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RESEARCH ARTICLE

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The future growth and spatial shift of Australia's Aboriginal and Torres Strait Islander population, 2016–2051

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Abstract

The Australian Aboriginal and Torres Strait Islander population more than doubled in size between 1996 and 2016. Growth was highest in urban areas and lower in rural and remote areas. An important contributor to growth was identification change, whereby individuals report their Aboriginal status differently over time. Official population projections in Australia currently do not incorporate this phenomenon, leading to underestimation of future populations which affects policies, targets and planning for demand-based services. We outline a new projection model to improve subnational estimates of future regional population growth by endogenizing identification change and Aboriginal/non-Aboriginal childbearing. Results suggest that growth will be higher than currently projected, especially in urban-dominated regions in New South Wales and Queensland where identification change is projected to account for more than 50% of growth. There will also be considerable population ageing, which has implications for services and policies relevant to Aboriginal and Torres Strait Islander people.

KEYWORDS

Aboriginal and Torres Strait Islander population, identification change, policy, population growth, population projections

1 | INTRODUCTION

Aboriginal and Torres Strait Islander people are the original inhabitants of Australia. Aboriginal people are thought to have arrived on the Australian continent at least 50,000 years ago, whereas the Torres Strait Islanders first settled the islands of the Torres Strait, located close to the northern tip of Queensland, approximately 3000 years ago (David et al., 2004; Rasmussen et al., 2011). Hereafter, we respectfully refer to the Aboriginal and Torres Strait Islander people of Australia as the Aboriginal population. At the start of European settlement in the late 18th century, the Aboriginal population of Australia is estimated to have been somewhere between 770,000 and 1.1 million, before falling to approximately 100,000 at the start of the twentieth century. The arrival and expansion of European settlement led to dramatic increases in mortality and declines in fertility for Aboriginal Australians, with deaths resulting from diseases, as well as frontier violence (Gray, 1985; Ross, 2002; Ryan et al., 2020; Williams, 2013).

In contemporary Australia, the Aboriginal population is experiencing very strong population growth relative to the non-Aboriginal population. Over the decade to 2016, it grew from 517,000 to 798,000 (an increase of 54%), whereas the non-Aboriginal population grew by 17% (Australian Bureau of Statistics [ABS], 2008, 2018a, 2019a). This population growth has displayed considerable spatial

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heterogeneity. Over the 2006–2016 decade, it grew proportionally by the smallest amount in the sparsely populated Northern Territory (16%) and the most in the more populated south-east of Australia, with growth of 75% recorded in the Australian Capital Territory, 74% in New South Wales and 72% in Victoria. At a substate scale, recent growth has been modest in many remote central parts of Australia and high in densely populated south-eastern coastal regions (Markham & Biddle, 2018).

Demographic sources of Aboriginal population growth are also different from those of the non-Aboriginal population. Net international migration of the Aboriginal population has very limited impact on growth throughout the country, though internal migration is important for some states and regions. There is a relatively large number of Aboriginal births every year because of higher than average fertility rates for Aboriginal women, a young population age structure with a large proportion of the population in the childbearing ages and also a high rate of Aboriginal intergenerational transmission. This last phenomenon is due to the fact that over half of partnered Aboriginal adults have a non-Aboriginal partner (Biddle & Wilson, 2013; Gray, 1998), and about nine out of every 10 babies born to these couples are recorded as Aboriginal. Despite lower life expectancies, deaths are considerably fewer in number than births because of the relatively small size of the older population.

The remaining component of Aboriginal population growth is identification change, where people report their Aboriginal or non-Aboriginal status differently over time, as recorded in the quinquennial Census of Population and Housing. In terms of official statistics, it refers to people identifying as Aboriginal in the latest census but non-Aboriginal in the previous census 5 years earlier, or vice versa. Data from the Australian Census Longitudinal Dataset (ACLD), a 5% sample of linked census records, suggests that the Aboriginal population of Australia experienced a net gain of about 80,000 from identification change during 2011 to 2016 (Biddle & Markham, 2018). Net identification gains have been high in New South Wales, Melbourne, Hobart and the Australian Capital Territory but low or zero in much of remote Australia (Biddle & Crawford, 2015).

These population dynamics in themselves are likely to be of interest to many demographers and geographers but are also highly relevant from a public policy perspective. The Aboriginal population receives considerable public policy attention because, according to most socio-economic indicators, it experiences considerable vulnerabilities (Australian Institute of Health and Welfare [AIHW], 2018a). Measures on school completions, unemployment, the proportion living in overcrowded housing, incarceration, infant mortality, chronic illness and life expectancy are all substantially worse for the Aboriginal population (relative to the non-Aboriginal), though many outcomes are gradually improving over time.

To address the longstanding disadvantage experienced by Aboriginal people, Federal and State/Territory Governments agreed a set of targets in 2008 as part of a 'Closing the Gap' policy framework. The aim was to reduce or eliminate gaps in life outcomes between Aboriginal and non-Aboriginal Australians, and a set of targets for outcomes in education, employment and mortality were agreed (AIHW, 2018a). The agenda is currently undergoing a 'refresh' (Australian Government, 2019, p. 9) to incorporate a new set of targets and engage Aboriginal people in the design of these. To effectively plan future programmes contributing to achieving these targets and provide key services for the Aboriginal population, reliable population estimates and projections are required. The reliability of Aboriginal projections is especially important because they also act as interim population estimates given that the Australian Bureau of Statistics (ABS) only updates its Aboriginal population estimates every 5 years, and these tend to be published about 3 years after the jump-off year for the projections.

Unfortunately, Aboriginal population projections in Australia are often inaccurate. Past official projections by the ABS have performed poorly, even over a short intercensal period (Wilson & Taylor, 2016). Partly this is the result of data quality limitations. Aboriginal Estimated Resident Populations (ERPs) are based on census data which suffer net undercount rates of about 17% and a Post Enumeration Survey which has a small Aboriginal sample size (ABS, 2018b). The ABS advises that, although most births and deaths are thought to be registered in Australia, not all Aboriginal births and deaths are identified as such (ABS, 2018c, 2019b). However, some studies have shown that a worrying proportion of Aboriginal births are not registered at all including for 18% of children aged under 16 in a recent study in Western Australia (Gibberd, Simpson, & Eades, 2016). ABS annual internal and international migration estimates do not contain an Aboriginal identifier. Data on identification change has only recently become available through the ACLD. This comprises a 5% sample of linked census records, but the quality is affected by probabilistic linkage (so it contains some false links) and a successful linkage rate of only 65% for Aboriginal records (ABS, 2019c).

Apart from these data quality problems, past projections have also performed poorly due to misspecified assumptions and model design limitations. In the most recent ABS Aboriginal projections, for example, no allowance is made for future identification change (ABS, 2019d). Given substantial growth of the Aboriginal population is generated by this process, it is a surprising omission. In addition, ABS projections are published for the geographies of the states and territories, remoteness areas and indigenous regions but are not available for one of the most valuable and widely used statistical geographies in Australia—greater capital city statistical areas (GCCSAs; ABS, 2016). These divide states/territories into two major regions: the greater capital city metropolitan region and the rest of the state/territory.

The aim of this paper is to present projections of Australia's Aboriginal population by GCCSA from 2016 to 2051. We employ a unique multistate cohort-component model, incorporating identification change and with adjustments for mothers who have a different Aboriginal status to their children. This latter adjustment reflects the significant impact of Aboriginal/non-Aboriginal partnering. Section 2 outlines the projection model, input data preparation and projection assumptions used, along with a description of the decomposition approach taken to quantify the contribution of each of the demographic components of change to population growth. In the presentation of results (Section 3), we outline the key demographic changes

which lie ahead and describe the contribution of the various demographic components of change which are driving the coming changes. The final section discusses the implications of the projected growth and altered spatial distribution of Australia's Aboriginal population for policy and service delivery.

