

Exploring best practices that integrate environmental health and primary healthcare in Indigenous populations: A scoping review

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Abstract

Purpose Country and the environment are essential components of Aboriginal and Torres Strait Islander wellbeing. Colonisation disrupted these essential connections, damaging important reciprocal beneficial relationships that kept Country and community well. As a result, Indigenous populations exhibit poorer health outcomes compared with non-Indigenous Australians, with the life expectancy of Indigenous Australians being 74 years compared with 84 years in the general population. It is reported that 20 to 30 per cent of Indigenous disease burden can be attributed to environmental factors; however, historically, there has been little coordination between the environmental and primary healthcare sectors in Australia. The National Aboriginal Community Controlled Health Organisation (NACCHO) has called for increased collaboration between environmental initiatives and primary healthcare to address various health disparities present within Indigenous Australians. This scoping review aimed to identify and analyse best practices that integrate environmental health initiatives and primary healthcare within Indigenous populations.

Methods Standard scoping review methodology was employed in accordance with PRISMA-ScR Joanna Briggs Institute guidelines. Databases that were searched included CINAHL, Scopus, MEDLINE and Embase, as well as grey literature, between 2004–24. Inclusion criteria focused on studies involving international Indigenous populations, environmental health factors and primary healthcare integration, with two primary reviewers and a third for resolving conflicts.

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Main findings A total of 32 papers, primarily from Australia, were included in the final review. Regarding environmental determinants, there was a strong focus on housing condition, water quality and Indigenous land management. Various integrated programs demonstrated significant health improvements, such as reduced prevalence of infectious disease, enhanced cardiovascular health and better mental health outcomes. The concept of Indigenous 'caring for Country' emerged as a central theme, demonstrating the benefits of a unified approach to healthcare.

Principal conclusions These findings demonstrate the value of implementing connections between environmental and primary healthcare services in improving Indigenous health. Factors leading to program success included community participation, Indigenous leadership and targeted, place-based interventions. However, there is a general lack of published evidence that sustainably integrates both environmental health and primary care. The limited number of examples demonstrated positive health outcomes, indicating the need for more community-led and Country-centred initiatives within primary care.

Keywords: Environment; Primary healthcare services; Indigenous health; Collaboration

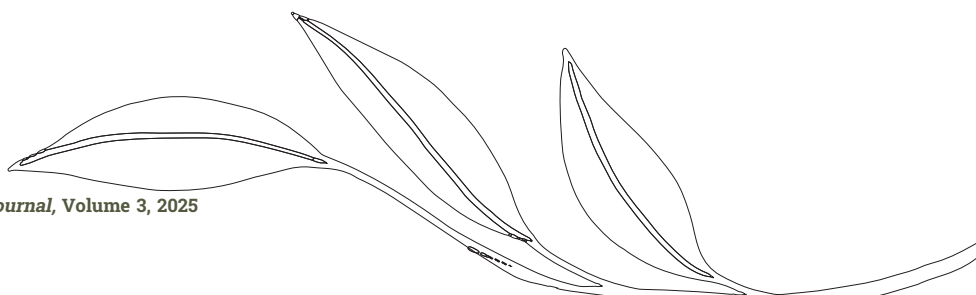
Highlights

- Holistic approaches targeting environmental determinants were found to be highly effective.
- High value was found in intersectoral partnerships and community programs.
- An emerging theme of value of Indigenous knowledge integration and caring for Country was seen.
- Targeted interventions were benefited by Indigenous leadership.

Introduction

Country and the environment are essential components of Aboriginal and Torres Strait Islander wellbeing. Colonisation disrupted these essential connections, damaging important reciprocal beneficial relationships that kept Country and community wellbeing. It is well recognised within global literature that the health of Indigenous peoples is consistently poorer than that of the respective general population, across multiple domains (Gracey and King 2009; King et al. 2009; Australian Bureau of Statistics 2022). The disparity in health outcomes between Aboriginal and Torres Strait Islander peoples (hereafter referred respectfully as Indigenous) and non-Indigenous Australians is multifactorial and complex; however, it is rooted in the continuing effects of colonisation, land

appropriation and ongoing discrimination (King et al. 2009). While these disparities are amplified in Indigenous communities that are situated within rural and remote settings (Australian Bureau of Statistics 2022), it is important to appreciate that living on Country represents a connection to the spiritual and physical home for many Indigenous peoples, which is essential to a sense of fulfillment and identity. Indigenous environmental management provides various positive benefits for Indigenous health, including strengthened identity and empowerment, engagement with physical activity and, in some cases, escape from townships where there is antisocial behaviour (Schultz and Cairney 2017; Kingsley et al. 2009). This review focused on Indigenous populations in rural and remote areas of Australia, where



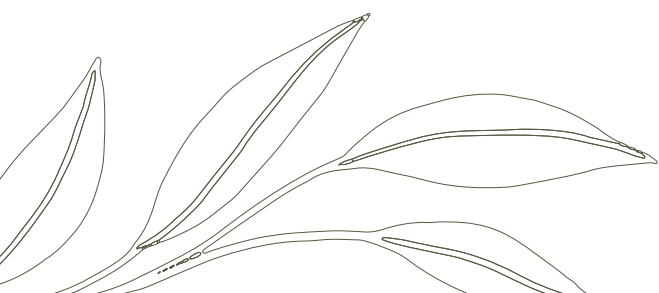


environmental determinants of health significantly impact community wellbeing.

