–26.3)	21.7 (19.8–23.8)
% Change in cases ^e	38.3%	46.8%	40.1%	31.1%	30.6%
% Annual change cases ^f	1.4%	1.7%	1.5%	1.2%	1.2%
% Change ASR ^g	–16.3%	–20.2%	–14.5%	–12.1%	–16.9%
Population ^h	6,208,355	2,488,585	1,227,125	1,082,925	1,409,720

^a Average observed cases per year over the period.

^b Age-standardised rate (ASR) over the 3-year period with 95% confidence intervals.

^c Projected cases with 95% uncertainty intervals.

^d ASR of projected cases with 95% uncertainty intervals.

^e Total percentage change in cases from observed 2020–2022 average.

^f Annual percentage change represents the compound annual growth rate (CAGR) between the 2020–2022 average and 2045.

^g Total percentage change in the ASR from observed 2020–2022.

^h 2021 estimated resident population, 2035 and 2045 population projection; some figures may not sum to total due to rounding.

Table 2: National lung cancer projections—by sex.

	National	Northern	Te Manawa Taki	Central	Te Waipounamu
Female					
2020–2022					
Observed ^a	1,313	444	299	269	300
ASR ^b	28.1 (27.2–29.0)	28.5 (27.0–30.1)	30.4 (28.3–32.5)	29.0 (26.9–31.1)	24.8 (23.1–26.5)
Population ^h	2,570,115	968,540	510,070	493,290	598,215
2035					
Projected ^c	1,606 (1,525–1,685)	571 (541–602)	370 (349–390)	301 (284–318)	365 (345–386)
ASR ^d	23.7 (22.2–25.4)	23.8 (22.2–25.5)	26.1 (24.2–28.1)	23.8 (22.2–25.6)	21.6 (20.1–23.3)
% Change in cases ^e	22.3%	28.6%	23.7%	11.9%	21.7%
Population ^h	2,938,795	1,152,260	583,410	532,370	670,755
2045					
Projected ^c	1,750 (1,625–1,875)	639 (591–685)	402 (372–432)	320 (295–344)	388 (358–420)
ASR ^d	22.0 (20.1–24.9)	21.7 (19.8–23.8)	24.3 (22.1–26.8)	22.4 (20.3–24.6)	20.0 (18.2–22.0)
% Change in cases ^e	33.3%	43.9%	34.4%	19.0%	29.3%
% Annual change cases ^f	1.3%	1.6%	1.3%	0.8%	1.1%
% Change ASR ^g	–21.7%	–23.9%	–20.1%	–22.8%	–19.4%
Population ^h	3,113,315	1,251,260	615,865	548,600	697,590
Male					
2020–2022					
Observed ^a	1,231	427	274	219	311
ASR ^b	28.7 (27.8–29.7)	30.1 (28.5–31.8)	30.5 (28.4–32.7)	25.8 (23.8–27.9)	27.7 (25.9–29.6)
Population ^h	2,540,860	955,170	502,265	477,540	605,885
2035					
Projected ^c	1,634 (1,548–1,717)	577 (545–610)	370 (348–391)	301 (283–318)	386 (363–408)
ASR ^d	27.5 (25.6–29.4)	27.6 (25.7–29.6)	29.8 (27.6–32.2)	27.6 (25.5–29.7)	25.3 (23.4–27.3)
% Change in cases ^e	32.7%	35.1%	35.0%	37.4%	24.1%

Table 2 (continued): National lung cancer projections—by sex.

	National	Northern	Te Manawa Taki	Central	Te Waipounamu
Population ^h	2,913,620	1,137,320	576,880	516,540	682,880
2045					
Projected ^c	1,772 (1,640–1,902)	640 (593–691)	401 (371–433)	319 (294–345)	410 (379–442)
ASR ^d	25.3 (23.2–27.6)	25.1 (22.9–27.5)	27.7 (25.1–30.4)	25.8 (23.4–28.3)	23.4 (21.2–25.8)
% Change in cases ^e	43.9%	49.9%	46.4%	45.7%	31.8%
% Annual change cases ^f	1.6%	1.8%	1.7%	1.6%	1.2%
% Change ASR ^g	–11.8%	–16.6%	–9.2%	0.0%	–15.5%
Population ^h	3,095,035	1,237,325	611,260	534,325	712,125

^a Average observed cases per year over the period.