2 | DATA AND METHODS

2.1 | Projection model

Projections of the Aboriginal population were prepared with a new biregional cohort-component projection model specially designed to project subnational populations by Aboriginal status (Aboriginal and non-Aboriginal). This new model represents an extension of the Aboriginal/non-Aboriginal projection model developed by Wilson (2009) for the Northern Territory and the three-region multistate model presented by Raymer, Shi, O'Donnell, and Biddle (2018). Using a movement accounts framework (Rees, 1984), the model explicitly accounts for all relevant demographic components of change, namely, births (including allowance for babies to have a different identification to their mothers), deaths, internal migration, overseas migration and identification change. National-level projections are calculated in a bottom-up approach by summing up outputs across all regions. This was chosen deliberately over a top-down approach (where a separate national-level projection would act as a constraint on subnational projections) because of the highly variable population growth rates across regions. The model differs notably from that used by the ABS because it models Aboriginal and non-Aboriginal populations simultaneously and their interaction through identification change and mother–baby identification differences. The model works with 5-year age groups and 5-year time intervals.

At the core of the projection model are a set of population accounting equations. In general terms, the accounting equation for any period-cohort is

$$P^{k}_{i,s,pc}(t+5) = P^{k}_{i,s,pc}(t) - D^{k}_{i,s,pc} - E^{k}_{i,s,pc} - ASOM^{k}_{i,s,pc} - OM^{k}_{i,s,pc} + IM^{k}_{i,s,pc} + ASIM^{k}_{i,s,pc} + I^{k}_{i,s,pc},$$

where *P* refers to population, *D* deaths, *E* emigration, *ISOM* Aboriginal status outward mobility, *OM* internal out-migration, *IM* internal in-migration, *ASIM* Aboriginal status inward mobility, *I* immigration, *k* Aboriginal status group, *i* region, *s* sex, *pc* period-cohort and *t* time. To ensure the total amount of in-migration and out-migration across all regions by sex and period-cohort is the same in this biregional simplification of the full multistate model, in-migration is constrained to out-migration across regions. All demographic components in the above equation are projected as rates multiplied by populations-at-risk. For example, deaths are projected as

$$D^{k}_{i,s,pc} = d^{k}_{i,s,pc}\ \frac{5}{2}\left(P^{k}_{i,s,pc}(t) + P^{k}_{i,s,pc}(t+5)\right),$$

where *d* refers to age-specific death rates. Because the population at t + 5 is unknown, initially, an iterative calculation scheme is applied.

Births are projected in the usual way for cohort-component models via age-specific fertility rates and female populations at risk, except that the calculations here are separate for Aboriginal and non-Aboriginal women:

$$B^{k(mother)}_{i}(t,t+5) = \sum_{a} ASFR^{k}_{i,f,a}\ \frac{5}{2}\left(P^{k}_{i,f,a}(t) + P^{k}_{i,f,a}(t+5)\right),$$

where *B* refers to births, *ASFR* age-specific fertility rate, *f* the female population and *a* age group. The model recognises that many Aboriginal people have non-Aboriginal partners and that the Aboriginal status of babies may differ from that of the mother. Births are therefore disaggregated by Aboriginal status of both infant and mother:

$$B^{m(infant),k(mother)}_{i}(t,t+5) = B^{k(mother)}_{i}(t,t+5)\ p(m(infant)|k(mother)),$$

where $p(m(infant)|\ k(mother))$ denotes the probability of the infant being of Aboriginal status *m* given the mother's Aboriginal status *k*. There are four types of births projected: (1) Aboriginal babies born to Aboriginal mothers, (2) non-Aboriginal babies born to Aboriginal mothers, (3) Aboriginal babies born to non-Aboriginal mothers and (4) non-Aboriginal babies born to non-Aboriginal mothers. Finally, these births are divided into males and females using sex ratio at birth assumptions.

Starting with a jump-off year of 2016, the model was used to create projections of Australia's population by Aboriginal status by sex and age group in 5-year intervals out to 2051 for 15 GCCSA regions described in the 2016 Australian Statistical Geography Standard (ABS, 2016) as shown in Figure 1.

2.2 | Projection assumptions

Total fertility rates (TFRs) for Aboriginal women were calculated from average fertility rates recorded for the 2011–2016 intercensal period. However, some upward adjustments were made following a validation run of the projection model from 2011 to 2016 to ensure 0- to 4-year-old 'projected' populations were close to 2016 ERPs. Aboriginal TFRs were assumed to decline gradually by 1% every 5 years subject to a constraint of not falling below the non-Aboriginal TFR. TFRs for non-Aboriginal women calculated for the 2011–2016 period were assumed to remain constant. The proportion of Aboriginal babies to Aboriginal and non-Aboriginal mothers was estimated from a customised 2016 Census table of the Aboriginal status of 0- to 4-year-old children and their mothers in households. The proportions were assumed to remain constant in the projections.

Mortality projections were specified in terms of life expectancy at birth and were linked to a national projection of life expectancy. The national projection was prepared using Ediev's (2008) extrapolative method. Life expectancies at birth by region and Aboriginal-status were estimated for 2011–2016, and the difference between these values at national life expectancies for the same period was assumed to remain constant throughout the projection horizon.

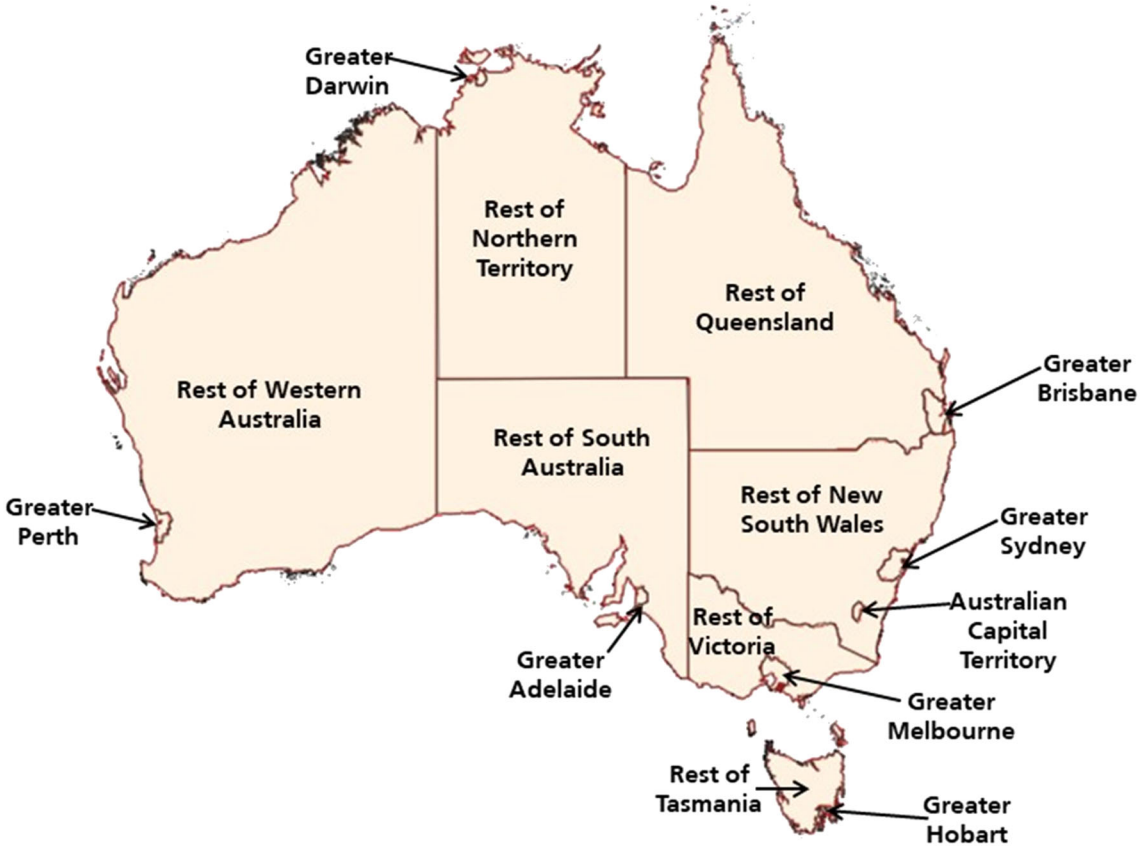


FIGURE 1 Map showing Australian Greater Capital City Statistical Area (GCCSA) boundaries. *Source:* ABS Table Builder, modified by the authors

Zero immigration and emigration were assumed for the Aboriginal population, a reasonable assumption given the available evidence—tiny numbers of Aboriginal people in the 2016 Census reported a usual address overseas 5 years ago. For the non-Aboriginal population, immigration and emigration were estimated from 2011 to 2016 population accounts reconciled so that all demographic components of change matched the difference between the 2011 and 2016 ERPs. Immigration and emigration flows were constrained to net overseas migration (NOM) totals by region. For Australia as a whole, we assumed 250,000 per annum for 2016–2021 and 225,000 per annum thereafter.