Especially important within an Indigenous context, primary healthcare aims to respond to individual as well as community health needs, and to promote social justice. In the 1970s, the Aboriginal and Torres Strait Islander community-controlled primary healthcare model emerged in response to the deficits of biomedical primary healthcare services to provide team-based, culturally safe and comprehensive care spanning health promotion, prevention, treatment and management (Harfield et al. 2018; Panaretto et al. 2014). This model includes advocacy for individual, social and community development, as well as health promotion alongside clinical services. Essential to the function of this model of primary healthcare is the integration and response to environmental risk and protective factors that impact both individual and community health. This is especially relevant within an Indigenous setting, as Indigenous Australians adopt a holistic approach to health, which encompasses the individual, community and environment (Kingsley et al. 2009). Actively participating in on-Country activities, living in quality housing and having opportunities for making healthy choices shape people's health behaviour, and thus the risk factors for chronic disease and infectious disease in rural and remote Indigenous communities (Daniel et al. 2011). It is therefore important for primary healthcare providers to recognise the importance of environmental factors in contributing to health and wellbeing. The National Aboriginal and Torres Strait Islander Community Controlled Health Organisation (NACCHO) has called for increased collaboration between primary healthcare and environmental initiatives, which have traditionally been based outside primary healthcare in local land councils or public health units (Department of Health and Aged Care 2023; National Aboriginal

Community Controlled Health Organisation 2019; Stephenson 2002).

Within the literature, the term 'environmental health' has come to encompass various aspects of the global, natural, built and local community environments. This is driven by an increased awareness of the upstream contribution of environmental risk factors toward various disease processes from a population health perspective. It has been estimated that 24 per cent of the global burden of disease is due to modifiable environmental risk factors (Prüss-Üstün and Corvalán 2007). Recognising the need for a more specific definition of environmental health in order for purposeful discussion, the World Health Organization (WHO) developed a classification system, in 2006, to evaluate modifiable environmental impacts on health (Prüss-Üstün and Corvalán 2007). Some examples of environmental risk factors within this system include air pollution, water quality, housing, land use patterns (such as roads) and sanitation facilities. Various programs have been employed in Australia, targeted at improving aspects of environmental health within Indigenous communities, with a number of campaigns receiving state and national funding since late in the 20th century (Marmot et al. 2008). Examples of such campaigns include the Housing for Health and Aboriginal Communities Water and Sewerage programs. To provide a targeted example, it has been demonstrated that housing conditions – such as crowding, hygiene infrastructure and ventilation – contribute to Group A Streptococcus transmission and related sequelae like rheumatic heart disease in remote Indigenous communities (Lansbury et al. 2024). These findings underscore the importance of targeted housing improvements as integral environmental health strategies within primary healthcare frameworks. Many of these environmental health programs are funded and implemented by





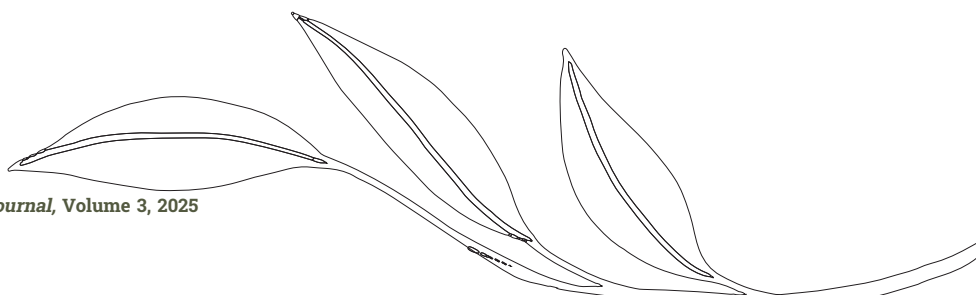
government organisations rather than the community-controlled sector. One particular study by [McMullen et al. \(2016\)](#) concluded that if environmental factors, such as water quality, sanitation, home condition and air pollution, were to be addressed, 20 per cent of total primary healthcare demand within Indigenous communities in the Kimberley region could be prevented as well as 26 per cent of presentations by Aboriginal children ([McMullen et al. 2016](#)). It should be noted that this study heavily relied on adapted WHO fractions, and that the data collection platform excluded emergency and inpatient services, possibly leading to an underestimation of the true environmental burden. Nevertheless, it provides a useful conceptual model for comparison.