^b Age-standardised rate (ASR) over the 3-year period with 95% confidence intervals.

^c Projected cases with 95% uncertainty intervals.

^d ASR of projected cases with 95% uncertainty intervals.

^e Total percentage change in cases from observed 2020–2022 average.

^f Annual percentage change represents the compound annual growth rate (CAGR) between the 2020–2022 average and 2045.

^g Total percentage change in the ASR from observed 2020–2022.

^h 2021 estimated resident population, 2035 and 2045 population projection; some figures may not sum to total due to rounding.

Female cases are projected to rise from 269 to 320, and male cases from 219 to 319, with ASRs declining in both groups.

In Te Waipounamu, lung cancer cases are projected to increase from 611 to 798 (95% UI 738–861), representing a 30.6% rise. The ASR is projected to decline from 26.1 (95% CI 24.9–27.3) to 21.7 (95% UI 19.8–23.8), a relative reduction of 16.9%. Among females, cases are projected to rise from 300 to 388, with ASRs falling from 24.8 to 20.0. Male cases are projected to increase from 311 to 410, with ASRs dropping from 27.7 to 23.4.

Ethnic-specific projections

Among Māori, lung cancer cases are projected to increase from 570 in 2020–2022 to 1,063 by 2045 (95% UI 981–1,145), an 86.5% rise (Table 3). While the overall ASR is expected to decline from 73.0 (95% CI 69.6–76.6) to 60.6 (95% UI 55.3–66.2), this still represents the highest rate across all ethnic groups. A rise in cases is projected for both sexes

(Table 4), with female lung cancers rising from 330 to 534 and male from 240 to 529. ASRs are projected to decline more steeply for females (from 79.7 to 56.2) than for males (from 65.7 to 65.6), where they are projected to remain flat. Rates are projected to remain the highest for Māori when compared with all other ethnic groups.

For Pacific peoples, while the total numbers are small, lung cancer cases are expected to nearly double by 2045, from 129 to 245 (95% UI 226–268). The ASR is projected to fall from 41.7 (95% CI 37.6–46.1) to 32.7 (95% UI 29.6–36.3), a 21.6% reduction. Among females, cases are projected to rise from 60 to 118, and for males, from 68 to 127. ASRs are expected to decline across both sexes, though the male rate remains higher than the female rate across the projection period.

Among people identified in the Asian ethnic group, case numbers are also relatively low but are projected to more than triple from 153 to 477 by 2045 (95% UI 435–520), an over 200% increase. This growth is largely driven by demographic

Table 3: National projections by ethnicity—total population.

	Māori	Pacific peoples	Asian	European/Other
2020–2022				
Observed ^a	570	129	153	1,693
ASR ^b	73.0 (69.6–76.6)	41.7 (37.6–46.1)	19.5 (17.8–21.4)	22.9 (22.2–23.6)
Population ^h	872,710	354,160	817,725	3,066,380
2035				
Projected ^c	885 (838–934)	199 (186–215)	331 (306–354)	1,825 (1,728–1,917)
ASR ^d	66.9 (62.3–71.8)	36.1 (33.2–39.4)	16.5 (15.1–17.9)	20.0 (18.7–21.4)
% Change in cases ^e	55.3%	54.3%	116.3%	7.8%
Population ^h	1,083,520	436,565	1,439,590	2,892,740
2045				
Projected ^c	1,063 (981–1,145)	245 (226–268)	477 (435–520)	1,736 (1,609–1,869)
ASR ^d	60.6 (55.3–66.2)	32.7 (29.6–36.3)	15.0 (13.4–16.5)	18.1 (16.6–19.8)
% Change in cases ^e	86.5%	89.9%	211.8%	2.5%
% Annual change cases ^f	2.7%	2.8%	5.1%	0.1%
% Change ASR ^g	–17.0%	–21.6%	–23.1%	–21.0%
Population ^h	1,250,820	479,535	1,755,565	2,722,430

^a Average observed cases per year over the period.