Interregional migration rates by age and sex were based on 2011–2016 reconciled population accounts. Smoothing was applied using De Beer's (2012) TOPALS method. The migration rates were then adjusted in the running of the projection model by constraining to fixed net internal migration totals.

Identification change rates by age from non-Aboriginal to Aboriginal, and for the opposite direction, were based on data from the ACLD. Figure 2 shows weighted estimates for 2011 to 2016 by sex and age group in 2016. This demonstrates rates of change from non-Indigenous to Indigenous were strongly age-related and are broadly similar for males and females within age groups. Meanwhile, rates of identification change from Indigenous to non-Indigenous are higher for males across all age groups leading into older ages where the data is impacted by small numbers. In terms of absolute numbers (the bottom two charts in Figure 2), there was a large net positive contribution (the gap between the two series) to the Aboriginal population at younger ages, diminishing progressively towards close to net zero at the very old ages. Smoothing of identification change rates across age was required due to small sample numbers and adjustments were made to ensure agreement with the 2011–2016 reconciled population accounts. Rates were adjusted during the running of the model to maintain fixed net identification change totals recorded over the 2011–2016 period. Overall, the projection assumptions can be summarised as 'business as usual' in which demographic trends of recent years are assumed to continue.

2.3 | Projection decomposition

A decomposition of the projections was undertaken to reveal the quantity of growth contributed by each of the demographic factors driving population increase. Based on the approach developed by Bongaarts and Bulatao (1999), this decomposition involved creating a series of analytical variant projections with the demographic factors driving growth cumulatively removed in successive variants. This same approach was applied by Rees, Wohland, and Norman (2013) to understand projections of subnational ethnic group populations in the United Kingdom and by Andreev, Kantorova, and Bongaarts (2013) to provide insights into United Nations Population Division projections.

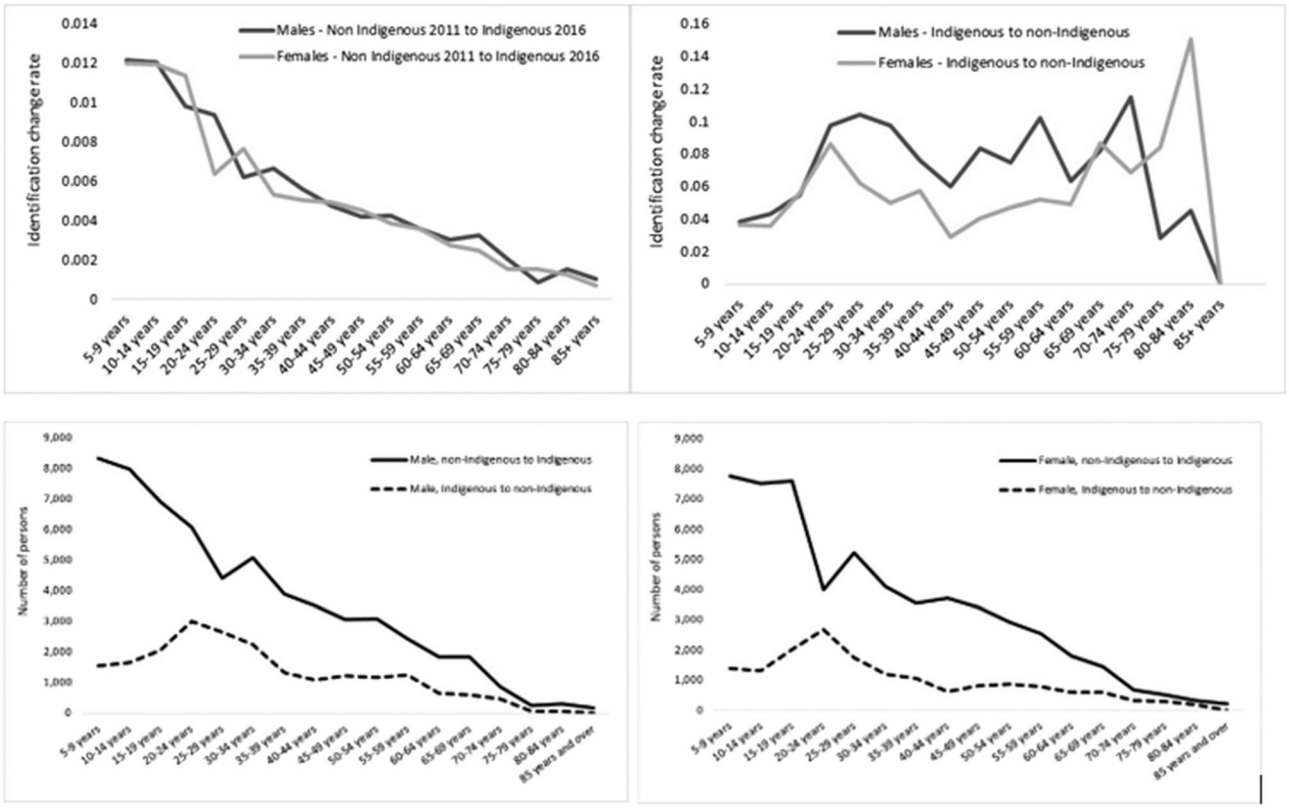


FIGURE 2 ACLD identification change rates (top charts) and numbers, 2011 to 2016. *Source:* ABS Table Builder, Microdata (ACLD)

TABLE 1 Analytical projection variants created for the decomposition

Analytical variant	Includes the following:
Standard	Age structure effects, rising life expectancy, nonreplacement fertility, migration, mother–baby identification differences, identification change
No Identification Change	Age structure effects, rising life expectancy, nonreplacement fertility, migration, mother–baby identification differences
No Identification Differences	Age structure effects, rising life expectancy, nonreplacement fertility, migration
Natural	Age structure effects, rising life expectancy, nonreplacement fertility
Replacement	Age structure effects, rising life expectancy
Momentum	Age structure effects

TABLE 2 Demographic factors affecting population growth

Effect	Calculated as follows:
Identification change	Standard—No Identification Change
Mother–baby identification differences	No Identification Change—No Identification Differences
Migration	No Identification Differences—Natural
Nonreplacement fertility	Natural—Replacement
Rising life expectancy	Replacement—Momentum
Age structure	Momentum—jump-off population

The analytical variants are listed in Table 1 below. The standard projection is the 'normal' projection already prepared. The 'No Identification Change' variant includes all demographic factors except identification change. In the next variant, labelled 'No Identification Differences', both identification change and mother–baby identification differences are absent (i.e., all Aboriginal mothers have Aboriginal babies and all non-Aboriginal mothers have non-Aboriginal babies). The 'Natural' variant further removes all migration flows, whereas the 'Replacement' variant has all TFRs set at replacement level. Finally, the 'Momentum' variant removes rising life expectancy and instead applies fixed base period life expectancy values throughout the projection horizon.

Once the analytical variants have been produced, it is relatively easy to determine the effects of each of the demographic factors on population growth. The effect of identification change is calculated as the difference between the Standard projection and the No Identification Change variant (Table 2). The impact of mother–baby identification differences equals the No Identification Change variant minus the No Identification Differences variant. The impact of population age structure, or momentum of growth embedded in the initial population, is determined by comparing the Momentum projection with

the jump-off population. The advantage of this decomposition approach is its simplicity and ease of comprehension. However, a disadvantage is that the ordering of the removal of factors affects the results due to interaction between them. Nevertheless, the order is designed to minimise any impacts from this.