Within the focus of environmental health as a protective factor for Indigenous health and wellbeing, it is important to recognise the significance of Indigenous land management, which foregrounds cultural practice to monitor and protect threatened species, induce revegetation, control fires and weeds and monitor feral animals ([Schultz and Cairney 2017](#)). Recent work examining climate change impacts on rural Indigenous communities in Northern New South Wales further reinforces the deep interconnection between Country, climate and health for Aboriginal communities ([Lee et al. 2023](#)). There are many co-benefits to Indigenous land management: provision of employment for Indigenous Australians, strengthening cultural knowledge within communities and improved physical and mental health outcomes by working on Country ([Gray et al. 2012](#)). Greater participation in Indigenous land management has been associated with increased physical activity and better diet, as well as lower body weight, blood pressure, blood sugar and cholesterol ([Burgess et al. 2009](#)).

It can thus be appreciated that the integration of environmental health and primary healthcare holds enormous potential for improving Indigenous health and wellbeing. Such services enable the prevention and early detection of infectious and chronic diseases and allow two-way communication and timely referrals for identifying and addressing environmentally mediated preventable illnesses. This potential forms the basis of NACCHO's calls for increased collaboration between environmental initiatives and primary healthcare ([Department of Health and Aged Care 2023](#)). As such, this scoping review aimed to identify and analyse the best practices supporting linkages between environmental health and primary healthcare within Indigenous populations. A further aim was to uncover gaps in literature on how environmental and primary healthcare services are integrated in detecting and addressing environmentally mediated disease and wellbeing outcomes in Indigenous communities. The results of this study are intended to inform the co-design of an Indigenous community-led pilot project that will enhance the linkages between environmental health and primary healthcare sectors in rural Northern New South Wales. The research team included an Indigenous author from the Quandamooka community, who brought lived experience and cultural insight to this study.

Methods

The protocol employed within this study followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA-ScR) guidelines, endorsed by the Joanna Briggs Institute ([Tricco et al. 2018](#)). The final protocol was prospectively registered on Open Science Framework on 26 June 2024 (<https://doi.org/10.17605/OSF.IO/A34FC>).



Search strategy and eligibility criteria

To identify potentially relevant literature to this project, a range of databases – including CINAHL, Scopus, MEDLINE and Embase – were searched between the years 2004–24. The search strategies that were employed were developed with the assistance of an experienced medical research librarian and further refined during discussions with senior researchers. The final search strategy for MEDLINE is provided in Supplementary material. The final search results for each database were imported into Covidence (<https://www.covidence.org/>). Grey literature was also included, including relevant papers found on government websites, Informit (<https://www.informit.com/>) and Australian Indigenous HealthInfoNet (<https://healthinfonet.ecu.edu.au/>).

Criteria for papers to be included within the review included publications between 2004–24 (i.e. last 20 years), primary healthcare related, environmental health related, involved Indigenous populations, and involving programs/services that provided links between environmental determinants and primary healthcare. Exclusion criteria were also defined as papers that were not in English, conference abstracts, editorials/opinion pieces without any primary research data, and papers that are not primary healthcare related and not environmental health related.

Selection of sources of evidence

To ensure reliability among papers selected for inclusion within the review, two reviewers were utilised, with both initially participating in title/abstract screening on Covidence to identify papers for full-text screening. The same two reviewers then conducted full-text screening of the papers within Covidence. As a quality assurance measure, conflicts over both screening rounds were resolved by a third reviewer, who was a senior researcher.

Data extraction and synthesis

After obtaining the final papers to be included in the review, descriptive data were extracted from these studies under the following headings: lead author's surname/year/country; title; study aim; study setting/ study period; study design/method; Indigenous population/study participants; summary of programs/ services/interventions linking environmental determinants of health to primary healthcare; summary of key findings (including linkages); conclusions. Given the broad nature of 'environmental determinants of health', the key environmental health factors pertaining to Indigenous health, identified by McMullen et al. (2016), were utilised within this review to provide structure to the search strategy as well as synthesis of the results (Table 1). Due to the varied nature of methodologies in the included studies, and the short timeframe for the review, a critical appraisal of the extracted papers was not undertaken.

Results

The literature searches identified 1,143 items: 1,132 papers from academic databases and 11 references from grey literature searches. After the removal of 134 duplicates, there were 1,009 papers identified for title and abstract screening. Of these 1,009 papers, 922 were excluded during the title and abstract screening phase, leaving 87 papers for full-text review. Of these 87 papers, 55 were excluded for various reasons, leaving 32 papers remaining for inclusion within the scoping review (Figure 1).