^b Age-standardised rate (ASR) over the 3-year period with 95% confidence intervals.

^c Projected cases with 95% uncertainty intervals.

^d ASR of projected cases with 95% uncertainty intervals.

^e Total percentage change in cases from observed 2020–2022 average.

^f Annual percentage change represents the compound annual growth rate (CAGR) between the 2020–2022 average and 2045.

^g Total percentage change in the ASR from observed 2020–2022.

^h 2021 estimated resident population, 2035 and 2045 population projection; some figures may not sum to total due to rounding.

growth and ageing as opposed to rising risk, as the ASR is projected to decrease from 19.5 (95% CI 17.8–21.4) to 15.0 (95% UI 13.4–16.5). Female cases are expected to increase from 68 to 239, and male cases from 85 to 237, with ASRs decreasing across both groups.

For European/Other populations, case numbers are expected to remain relatively stable, increasing slightly from 1,693 to 1,736 (95% UI 1,609–1,869) by 2045, a 2.5% increase. The ASR is projected to decline from 22.9 (95% CI

22.2–23.6) to 18.1 (95% UI 16.6–19.8), reflecting a 21.0% reduction. Female cases are projected to remain relatively flat, from 855 to 858, with ASRs dropping from 22.5 to 16.8. Among males, cases are expected to increase slightly from 838 to 879, though the ASR is also projected to decline, from 23.6 to 19.6. A feature of the projections for this group is that absolute case numbers reach a peak around 2035 before decreasing by 2045, a pattern not observed for other ethnic groups.

Table 4: National projections—by ethnicity and sex.

	Māori	Pacific peoples	Asian	European/Other
Female				
2020–2022				
Observed ^a	330	60	68	855
ASR ^b	79.7 (74.7–84.8)	36.5 (31.4–42.2)	16.2 (14.1–18.7)	22.5 (21.6–23.5)
Population ^h	438,630	175,435	414,190	1,541,860
2035				
Projected ^c	444 (418–468)	96 (90–104)	168 (156–180)	899 (852–944)
ASR ^d	61.2 (57.7–66.8)	33.4 (30.7–36.6)	15.3 (14.0–16.7)	18.6 (17.3–19.9)
% Change in cases ^e	34.5%	60.0%	147.1%	5.1%
Population ^h	543,550	216,575	725,800	1,452,870
2045				
Projected ^c	534 (495–575)	118 (108–129)	239 (217–260)	858 (796–922)
ASR ^d	56.2 (51.3–61.6)	30.2 (27.3–33.7)	13.9 (12.5–15.4)	16.8 (15.3–18.4)
% Change in cases ^e	61.8%	96.7%	251.5%	0.4%
% Annual change cases ^f	2.1%	3.0%	5.6%	0.0%
% Change ASR ^g	–29.5%	–17.3%	–14.2%	–25.3%
Population ^h	626,225	238,430	881,000	1,367,655
Male				
2020–2022				
Observed ^a	240	68	85	838
ASR ^b	65.7 (60.9–70.8)	48.4 (41.8–55.7)	23.6 (20.8–26.7)	23.6 (22.6–24.5)
Population ^h	434,080	178,725	403,535	1,524,520
2035				
Projected ^c	443 (419–467)	103 (96–111)	162 (150–174)	926 (875–974)
ASR ^d	72.5 (67.3–78.0)	38.9 (35.8–42.6)	17.9 (16.3–19.5)	21.6 (20.2–23.2)
% Change in cases ^e	84.6%	51.5%	90.6%	10.5%
Population ^h	539,970	219,990	713,790	1,439,870
2045				
Projected ^c	529 (488–570)	127 (117–139)	237 (216–259)	879 (814–945)

Table 4 (continued): National projections—by ethnicity and sex.