Ethics approval for our project was confirmed by the Melbourne School of Population and Global Health Human Ethics Advisory Group (HEAG)—Ethics ID: 1955637. Our research team included both Aboriginal and non-Indigenous researchers.

3 | RESULTS

3.1 | National Aboriginal population projections

The Aboriginal population of Australia is projected to grow substantially in coming decades, increasing from 798,000 in 2016 to 1.89 million by 2051. Figure 3 illustrates our projection, together with the latest ABS projection of Australia's Aboriginal population for comparative purposes and Aboriginal ERPs from past years to provide context. The projected 136% increase in the size of the Aboriginal population from 2016 to 2051 compares to projected growth of 55% for the non-Aboriginal population over the same period (increasing from 23.4 to 36.4 million), which itself is relatively fast growth for a developed country population (United Nations Population Division, 2019). The result of this differential growth is an increase in the Aboriginal share of Australia's population from 3.3% in 2016 to 4.9% in 2051.

In terms of population change over time, annual average growth rates are projected to steadily decelerate, from 3.1% in 2016–2021 to 1.9% by 2046–2051, due to population ageing and an assumption of a fixed net identification change total in the context of a rapidly increasing population (i.e., effectively a declining crude net identification change rate). However, for many policy and service provision purposes, growth rates are less important than absolute changes in population over time, and the projections show numerical growth increasing over the course of the projection horizon (from 134,000 between 2016 and 2021 to 175,000 between 2046 and 2051).

As Figure 3 illustrates, our projection differs notably from that of the ABS (2019d). The latest ABS medium series Aboriginal population projection, labelled Series B, projects a population of 1.07 million by 2031 (the end of their projection horizon), whereas our projection for that year is 95,000 higher at 1.22 million. The two projections equate to growth over the 2016–2031 period of either 34% (ABS) or 53% (our projections). The main reason for the difference is the assumption of zero identification change in the ABS projection. Our projection is also substantially higher than the 2011-based national projection of Australia's Aboriginal population prepared by Wilson (2016), which projected a 2051 population of 1.66 million. The difference is due to a higher 2016 jump-off population and greater assumed net identification gains, as informed by the latest ACLD data.

Projected changes to the age structure of the Aboriginal population are illustrated in Figure 4. In the left-hand graph, the black bold outline indicates the size of the population by age group in 2016 whereas the shaded blue bars show projections for 2051. Clearly, there are substantial numerical increases expected for every 5-year age group. In terms of broad age ranges, the 0- to 14-year-old population is expected to grow from 274,000 in 2016 to 527,000 by 2051 (an increase of 252,000), the 15–44 age group is projected to increase from 357,000 to 847,000 (+490,000), whereas the 45+ population grows from 167,000 to 511,000 (+344,000). Age 45 is used as the cut-off age to define older Aboriginal populations because high rates of mortality and morbidity and the early onset of chronic diseases are common above this age when compared to the non-Aboriginal population (AIHW, 2017; Cotter, Anderson, & Smith, 2007; Waugh & Mackenzie, 2011).

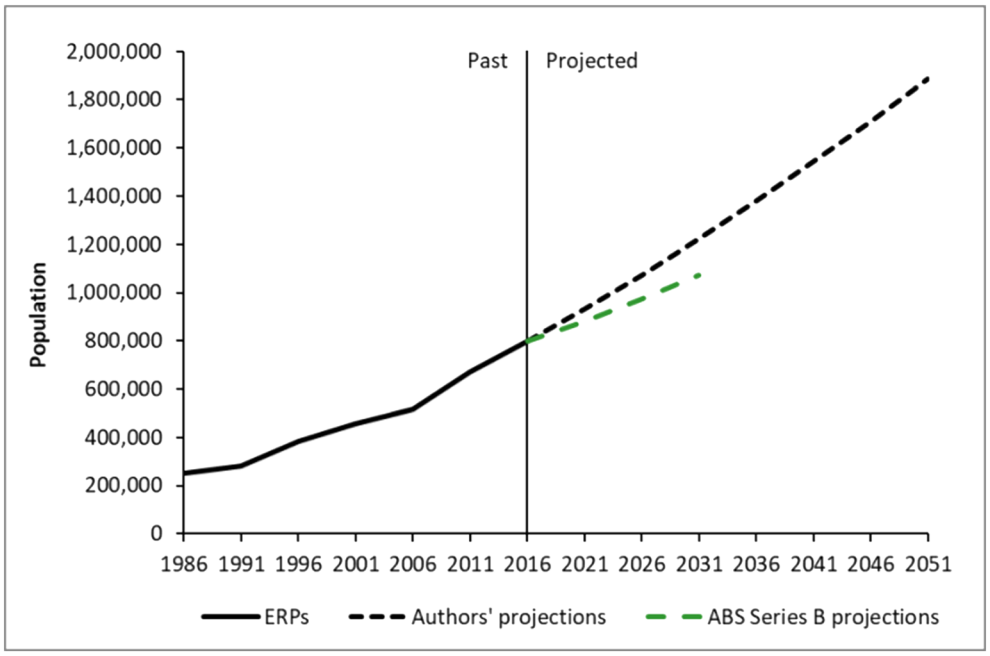


FIGURE 3 The past and projected Aboriginal population of Australia, 1986–2051.
Sources: ABS; authors' projections

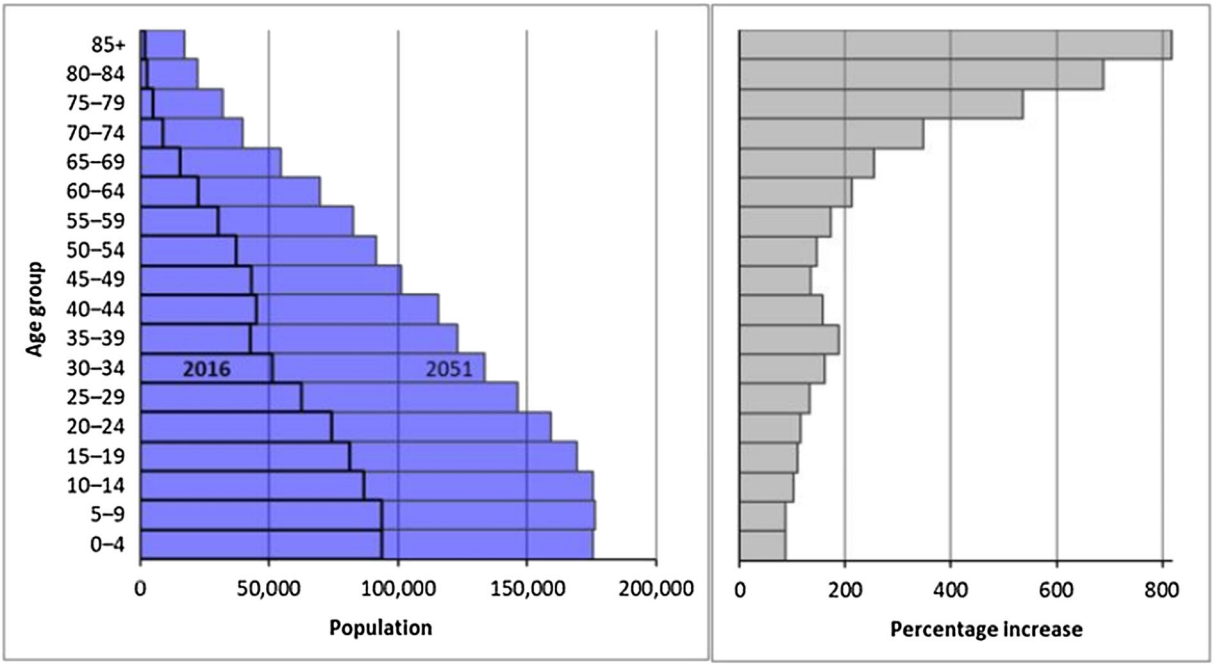


FIGURE 4 Projected changes to the age structure of Australia's Aboriginal population, 2016–2051.
Source: authors' projections. Rest NSW, rest of New South Wales; Rest Qld, rest of Queensland; Rest WA, rest of Western Australia; Rest NT, rest of Northern Territory; Rest Vic, rest of Victoria; Rest Tas, rest of Tasmania; Rest SA, rest of South Australia

The right-hand side of Figure 4 shows the projected percentage changes by 5-year age group, with the greater relative increases in the older ages illustrating structural population ageing taking place. The age structure nonetheless remains relatively young thanks in large part to Aboriginal/non-Aboriginal partnering and the high rate of Aboriginal intergenerational transmission generating large numbers of Aboriginal births, together with substantial net identification change which has greater impact at younger ages. The median age increases from 23.0 to 28.0 years over the 2016 to 2051 period, whereas the proportion of the Aboriginal population aged 45 years and over rises from 20.9% in 2016 to 27.1% by 2051; the equivalent figures for the non-Aboriginal population are median ages of 37.8 and 41.2 years respectively, and 40.4% and 45.0% aged 45 years and over.