The 32 papers that were included in the final review originated from various countries, with the majority being from Australia (66%), the United States (19%) and Canada (6%). Other countries from which studies were obtained included Indonesia, New Zealand and India (Figure 2, left). The modal period from which the studies were produced was 2021 to present (44% of



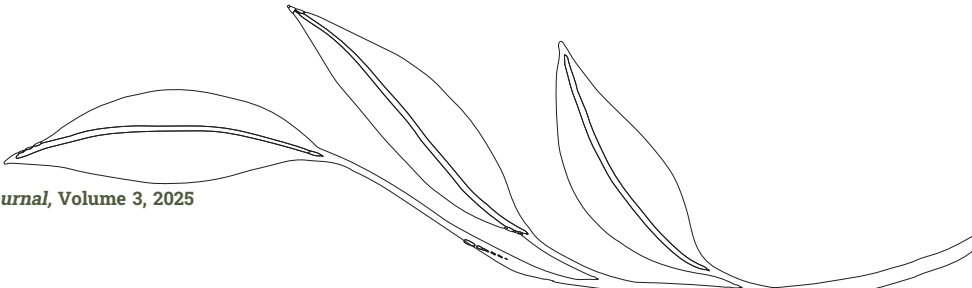
Group	Examples of environmental risk factors
Water quality, sanitation and hygiene	Food hygiene Water treatment and monitoring Hand hygiene Bathing and laundry facilities Rubbish removal
Home condition	Home hazards Crowding Pests Pests Temperature control
Indoor air pollution	Tobacco smoke Combustible fuels
Built environment and land use	Road design and maintenance Transport Infrastructure
Non-occupational, non-domestic chemical exposure	Environmental chemical levels Pesticides
Recreational environment	Bushland Oceans and rivers
Climate	Air temperature Extreme weather Humidity
Public water resources	Drainage Irrigation Storage
Outdoor air pollution	Smog Transport pollution Industry pollution Dust
Radiation	Ultraviolet radiation Ionising radiation
Environmental noise	Non-occupational ambient noise
Occupational factors	Occupational noise Occupational chemical poisoning
Indigenous caring for Country	Indigenous land management Indigenous access to traditional sites

Table 1: Environmental risk factor classification scheme, adapted from McMullen et al. (2016). Indigenous caring for Country was included as an additional area, based on a preliminary literature review

studies), with an approximate steady increase in literature being produced since 2000. Three per cent of the included studies were from the 2000–05 period (Figure 2, right).

The modal environmental determinant of health addressed by the linkage programs included within this review was ‘home condition’, being related to 27 per cent of the overall studies and 35 per cent of the Australian studies. Other topics that were more widely explored included ‘water quality, sanitation and hygiene’, ‘Indigenous caring for Country’ and ‘climate’. Various other environmental determinants according to McMullen’s classification scheme including ‘recreational environment’, ‘outdoor air pollution’, ‘radiation’, ‘environmental noise’ and ‘occupational factors’ received little or no attention within the literature in relation to linkage to primary healthcare services (Figure 3).

Table 2 and Table 3 summarise key findings from Australian papers from the peer-reviewed and grey literature, respectively. Of the papers included, many focused on the importance of Indigenous community involvement as a means of effectively fostering program engagement in environmental and health programs (Tables 2 and 3). For example, Riley et al. (2023) found that a community-wide ‘One Health’ approach to healthcare, involving Indigenous local government authorities in various rural/remote communities in Queensland, provided utility in ensuring transdisciplinary engagement. Furthermore, the employment of Aboriginal health workers, as reported by both Thomas et al. (2019) and Ralph et al. (2022) and many of the programs identified within the grey literature, was a common theme for ensuring Indigenous participation and engagement. Additionally, Miller et al. (2018) found that the implementation of an Indigenous-led community-wide health program by the local primary healthcare service, which focused on risk factors for strongyloidiasis (such as housing improvement and safe water infrastructure), was able