	Māori	Pacific peoples	Asian	European/Other
ASR ^d	65.6 (59.7–72.0)	35.2 (31.8–39.2)	16.2 (14.5–18.0)	19.6 (17.9–21.4)
% Change in cases ^e	120.4%	86.8%	178.8%	4.9%
% Annual change cases ^f	3.5%	2.8%	4.6%	0.2%
% Change ASR ^g	–0.2%	–27.3%	–31.4%	–16.9%
Population ^h	624,495	241,105	874,560	1,354,775

^a Average observed cases per year over the period.

^b Age-standardised rate (ASR) over the 3-year period with 95% confidence intervals.

^c Projected cases with 95% uncertainty intervals.

^d ASR of projected cases with 95% uncertainty intervals.

^e Total percentage change in cases from observed 2020–2022 average.

^f Annual percentage change represents the compound annual growth rate (CAGR) between the 2020–2022 average and 2045.

^g Total percentage change in the ASR from observed 2020–2022.

^h 2021 estimated resident population, 2035 and 2045 population projection; some figures may not sum to total due to rounding.

Discussion

This study presents projections of lung cancer incidence in Aotearoa New Zealand stratified by sex, prioritised ethnicity and Health New Zealand region. The findings provide a more nuanced view of how lung cancer incidence may evolve over the coming two decades and highlight implications for equitable service planning and cancer control efforts.

Our estimate of approximately 3,500 lung cancer cases by 2045 aligns with projections published by Teng et al., who estimated around 3,850 cases per year by 2044.¹⁴ Although the absolute figures differ slightly, both analyses indicate a substantial increase in future lung cancer burden. Given the inherent uncertainty in projecting incidence two decades ahead, the overall direction and magnitude of change are consistent across studies.

Persisting and unequal burden

The modelled projections indicate that although lung cancer incidence rates are declining and are projected to continue to decline, the absolute number of lung cancer cases is expected to increase over much of the projection period. Lung cancer is also projected to continue to disproportionately affect Māori and Pacific peoples. Lung cancer cases among Māori are projected

to nearly double by 2045 and, although ASRs are expected to decline, they remain the highest of all ethnic groups. A similar pattern is observed for Pacific peoples, with increasing absolute case numbers alongside declining ASRs.

Absolute lung cancer case numbers in the European/Other population increased by approximately 10% between 2013 and 2022, compared with around 30% for Māori, 50% for Pacific peoples, and a doubling among Asian populations. The projected increase of around 8% for the European and Other population by 2035 therefore represents a continuation of recent observed trends. Model outputs indicate that absolute case numbers are likely to peak in the mid-2030s and then decline towards 2045, as reductions in age-specific incidence associated with cohort effects, including declining smoking prevalence, increasingly outweigh the effects of population ageing. This decline is further reinforced by projected population contraction, with the European/Other population estimated to be around 10% smaller in 2045 than in 2021, rather than the continued growth projected for other ethnic groups.

In contrast, for Māori and Pacific populations, increases in absolute lung cancer case numbers beyond 2035 are likely to reflect continued population growth and younger age structures, which delay the full impact of cohort-related declines in

smoking exposure. For Māori males, ASRs show a modest increase to the mid-2030s before declining, likely due to higher-risk birth cohorts entering peak lung cancer risk ages during this period, followed by replacement by cohorts with lower cumulative smoking exposure. Smoking prevalence has historically been high among Māori for both men and women,²¹ and completely disentangling cohort, period and demographic effects in APC modelling is inherently challenging. Accordingly, this pattern should not be interpreted as evidence of emerging increases in underlying risk, but rather as likely reflecting delayed cohort effects interacting with sustained population growth and ageing. In addition to smoking, other lung cancer risk factors, including occupational exposures, ambient air pollution and second-hand smoke, may also potentially contribute to observed trends and could benefit from further study.

The Northern Region is expected to see the largest increase in case numbers (46.8% by 2045), reflecting both high population growth and a concentration of higher-risk populations. Although ASRs are projected to decline in all regions, the magnitude of these reductions varies, with smaller relative declines observed in Te Manawa Taki (14.5%) and the Central Region (12.1%). The observed geographical variation in projected cases is based on a combination of demographic shifts, regional smoking patterns and underlying population growth, and highlights the potential need for locally tailored responses that account for both current and future cancer service demands.