The decomposition analysis quantifies which demographic factors contribute most to projected growth over the 2016–2051 period. Of the total projected increase to the Aboriginal population of 1.09 million, 43% is due to net identification change (+471,000), 29% due to momentum (+311,000), 21% due to mother–baby identification differences (+231,000), 4% due to life expectancy gains (+48,000), and most of the remainder the result of nonreplacement fertility (+34,000). With identification change removed, our projection of the total Aboriginal population comes very close to that of ABS (2019d). The 'traditional' demographic factors of fertility, mortality and migration which are dominant factors in the future of many western populations play only minor roles; the effects of identification change, Aboriginal/non-Aboriginal partnering and its resulting fertility outcomes are far more important.

3.2 | Subnational Aboriginal population projections

The national picture of projected Aboriginal population change masks a diversity of patterns at the regional scale. Figure 5 presents projections of the Aboriginal population by GCCSA region (with logarithmic y-axes). It is important to note that the projections begin with an Aboriginal population geography quite different from that of the non-Aboriginal population. In 2016, about two thirds (68%) of the non-Aboriginal population of Australia lived in the eight state and territory capital cities. For the Aboriginal population, it was about one third (35%) with the largest Aboriginal populations living in the rest of New South Wales (179,000) and the rest of Queensland (156,000).

All regions are projected to experience increases in Aboriginal populations over the projection horizon. The largest absolute increases are projected for the Rest of New South Wales, growing from 179,000 in 2016 to 493,000 by 2051 (+314,000) and Sydney (87,000 to 262,000; +175,000). The largest proportional increases are projected for Sydney (201%), Melbourne (188%) and Brisbane (178%), and the smallest for the Rest of the Northern Territory (25%) and Rest of South Australia (53%). As Figure 5 suggests, there is greater variation in relative growth among the rest of state/territory regions, which range in growth from 25% to 176% over the projection horizon, whereas the capital cities' Aboriginal populations are all projected to grow in excess of 100%. The higher growth rate of the capitals in aggregate results in continuing urbanisation of the Aboriginal population, with the share living in the capital city regions increasing from 35% in 2016 to 41% by 2051. In absolute numbers, the capital cities'

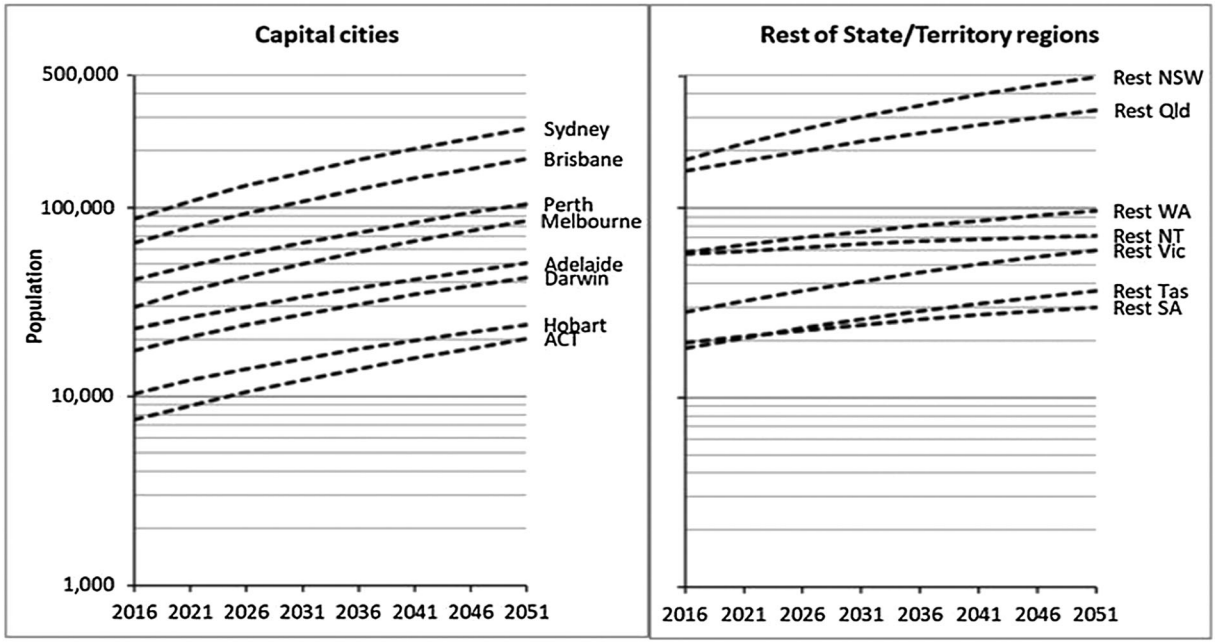


FIGURE 5 Projected Aboriginal population by GCCSA region, 2016–2051. *Source:* authors' projections

Aboriginal populations in aggregate are projected to grow from 281,000 in 2016 to 769,000 by 2051; the equivalent numbers for all rest of state/territory regions are 517,000 in 2016 and 1.12 million in 2051. In terms of the distribution of the national Aboriginal population across the states and territories, there will be a shift to the south-east of the country. New South Wales is expected to experience the largest percentage point increase (home to 33.3% of Australia's Aboriginal population in 2016 and 40.0% in 2051), with small gains for Victoria (7.2% in 2016 and 7.7% in 2051) and the Australian Capital Territory (0.9% and 1.1%). All other jurisdictions are projected to lose share, with the Northern Territory expected to experience the largest percentage point decline (from 9.3% in 2016 to 6.0% in 2051). Overall, the projections suggest a continuing spatial shift towards the capital cities and more populous states and territories of Australia. This shift has implications for state and territory governments with regard to Aboriginal-specific federal funding.

An advantage of employing a model which projects Aboriginal and non-Aboriginal populations simultaneously is that it provides data on the changing Aboriginal status composition of regional populations. Table 3 presents the Aboriginal share of the population of each region over the projection horizon. All regions are projected to experience an increase in their Aboriginal share of the population. The larger capital cities of Sydney, Melbourne, Brisbane, Adelaide, Perth and the Australian Capital Territory (Canberra) are likely to experience modest percentage point increases in Aboriginal share. Larger increases are anticipated in the smaller capital cities of Hobart and Darwin and the rest of state/territory regions. The rest of New South Wales is projected to experience the largest percentage point increase, with the Aboriginal proportion of the population increasing from 6.6% in 2016 to 15.4% by 2051, followed closely by the rest of Tasmania (6.2% to 13.6%). The rest of the Northern Territory, which is the only region with a majority Aboriginal population in 2016, is also expected to increase its Aboriginal share (57.9% to 63.8%).

Aboriginal populations in every GCCSA region are projected to experience absolute population growth in every 5-year age group, with the one exception of the rest of the Northern Territory where the population aged under 25 is expected to be a little smaller in 2051 than 2016. For nearly all regions, growth over the projection horizon is substantial. In the fastest growing region, the rest of New South Wales, the 0–14 population increases from 64,000 in 2016 to 135,000 by 2051 (+71,000), the 15–44 population grows by 136,000 from 75,000 to 212,000, whereas the 45+ population increases from 40,000 to 146,000. In the slowest growing regional population, the rest of the Northern Territory, the 0–14 and 15–44 age groups are not expected to change in size by much over the projection horizon, but the 45+ population still more than doubles, from 12,000 in 2016 to 26,000 by 2051. In all regions, the demand for a range of services will clearly increase substantially.