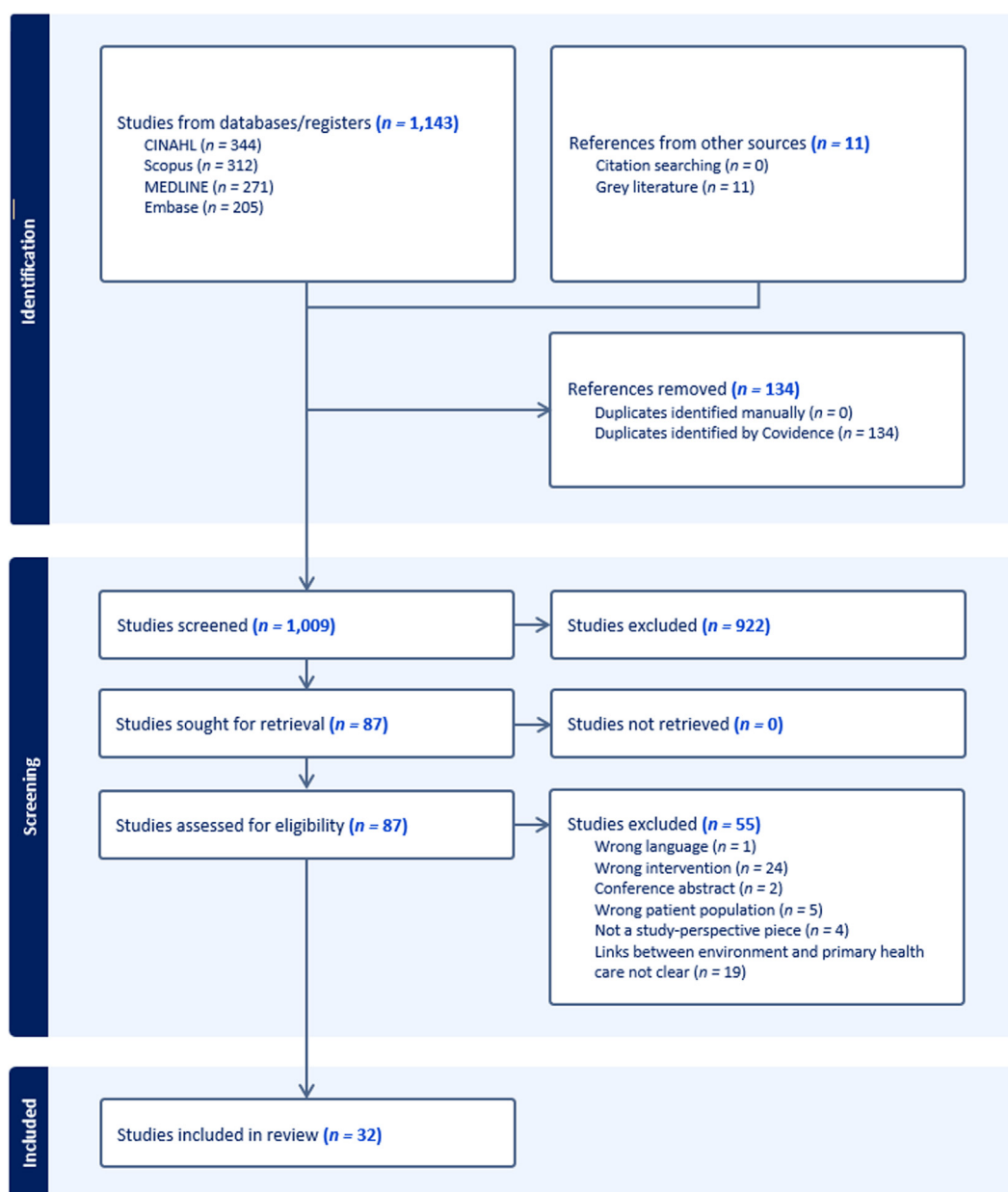


Figure 1: PRISMA flow diagram of initial searches, screening and included papers in the scoping review.

to contribute towards a significant reduction in strongyloidiasis prevalence (Table 2).

An emerging theme within recent literature is the concept of Indigenous ‘caring for Country’, which is

framed as a holistic approach to Indigenous healthcare, incorporating elements of environmental, spiritual and physical health. Various programs reported on ‘caring for Country’, including Burgess et al. (2008) who described the integration of caring for

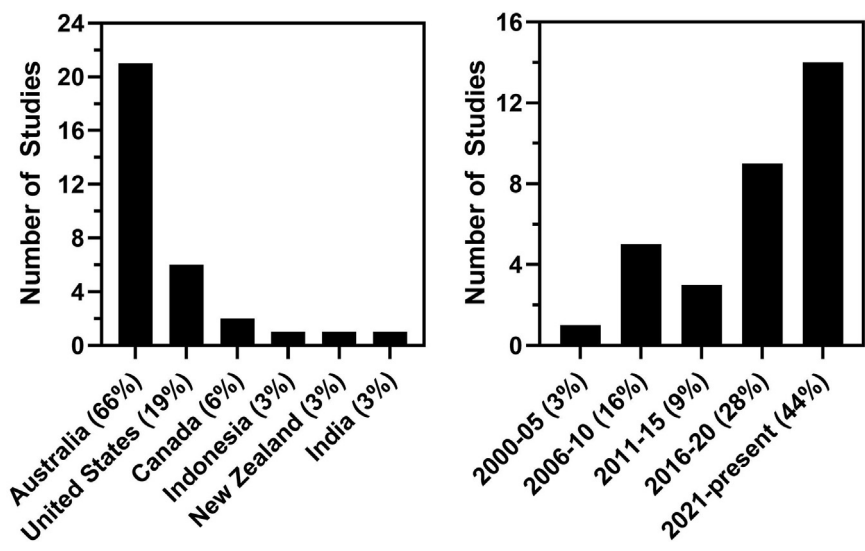


Figure 2: Overview of country (left) as well as time period (right), from which studies were procured ($n = 32$).