While the model does not explicitly account for factors such as access to care, diagnostic delays or treatment disparities, these projections should be interpreted within the context of long-standing inequities across the cancer care continuum. Previous research shows that these inequities contribute to poorer outcomes even after accounting for differences in risk factor exposure, particularly among Māori.^{2,5} The projected increases in case numbers reinforce the need for focussed and intentional planning that embeds equity throughout early detection, treatment pathways and service design. Improving outcomes for Māori will require shifting diagnosis to earlier stages through greater responsiveness in primary care and targeted LCS, ensuring equitable access to curative surgery, reducing the treatment travel burden, improving cultural responsiveness and strengthening the completeness and timeliness of cancer data collections.²

Research further documents the barriers faced by Māori in achieving timely diagnosis and treatment, including delays in referral and access to diagnostics, long waiting times, fragmented communication and limited cultural safety in secondary care.⁵ Experiences of racism and the lack of respect for tikanga and whānau involvement can erode trust and engagement. Important enablers for Māori include whānau agency, culturally safe communication and support from Māori health navigators. Strengthening these enablers while addressing systemic barriers will be essential to ensuring that future initiatives, including LCS, lead to equitable improvements in survival.

Given the historically high prevalence of smoking in Aotearoa New Zealand, long-term follow-up of ex-smokers will be an important factor moving forward. Compared to current smokers, individuals who have quit smoking have a 39% lower risk of developing lung cancer within the first 5 years since quitting, and this risk continues to decline the longer they remain smoke-free.²² However, even after 25 years since quitting, former smokers still face a lung cancer risk more than three times higher than that of people who have never smoked.²²

E-cigarette use and vaping are important smoking cessation aids.^{23,24} However, the long-term effects of these products remain uncertain. Recent evidence has indicated that exclusive e-cigarette use may be associated with higher odds of several respiratory and cardiometabolic outcomes,^{25,26} and provides limited reduction in risk relative to cigarette smoking for some conditions.²⁶ Dual use of cigarettes and e-cigarettes may confer higher risk than smoking alone; however, evidence is still evolving.²⁶ Emerging evidence suggests that e-cigarette aerosols may trigger inflammatory pathways similar to those implicated in cancer risk. Biomarker, *in vitro* and animal studies have demonstrated DNA damage, oxidative stress and other carcinogenic pathways associated with e-cigarette aerosols, but translation of these biological signals into long-term cancer risk in humans remains uncertain.^{27,28} Monitoring of potential e-cigarette-related impacts is therefore important; should future research confirm e-cigarette use as an emerging risk factor there are implications for health services, including early detection and screening as described below.

Planning for services and workforce

The projected growth in the absolute number

of lung cancers and the projected regional variation has important implications for diagnostic and treatment service planning. Even with declining ASRs, the projected rise in total lung cancer cases means increased demand for imaging, bronchoscopy, surgery, systemic therapy and palliative care. Regional variation in projected cases highlights the need for flexible, localised capacity planning and may require expanded specialist workforce and infrastructure investment in higher-growth regions. Recent commentary has also called for Aotearoa New Zealand to adopt the internationally recognised model of comprehensive cancer centres, in which multidisciplinary clinical care, research, education and regional networks are integrated.²⁹ This model has been presented as a necessary response to rising demand, capacity constraints and workforce pressures, while supporting equity-focused approaches and improved outcomes.

The projections also support modelling of future demand for lung cancer nurse specialists, kaiāwhina or navigation roles, smoking cessation services and culturally safe models of care that improve engagement and continuity. Strengthening community-facing pathways, including timely access to diagnostics and coordinated referral processes, will be important in managing increasing volumes. Ensuring that service responses are both scalable and adaptable will help avoid reinforcing current access barriers and will support consistent quality of care across regions.

Tobacco control and system-level alignment

These findings should be interpreted within the broader context of tobacco control, nicotine product use change and health system transformation in Aotearoa New Zealand.³⁰ Changes to smokefree legislation introduce additional uncertainty to future lung cancer trends, particularly for younger cohorts. Sustained investment in tobacco harm reduction and culturally grounded prevention efforts will be essential to shift long-term trends in risk.