The ternary plot in Figure 6 summarises the shifts in age structure projected for each of the regions' Aboriginal populations over the 2016–2051 projection horizon. The three sides of the triangle show the percentage of the population in each of the broad age groups 0–14, 15–44 and 45+. Capital cities are depicted by navy blue squares and the rest of state/territory regions by red diamonds. Arrows indicate the extent and direction of age structure shift between 2016 and 2051. Movement down to the left at 45° indicates a larger proportion of the population aged 45+ whereas shifts up to the left at 45° indicate a reduction in the proportion aged 0–14. All regional populations are projected to experience population ageing as measured by an increase in the proportion aged 45+, with the rest of state/territory populations generally ageing more than the capital cities. The rest of the Northern Territory population ages the most (from 21.1% to

TABLE 3 Projected share of the population identifying as Aboriginal(%), 2016–2051

Region	2016	2021	2026	2031	2036	2041	2046	2051
Sydney	1.7	2.0	2.2	2.4	2.6	2.8	3.0	3.1
Rest NSW	6.6	7.8	8.9	10.1	11.4	12.7	14.0	15.4
Melbourne	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0
Rest Vic	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.4
Brisbane	2.7	3.0	3.3	3.5	3.7	3.9	4.1	4.3
Rest Qld	6.3	6.7	7.0	7.4	7.8	8.2	8.6	9.0
Adelaide	1.7	1.9	2.0	2.2	2.3	2.5	2.6	2.8
Rest SA	5.0	5.3	5.6	6.0	6.4	6.9	7.4	7.9
Perth	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
Rest WA	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.6
Hobart	4.6	5.1	5.7	6.2	6.7	7.3	7.8	8.4
Rest Tas	6.2	7.1	8.0	8.9	10.0	11.1	12.3	13.6
Darwin	11.9	12.4	13.1	13.8	14.4	15.0	15.6	16.1
Rest NT	57.9	60.7	61.6	62.2	62.8	63.2	63.5	63.8
ACT	1.9	2.0	2.2	2.3	2.5	2.6	2.8	2.9
Capitals	1.7	1.9	2.0	2.2	2.3	2.5	2.6	2.7
Rest of state/territory	6.5	7.1	7.7	8.4	9.0	9.7	10.4	11.1
Australia	3.3	3.5	3.8	4.0	4.3	4.5	4.7	4.9

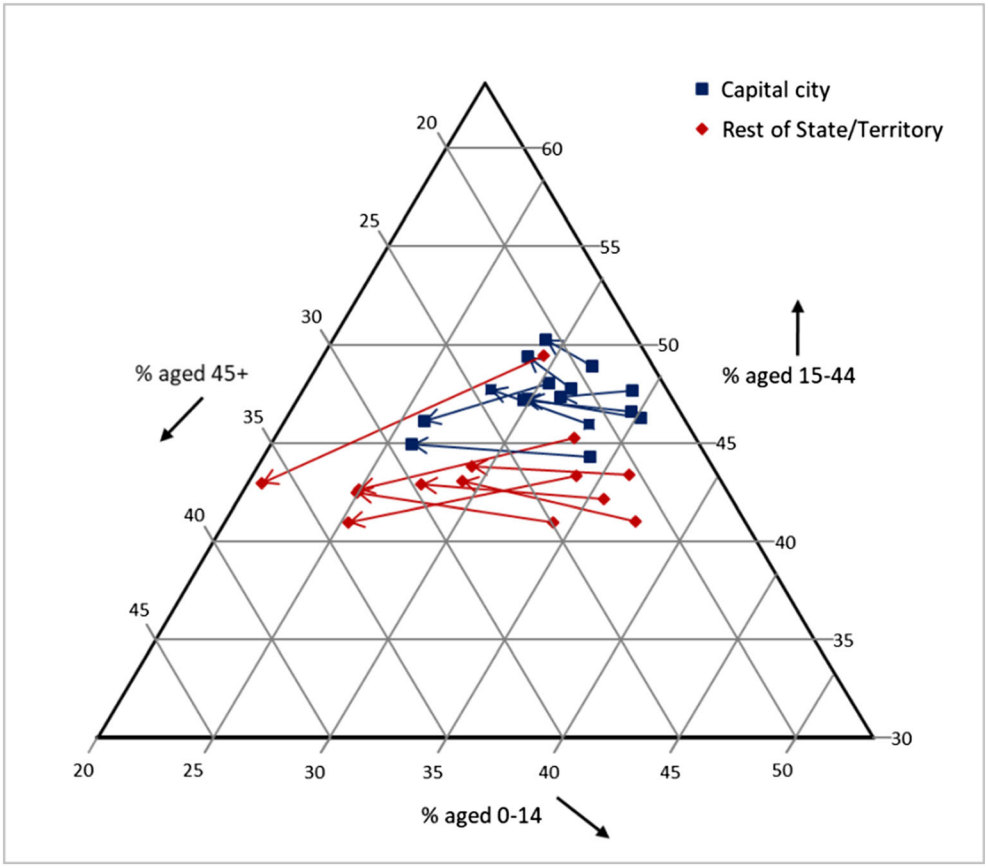


FIGURE 6 Projected changes in the broad age structure of Aboriginal populations by GCCSA region, 2016–2051.
Source: authors' projections.
Arrows indicate age structure shifts between 2016 and 2051. Any upwards movement indicates a larger proportion of the population aged 15–44; any movement at 45° down/left indicates a larger proportion aged 45+; and any shift at 45° down/right indicates a larger proportion aged 0–14

36.5% aged 45+) whereas Melbourne experiences the smallest percentage point increase in the share aged 45+ (20.7% to 21.8%). As older shares of the population increase, the proportion in childhood ages not surprisingly falls, and this occurs for every region. For most regions, proportions in the adult ages 15–44 change relatively little.

What factors are driving the projected changes in size and age structure of the regional populations? Results of the decomposition analysis are shown in Figure 7. Nonreplacement fertility adds a little to growth in some regions where the TFR is assumed to be above replacement (e.g., rest of New South Wales) and reduces growth in some others where it is below-replacement (e.g., Sydney). Rising life expectancy adds to growth in all regions but only by modest amounts. Net internal migration has a slightly larger impact, with net migration gains evident for many of the capital cities, and net migration losses in the rest of state/territory regions. Population momentum, the growth embedded in a young population age structure (Kim, 2001), makes a far larger contribution to future growth, but the largest contributors are identification change and growth from mother–baby identification differences. The latter occurs because the majority of babies born to Aboriginal/non-Aboriginal couples are identified as Aboriginal. In Sydney, the rest of New South Wales, Hobart and the rest of Tasmania identification change contributes over 50% of growth. It makes much smaller contributions in the rest of the Northern Territory and the rest of Western Australia, where there are many remote Aboriginal communities, less Aboriginal/non-Aboriginal partnering and much less identification change.

In terms of these factors' impact on the age structure, the higher the TFR, the greater the effect of slowing population ageing, and the higher the life expectancy increase, the greater the contribution to population ageing. A young age structure at the start of the projections makes a large contribution to population ageing (the momentum analytic projection variant). Identification change acts to slow population ageing because the largest net gains to the Aboriginal population from this factor occur in the childhood and younger adults ages. A greater impact on slowing ageing derives from mother–baby identification differences, where the number of Aboriginal births from Aboriginal/non-Aboriginal couples is much greater than would be the case if there was no intergenerational identification change because about nine out of 10 births to such couples are identified as Aboriginal. Indeed, in the absence of identification change and mother–baby identification differences, the proportion of Australia's Aboriginal population aged 45+ in 2051 would be about 34% rather than 27%.