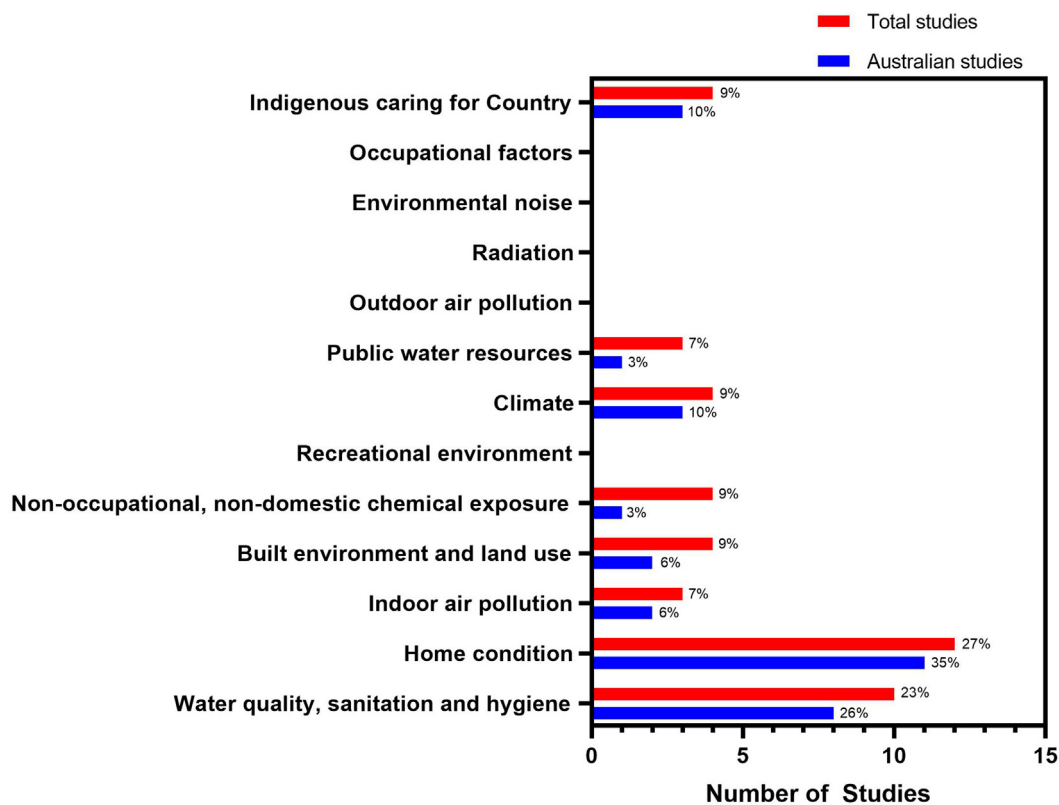
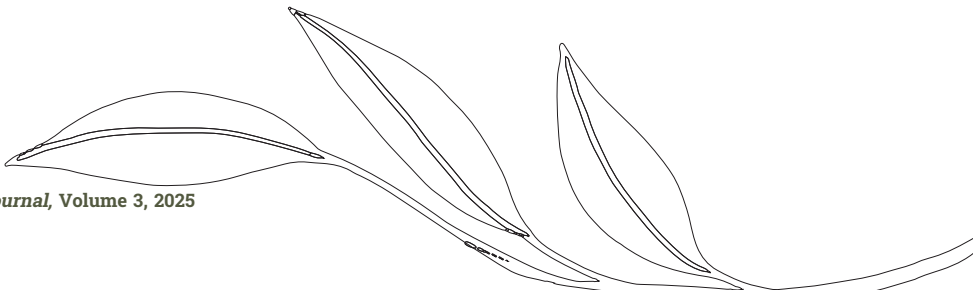


Figure 3: Overview of environmental determinants addressed within the studies, both overall (red, $n = 32$) and within an Australian context (blue, $n = 21$). Categories adapted from McMullen et al. (2016).