In parallel, efforts to realign cancer services under the Health New Zealand system must centre equity. Lung cancer is the leading contributor to the life expectancy gap between Māori and non-Māori, and one of the cancers with the most pronounced inequities in both incidence and survival.^{2,4} Projections like these are important for ensuring national strategies and planning avoid uniform approaches that do not reflect differential

need. In this sense, the results support the broader objectives of the New Zealand Cancer Action Plan 2019–2029, particularly in achieving equity and improving survival.¹

Implications for screening and early detection

It is now well established that low-dose computerised tomography (CT) screening can reduce lung cancer mortality, particularly when targeted to high-risk populations. Simulation modelling in Aotearoa New Zealand has shown that it will likely be cost effective, as well as providing improvements to overall population health.^{31,32} It is essential that implementation of a future LCS programme, at a minimum, does not exacerbate current inequities, and ideally benefits those with the highest health need. This will require deliberate planning and adequate resourcing across the full screening and diagnostic pathway to ensure that increased demand for imaging, follow-up investigations and treatment can be met equitably, and planned alongside other diagnostic CT requirements such as the recent new investment in systemic anticancer medications. World-leading Indigenous research in Aotearoa New Zealand is seeking to directly inform the development of equitable LCS programme design, reflect local context and establish the parameters to plan for the downstream impacts of the screening pathway including increasing early-stage diagnosis and managing actionable incidental findings.¹⁰

The projected increase in lung cancer incidence, particularly among Māori and Pacific peoples, reinforces the importance of early detection as a key component of equitable cancer control. While this study does not model screening directly, the findings provide important context for designing and targeting a potential national LCS programme in Aotearoa New Zealand. Higher projected ASRs among Māori highlight the importance of embedding equity in programme design and in the development of quality improvement initiatives and interventions.

Alongside LCS implementation to assist in the early detection of asymptomatic lung cancers, symptom awareness campaigns have been shown to shift lung cancer stage at diagnosis.³³ Opportunities exist to strengthen programmes and campaigns that focus on symptom recognition that may further assist in earlier detection. Examples of programmes include the rollout of community-referred radiology pathways (rapid

access pathway), the Te Aho o Te Kahu optimal cancer care pathway¹⁵ and tailored awareness campaign development—for example, the Midland Cancer Network “cough cough” campaign.³⁴

Strengths

This study provides the first national and regional projections of lung cancer incidence in Aotearoa New Zealand disaggregated by sex, prioritised ethnicity and Health New Zealand region. By presenting disaggregated results across multiple population groups including Māori, Pacific, Asian and European/Other, and across all four Health New Zealand regions, this work supports regionally tailored planning and equity-focussed prioritisation. These outputs are particularly relevant given the emerging policy interest in LCS and the potential role of projections in informing decisions around screening eligibility, regional rollout and workforce needs.

Finally, this study offers a timely and policy-relevant contribution to cancer control in Aotearoa New Zealand, highlighting where the future burden of lung cancer is expected to be most pronounced and where screening and service responses may need to be strengthened.

Limitations

Several limitations should be considered when interpreting these projections. First, the model assumes that incidence trends continue. While time-weighting prioritised more recent trends, the model does not incorporate prospective changes in underlying risk factors such as tobacco exposure, the use of e-cigarettes and other nicotine products, air pollution or occupational risks. It also does not account for policy changes, such as changes to Smokefree legislation, or the potential introduction of LCS programmes, any of which could shift future incidence in ways not captured by the current model.

The model included main effects for sex, prioritised ethnicity and region but did not include interactions with age, period or birth cohort. This structure implies that all groups share the same underlying age, period, and cohort patterns, with constant multiplicative differences in incidence between population groups. Although the model assumes a common underlying temporal pattern, observed differences in projected ASRs and case numbers across groups can still arise through differences in baseline incidence and changing population age structures within each sex and ethnicity stratum. The resulting projections there-

fore reflect differences in baseline incidence and population composition rather than group-specific temporal trends.