4 | DISCUSSION

4.1 | High population growth

Results from our modelling indicate the future Australian Aboriginal population size, and growth rate will be substantially larger than in the most recent ABS projections (ABS, 2019d). By 2051, we project a

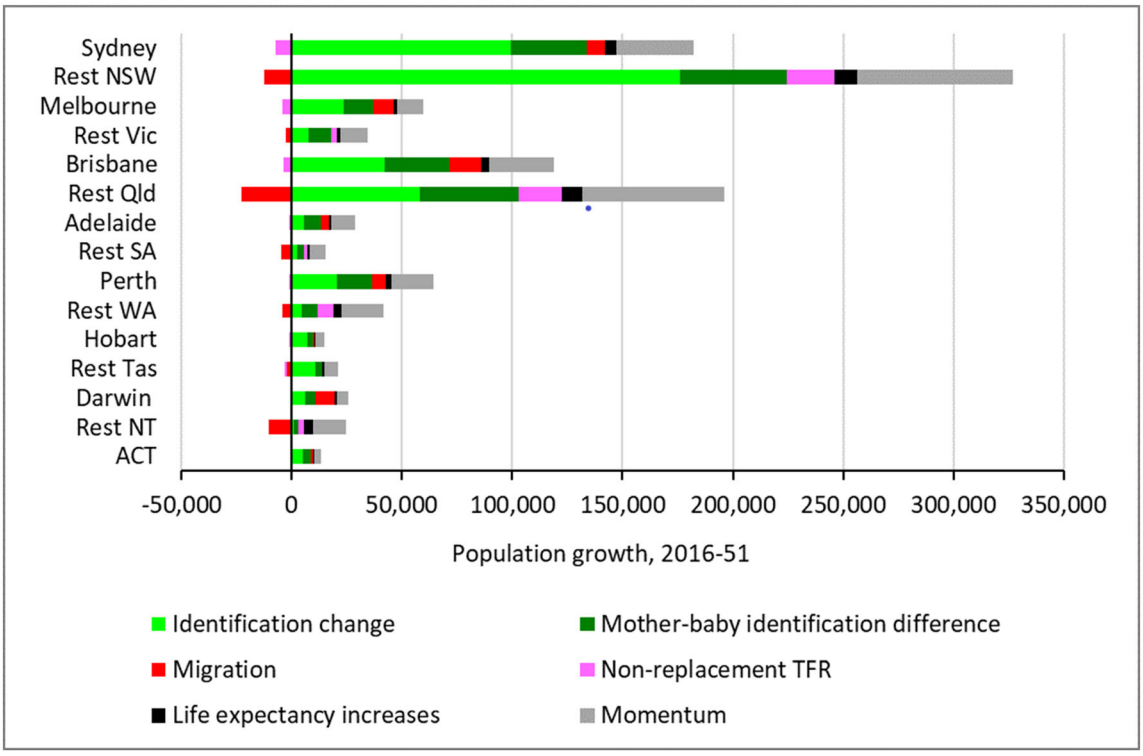


FIGURE 7 Demographic factors contributing to projected Aboriginal population growth by GCCSA region, 2016–2051.
Source: authors' projections

national Aboriginal population just short of 2 million, an absolute increase of 1.1 million people over the 2016 population estimate. The projected 136% growth in the Aboriginal population of Australia compares to 55% for the non-Aboriginal population over the same period. This will increase the national Aboriginal share of the population significantly from 3.3% in 2016 to 4.9% in 2051.

The extent of growth at the national and regional levels outlined in this paper, over and above that previously projected by the ABS (Figure 2), has significant implications for a range of policy areas. One clear example is the National Partnership Agreement on Closing the Gap (McCalman, Bainbridge, Percival, & Tsey, 2016). A refresh of the policy was underway at the time of writing (Australian Government, 2019). The future health, social and economic needs of the Aboriginal population should be designed with an understanding of the higher than anticipated population growth, as well as shifts in the spatial and structural distributions of the Aboriginal population of Australia.

Moreover, the identified ageing of the Aboriginal population also brings with it considerable advantages. The continued growth in the proportion of Aboriginal people aged 45 and over is beneficial to Aboriginal families, providing larger numbers of older Aboriginal people in families able to provide social and economic support to children and youth. At a population level, rates of deleterious mental health are also likely to improve with an ageing population, given greater incidence of mental health conditions among younger Aboriginal people (Williamson et al., 2014). However, in order to maximise the benefits to Aboriginal families, attention must be given to ensuring a new generation of urban poor Aboriginal communities does not eventuate. Efforts to 'Close the Gap' in Aboriginal disadvantage will need to focus carefully on disadvantaged urban Aboriginal people and remote dwelling Aboriginal people to ensure every Aboriginal child gets a good start in life with solid educational outcomes. The growth in Aboriginal populations has wide ranging implications for policy and service delivery across multiple domains. The mix of Aboriginal-led service delivery in line with Aboriginal self-determination is key and will necessitate careful planning for the growth of Aboriginal-led health, education, employment and social services.

4.2 | Differential age growth

The Aboriginal population at the national level will grow substantially across all age groups, with the population of young people (0–14 years) increasing by 252,000 between 2016 and 2051, those aged 15–44 years by 490,000 and those 45 years and older by 344,000. Proportionally, the largest growth is for those aged 45 years and over which increases its share of the total Aboriginal population from 20.9% in 2016 to 27.1% in 2051. This is reflected in an increase in the median age from 23.0 years in 2016 to 28.0 in the year 2051.

Almost all research on access to health services for Aboriginal people recognises that culture is integral to the health, well-being and safety of Aboriginal people (Canuto et al., 2019; Davy et al., 2016; McCalman et al., 2016, 2017). These also recognise that the only services where this is most effectively achieved are the Aboriginal Community Controlled Organisations (ACCOs; McCalman et al., 2016). Although there are ongoing changes to mainstream systems to ensure that culture is incorporated in the services provided for Aboriginal people (e.g., kinship care in child protection and Aboriginal Health checks in primary care), the emphasis is on secondary and tertiary prevention, that is addressing problems that already exist. Lack of access to preventive programmes is a key contributor to worse outcomes among Aboriginal people children, youth and younger adults (Dossetor et al., 2019; Kildea, Tracy, Sherwood, Magick-Dennis, & Barclay, 2016; McCalman et al., 2017; Whop et al., 2017; Young, Hanson, Craig, Clapham, & Williamson, 2017). Primary prevention, particularly culturally appropriate approaches, is insecurely funded or unfunded despite evidence of its benefit (Jackson, 2017). The stronger than projected growth of the Aboriginal population in general highlights the need for increased funding for programmes that meet the needs of Aboriginal people, particularly through the ACCOs. For those in younger age groups, children (0–14 years) and younger people (15–44 years) in particular, this requires an increase in access to preventive programmes to reduce the burden of disease (Titmuss, Davis, Brown, & Maple-Brown, 2019). Although this need is recognised in the National Health Plan (Australian Government Department of Health, 2019), it will be critical that, as this plan is implemented, it takes into account projected population growth.

Strong absolute and proportional growth in the Australian Aboriginal seniors population have widespread implications for aged care and health care policy and programmes (Temple, Wilson, Taylor, Kelaher, & Eades, 2020). In spite of the national government of Australia and its state/territory governments being attentive to the economic and social impacts of general population ageing since at least the early 1990s, little attention has been paid to the rapid Aboriginal ageing phenomenon and specific issues associated with it. Not least, in rural and remote parts of the country, the older Aboriginal population will be dispersed across great distances living in relatively small settlements which have limited health and aged care infrastructure. There is already evidence that Aboriginal people are more likely than other Australians to be in community rather than residential care as they age (AIHW, 2018b). To support the ageing Aboriginal population, it is imperative that there is a focus on developing culturally appropriate approaches to aged care. With the early onset of a range of chronic diseases evident in the Aboriginal population (Titmuss et al., 2019), this will challenge government's ability to provide services in these areas and to conceive services and policies which are culturally appropriate.

4.3 | Identification change

Our projections emphasise the importance of net identification change in future growth of the Aboriginal population of Australia. We have projected that it will account for a large proportion of all growth nationally over the projection period from 2016 to 2051. The actual

amount of projected net identification change over the projection horizon is 376,000, but because of feedback effects via fertility, the decomposition analysis revealed its overall effect on population growth to be greater than that at 471,000. This figure represents 43% of national growth in the Aboriginal population, significantly more than any of the other factors described in the decomposition.