Lead author surname, year	Program linking environmental and primary healthcare	Key findings
Miller, 2018; (Miller et al. 2018)	Interventions included the administration of oral ivermectin to all residents, health promotion campaigns targeting environmental health issues, and community participation in the implementation and monitoring of the program, designed and delivered by a local community health service. Additionally, a community wide program was formed to target environmental risk factors, focusing on areas such as housing improvement and repairing water infrastructure.	The program resulted in a significant reduction in strongyloidiasis prevalence, with a 79.8 per cent cure rate after two doses of ivermectin. Program success was attributed to high community involvement, local leadership and addressing environmental health factors.
Thomas, 2012; (Thomas et al. 2013)	The lead management program was delivered by primary healthcare services, including the Broken Hill Child and Family Health Services and Maari Ma Health Aboriginal Corporation. The program integrated blood lead screening into existing child health services. This was facilitated by using a culturally acceptable model, linking lead screening with routine health checks, employing Aboriginal health workers and using finger-prick testing.	Declines in screening rates occurred due to reduced service capacity and socioeconomic barriers. Enablers included culturally appropriate models and linking lead screening with other health services. Early identification of cases enabled treatment prior to the development of neurological decline.
Walker, 2009; (Walker, 2009)	The paper outlines how primary healthcare services, through integrated health promotion and partnerships, can address climate change impacts by promoting resilience and adaptation strategies within communities. Suggested strategies include the provision of self-management plan for chronic diseases, in preparation for times of climate emergency.	Primary healthcare can mitigate climate change effects through community resilience, adaptive strategies and intersectoral partnerships. Integrated health promotion and chronic disease management are crucial for addressing the health impacts of climate change in disadvantaged groups.
Lange, 2017; (Lange et al. 2017)	The intervention included the Trachoma Story Kit, clinical training tools, patient education material, an e-learning module, and public health campaigns. These resources aimed to improve hygiene practices, specifically facial cleanliness, to reduce trachoma transmission.	Implementation of the health promotion strategy significantly increased trachoma knowledge, attitudes and practices among staff. There was a notable rise in the understanding and practice of facial cleanliness, crucial for trachoma prevention, linking environmental health improvements to better primary healthcare outcomes.
Riley, 2023; (Riley et al. 2023)	The study implemented a One Health approach to collect and analyse data on the health of humans, animals and the environment. Interventions included community-wide preventive animal health programs and environmental health assessments, framing primary healthcare in Indigenous communities as a transdisciplinary endeavour, which incorporates all of these key factors.	High levels of environmental health concerns (86.6%) and a strong desire for improved animal healthcare were noted. No significant association was found between human and environmental health exposures and animal health outcomes. Environmental health programs should prioritise household improvements. A One Health transdisciplinary approach to healthcare is recommended.
Hart, 2011; (Hart et al. 2011)	Rural adversity mental health program included mental health literacy training supporting local primary healthcare, community events, dissemination of drought-related information, and a free rural mental health support line for crisis help and referrals.	Over 3,000 people received mental health literacy training; numerous mental health events were conducted; the support line provided over 270 crisis calls and numerous contacts with rural services.
Burgess, 2008; (Burgess, 2008)	Explored links and validated a questionnaire measuring participation in 'caring for Country' programs and health outcomes. Caring for Country involves employment of Aboriginal land and sea rangers, integrating customary practices with environmental services to promote ecological and human health.	Marked health benefits were observed with increased participation in caring for Country activities, including reduced body mass, lower risk of diabetes, and improved cardiovascular health. Environmental indicators also suggested healthier landscapes under customary management.
Johnston, 2013; (Johnston et al. 2013)	Of the services discussed, those that linked to primary healthcare included the Minjilang project, which involved a risk factor screening program, as well as the Urapuntja Health Service, which provided outreach clinical services to Homeland communities.	Interventions targeting environmental determinants led to better nutrition, increased physical activity, improved housing conditions and reduced smoking rates. These outcomes highlight the importance of integrating primary healthcare with environmental strategies.
Schultz, 2018; (Schultz et al. 2018)	Indigenous land management programs enhance wellbeing through identity recognition, access to traditional foods, physical activity and reduced alcohol access. Indigenous land management is framed as serving as a comprehensive primary healthcare model, by integrating clinical benefits and environmental outcomes.	Indigenous land management enhances wellbeing through strengthened identity, empowerment, traditional food access, physical activity and reduced alcohol-related harms. It fosters service collaboration, highlighting the role of environmental management in comprehensive primary healthcare for Indigenous Australians.

(Table 2 continues on next page)



Lead author surname, year	Program linking environmental and primary healthcare	Key findings
(Continued from previous page)		
Wyber, 2020; (Wyber et al. 2020)	The Endgame Strategy includes reducing household crowding, improving hygiene infrastructure, and strengthening primary healthcare to address environmental determinants linked to rheumatic heart disease.	Key findings highlight the need for comprehensive environmental and healthcare interventions to eliminate rheumatic heart disease.
Ralph, 2022; (Ralph et al. 2022)	In addition to penicillin prophylaxis, programs included acute rheumatic fever prevention education, health hardware repairs (showers) and healthcare navigation. Aboriginal community workers provided these services.	Infection rates initially appeared to increase due to increased screening but decreased over time, although not statistically significant. New acute rheumatic fever cases dropped from six to zero over three years. There was a significant relationship between household occupancy and infection numbers.
Kay, 2018; (Kay and Livingstone, 2018)	Programs included community gardens, equity principles in environmental groups, energy efficiency training, and initiatives to improve housing sustainability and transport systems. These interventions aimed to enhance food security, reduce energy costs and improve social inclusion.	Found that local health promotion projects could concurrently address environmental sustainability and equity, particularly benefiting low-income and disadvantaged groups. Key themes included improving food systems, housing and transport, alongside enhancing social inclusion.
Brodie, 2021; (Brodie et al. 2021)	Implements strengths-based case management to address social determinants of health, including cultural and community connection, food and financial security, housing, mental health, and transport, by brokering connections with social and health services.	The program identified unmet needs, facilitated goal setting and prioritisation, and brokered connections to relevant services. It emphasised continuous monitoring and culturally relevant supervision to enhance service delivery, demonstrating the potential for improved social and emotional wellbeing outcomes.
Fatima, 2023; (Fatima et al. 2023)	Programs included caring for Country activities such as land management, bush food harvesting and environmental conservation, integrating cultural knowledge with land conservation to enhance social and emotional wellbeing.	Participation in caring for Country activities was linked to lower psychological distress, improved physical health, and strengthened cultural identity and community bonds, highlighting the potential of nature-based interventions for social and emotional wellbeing improvement. Presents caring for Country as an integral part of primary healthcare within Indigenous communities.