Undercounting of certain population groups is a recognised limitation in health and cancer data in Aotearoa New Zealand, especially among those who identify with multiple ethnicities.¹⁸ This can obscure the actual burden of disease and hinder efforts to detect and address inequities. The use of prioritised ethnicity, where individuals are assigned to a single ethnic category based on a set hierarchy, can conceal the experiences of those with multi-ethnic identities. In this study, this method may result in under-representation of some groups, such as Pacific peoples, when individuals identifying as both Pacific and Māori are included only in the Māori category.^{18,19} This may lead to an underestimation of lung cancer burden among Pacific populations. There is also known under-representation of Māori within health and disability data by possibly as much as 20%, and undercounting in cancer registry data has been previously reported.^{18,19} Although prioritised ethnicity allows for mutually exclusive groupings useful for statistical comparisons, it does not fully capture the complexity of ethnic identity in Aotearoa New Zealand. Despite these challenges, prioritised ethnicity was used in this analysis as it remains the most practical and reliable option within existing data systems. It aligns with national reporting standards, enables comparison across datasets and supports statistical stability, particularly for Māori and Pacific population analyses.

The broad Level 1 groupings used in this analysis may mask important heterogeneity within some populations. More detailed disaggregation, for example by Chinese, Indian and Other Asian, or by specific Pacific sub-groups such as Samoan, Tongan and Cook Islands Māori, would provide a clearer understanding of differences in cancer risk and projected burden. However, the data required for such analyses, including consistent historical and projected population estimates at this level of detail, are not yet available or easily obtainable.

While population denominators were sourced from official Statistics New Zealand projections, uncertainty in these estimates increases over time. The bootstrap-based approach incorporated increasing perturbation of population denominators to reflect this growing uncertainty. However, structural changes such as migration patterns, differential population ageing and future policy

or behavioural shifts are not fully captured. As with any long-term projection, uncertainty accumulates as estimates extend further into the future.

The 95% UIs presented reflect statistical variation within the fitted modelling framework, including stochastic variation in observed case counts and uncertainty in population inputs, but they do not encompass all sources of uncertainty, particularly those related to model specification or alternative assumptions about future trends. These intervals are therefore intended to provide context around point estimates and to discourage over-interpretation of single projected values. The results should be interpreted as indicative trends and plausible ranges to support planning and monitoring, rather than as precise forecasts.

Conclusion

Although age-standardised lung cancer incidence rates are projected to decline, the number of cases is expected to rise through 2045, driven by population growth, ageing and the ongoing impact of historically high smoking rates. This burden will continue to fall disproportionately on Māori and Pacific peoples. While reductions in smoking prevalence will shape future trends, the elevated lung cancer risk among former smokers will likely persist for decades. These projections emphasise the importance of equitable design and access to and outcomes of early detection and future screening programmes, alongside sustained investment in culturally responsive prevention, cessation support and service planning aligned to population need.

COMPETING INTERESTS

KP holds shares in GlaxoSmithKline.

AUTHOR INFORMATION

Michael Walsh: Epidemiologist, Planning, Funding and Outcomes, Health New Zealand – Te Whatu Ora, Auckland, Aotearoa New Zealand.

Kate Parker: Programme Manager, Planning, Funding and Outcomes, Health New Zealand – Te Whatu Ora, Auckland, Aotearoa New Zealand.

Sue Crengle: Professor, Preventive and Social Medicine, University of Otago, Dunedin, Aotearoa New Zealand.

Karen Bartholomew: Director of Health Gain Development, Planning, Funding and Outcomes, Health New Zealand – Te Whatu Ora, Auckland, Aotearoa New Zealand.

CORRESPONDING AUTHOR

Michael Walsh: Epidemiologist, Planning, Funding and Outcomes, Health New Zealand – Te Whatu Ora, Level 2, Q4 Building, Smales Farm, 74 Taharoto Road, Takapuna, Auckland 0622 | Private Bag 93-503, Takapuna 0740.

E: michael.walsh@tewhatauora.govt.nz

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