Its impact is also highly variable geographically, contributing to just 7% of 2016–2051 population growth in the rest of the Northern Territory but 57% in Sydney and 60% in the rest of Tasmania. Numerically, net identification change is projected to be greatest in the rest of New South Wales (growth of 176,000 over 2016–2051) and Sydney (100,000). Identification change, then, plays a pivotal role in geographical variations in future Aboriginal population growth.

Clearly, the inclusion of identification change in projections of the Aboriginal population is essential. It has been shown that past projections which have omitted this component of change have proved to be markedly inaccurate (Wilson & Taylor, 2016). Even though the quality of data on identification change in the ACLD is far from perfect, the availability of this data source represents a substantial improvement on the data environment of only a decade ago. And it is of course the case that we do not have a firm idea of where identification change trends will head in the future; our assumptions represent a conservative approach of 'business as usual'. But if projections of the Aboriginal population are to be prepared at all, there is a responsibility to incorporate *all* demographic influences on population change. Achieving the greatest possible accuracy of Aboriginal projections is paramount for a whole range of planning and policy purposes. Accurate Aboriginal projections are additionally important because, in the short term, they are also used as population estimates. Official Aboriginal ERPs in Australia are only produced every 5 years following a census and are published about 2 years after the census reference date (ABS, 2018d).

It is important to note that the issue of identification and identification change is a complex and multifaceted phenomenon which is much simplified through the prism of official statistics. Growth in the Aboriginal population partially stems from the 1980s when a new definition was proposed in the Constitutional Section of the Department of Aboriginal Affairs 1981 report on a Review of the Administration of the Working Definition of Aboriginal and Torres Strait Islanders (Parliament of Australia, 2003). The following definition was proposed: *An Aboriginal or Torres Strait Islander is a person of Aboriginal or Torres Strait Islander descent who identifies as an Aboriginal or Torres Strait Islander and is accepted as such by the community in which he (she) lives* (Parliament of Australia, 2003). As a consequence, population changes are likely from changes in identification as historical events (including the removal of Aboriginal children from their parents) that made Aboriginal people fearful of identifying recede. In addition, pride in Aboriginal identity contributes to the very high level (around 90%) of births to Aboriginal and non-Aboriginal parent pairs identifying as Aboriginal and contributing to growth in the overall Aboriginal population. More generally, formal legal acceptance for land rights and improving societal understanding about impacts from Aboriginal affairs is thought to have encouraged some individuals who might not have otherwise declared their Indigenous identify to do so (ABS, 2013). It must be stated, however, that studies on the root causes are thin. Identification change is a highly individualistic decision, likely based on complex choice-sets and circumstances (Leroux and Gaudry, 2017).

Notwithstanding these issues, large and rapid growth in Canadian Indigenous groups have been observed in recent decades, especially for those identifying as Métis (Flanagan, 2017; Leroux and Gaudry, 2017). In both Australia and Canada, census counts and ERPs for the Aboriginal population are based on answers to a 'standard' self-identification question (in Australia: 'Is this person of Aboriginal or Torres Strait Islander origin?') (ABS, 2018d). How individuals respond to the question is a decision for the person completing the census or survey questionnaire. Focus groups conducted for the ABS (2013) showed that Aboriginal peoples are not always happy with the question and responses can vary depending on the social context. In addition, the question suffers from a high non-response rate in the census (ABS, 2018b) such that the number of people not answering it is greater than the census count of people reporting Aboriginal and Torres Strait Islander origins.

However, it is important to note that other countries' statistical agencies allow for some form of identification change in official Aboriginal projections. For example, Statistics Canada projections allow for 'intragenerational ethnic mobility' and Stats NZ projections include 'inter-ethnic mobility' assumptions (Statistics Canada, 2015; Stats NZ, 2017). The ABS has recently outlined work to measure 'unexplained growth' in the Aboriginal population (ABS, 2018d), but these findings do not feed into its population projection assumptions.

4.4 | Demographic modelling issues

The construction of our projection model and the preparation of the projections reported in this paper required us to address a number of important issues regarding the modelling of populations by Aboriginality. One of the key features of the model is the simultaneous modelling of both Aboriginal and non-Aboriginal populations. This is crucial for populations which interact from both conceptual and practical perspectives. Without the presence of both populations in the model, there would not be populations at risk for age-specific identification change and female populations at risk for giving birth to babies where there are mother–baby identification differences. More generally, where nonrivial changes to reported identity occur over time, it is important to incorporate such changes into the projection model, whether the focus is on Aboriginality, ethnicity or other categories of population based on self-identification. Although intergenerational identification change is often modelled in the international literature, whereby babies and mothers belong to different identity groups (e.g., Rees, Wohland, Norman, & Boden, 2012), identification change across the age range is often not included.

A second important feature of our modelling is the use of a bottom-up approach in the projections (Rees, 1994). In other words, national-level projections were created simply as the sum of the

GCCSA regional projections, rather than being prepared separately and using them to constrain the regional projections to the independent national total. This decision was taken because of the large variations in demographic rates between subnational Aboriginal populations and because national-level Aboriginal demographic data quality and coverage are not clearly superior to state/territory and substate data. Essentially, Australia's Aboriginal population is modelled, and conceptualised, as a series of regional populations interacting with one another and non-Aboriginal subnational populations.

4.5 | Limitations and uncertainty

There are a range of limitations to this study as a result of issues with input data and the assumptions necessary to model plausible projections at the GCCSA region level. With regard to input data, the quality and coverage of demographic data for both Aboriginal and non-Aboriginal populations are far from idea and bring additional challenges to the projections process. Even when demographers have access to very high quality data on recent demographic change, achieving accurate projections is hard enough. Although the data environment for Aboriginal projections is better than it once was, the quality of data for all demographic components of change and population estimates leaves much room for improvement.

With our results showing net identification change producing significant absolute and proportional growth in almost all GCCSA regions in future, it must be noted that the assumptions for this component were drawn from a sample of probabilistically linked records (ABS, 2019c). Disaggregation of these by age, gender and region adds more uncertainty to our projections.

The base period population accounts for the 2011–2016 intercensal interval prepared for this study required considerable adjustment to obtain consistency. This was achieved through iterative proportional fitting to ensure complete population accounting consistency, that is, to ensure that the 2011 ERP for any population (by region and Aboriginal status) plus all inward flows to the population minus all outward flows equalled the 2016 ERP. The net identification change gain to the Aboriginal population across all regions during 2011–2016 was adjusted from an initial value of about 79,000 to 54,000 after constraining. The fact the base period population accounts required extensive adjustment to ensure consistency is indicative of data quality problems.

Because of uncertainty about the past and future trajectory of many demographic parameters, we held some of the main assumptions in our projections model constant, such as the key assumption of identification flows in both directions constrained to a fixed net identification change number. Nevertheless, although a range of alternatives might be proposed in relation to the assumptions, it is difficult to make a case that any reasonable and considered variation in these would change the headline messages. We therefore consider our projections to be plausible but not perfect and, as is the case with all population projections, there is an element of uncertainty associated with the outputs, such that the actual population in future may be different to that projected here.

5 | CONCLUSION

Noting these limitations, the unique contribution of this study has been the analysis of new projections which incorporates assumptions on the full range of future drivers of growth and structural change in the Aboriginal population of Australia at the GCCSA regional level. Although the latest ABS (2019d) projections do not include them, our model shows identification change (in particular), and the high rate of Aboriginal intergenerational transmission in births will contribute substantially to future growth, over and above that which is projected by the ABS. The stark differences in our results compared to existing projections and the extent of future growth and change at regional levels have important policy implications, not least in relation to the refresh of the national closing the gap policy. Net identification change will in future fundamentally alter the spatial distribution of the Aboriginal population of Australia, along with its age structure and gender balance. Governments at all levels will benefit from understanding the implications of these projected changes for their regions and incorporating this understanding into policy making and service delivery models.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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