Table 2: Overview of program linking environmental and primary healthcare, as well as key findings, focusing only on Australian papers (n = 14)

Country with community-based outreach programs offering adult health checks. This concept is also explored in Schultz et al. (2018), where Indigenous land management programs, which enhanced Indigenous cultural identity, access to traditional foods, physical activity and reduced alcohol access were found to enhance wellbeing. Fatima et al. (2023) described a similar approach, whereby participation in caring for Country programs, such as land management, bush food harvesting and environmental conservation, was linked to lower psychological distress, improved physical health and strengthened cultural identity (Table 2). Programs with the greatest reported impact were Indigenous-led, grounded in cultural knowledge and focused on practical improvements, especially housing, water and land management. Interventions

were most effective when co-designed with community, employed Aboriginal health workers and integrated environmental and cultural goals. Strong outcomes included improved mental wellbeing, reduced disease burden and higher program engagement where traditional practices were central.

Similar themes were found in the international literature (Table 4). There was a strong focus on Indigenous community-led initiatives, which were found to foster community involvement and greater engagement. As an example, the Indigenous Inuit-led eNuk program, reported by Kipp et al. (2019), engages community members in recording climate and health data via the use of mobile technology in order to link





Year	Program linking environmental and primary healthcare	Key findings
2024 (Department of Health, 2024)	Clinicians refer patients with preventable conditions for home environment assessments. Aboriginal environmental health service providers address physical deficiencies and promote hygiene and health practices, integrating environmental and primary healthcare.	The program identifies and mitigates environmental health risks, improving health outcomes by linking home environment assessments with clinical care, thereby preventing recurrent infections and chronic conditions.
2024 (Australian Indigenous HealthInfoNet, 2024a)	In collaboration with the Geraldton Regional Aboriginal Medical Service, interventions employed include rubbish removal, dog health, pest control, dust suppression, mould assessment, septic tank maintenance, community plumbing and education on environmental health principles.	The program demonstrates several practical interventions, due to successful collaboration between the WA Government and the Geraldton Regional Aboriginal Medical Service.
2024 (Australian Indigenous HealthInfoNet, 2024b)	The program employs local environmental health practitioners to conduct health audits, home checks and facilitate referrals, addressing issues like overcrowding and infectious diseases, and integrating environmental health with primary healthcare services.	The program developed and implemented an environmental health plan, supported a regional health coordinator, and equipped local health workers. It addressed health issues linked to environmental conditions such as overcrowding and infectious diseases.
2024 (Australian Indigenous HealthInfoNet, 2024c)	Development of a community environmental health action plan to identify sustainable trachoma prevention strategies within a broader environmental health context. Four community-led demonstration projects funded each year aimed to reduce trachoma and build community capacity of Aboriginal health workers.	The project successfully reduced trachoma incidences by integrating environmental health strategies with primary healthcare initiatives. Resources such as Milpa's six steps to stop germs supported field practitioners.
2023 (EHSC, 2023)	Improves the capacity of the Kimberley Aboriginal Health Planning Forum member services to address environmental health by setting strategic directions, providing expert advice and advocating for environmental health issues. Programs include community engagement activities, training opportunities, resource sharing and the development of action plans and protocols.	Emphasises the importance of a collaborative approach to environmental health, recognising the impact of environmental conditions on health outcomes. This is intended to lead to better health outcomes in the Kimberley and reduced demand on primary and hospital care services.
2024 (Australian Indigenous HealthInfoNet, 2024d)	Nirrumbuk Environmental Health and Services programs include environmental health assessments, health prevention practices, infection control, housing support, waste disposal, pest control and health education. Collaboration with medical services, such as the Kimberley Aboriginal Medical Services and the Broome Regional Aboriginal Medical Service, serve to aid in disease prevention and health promotion, integrating environmental health with primary healthcare.	Nirrumbuk Environmental Health and Services successfully links environmental health determinants with primary healthcare through comprehensive service delivery, improving health outcomes by addressing housing, sanitation and infection control. These measures have been shown to foster resilience against diseases like COVID-19 and rheumatic heart disease.
2024 (Australian Indigenous HealthInfoNet, 2024e)	Health promotion campaigns, community gardens, pest management and safe bathroom checks link environmental health improvements with primary healthcare by addressing preventable disease risks. The program is facilitated by the Aboriginal Medical Service.	Effective management of health risks through integrated services improves hygiene, animal health and pest control, reducing disease incidence and enhancing community wellbeing.

Table 3: Overview of program linking environmental and primary healthcare, as well as key findings, focusing only on Australian grey literature (n = 7)

the environment to physical and mental healthcare outcomes.

Discussion

This scoping review identified several programs and initiatives that link environmental health with primary healthcare within Indigenous populations. A holistic approach to healthcare that encompasses

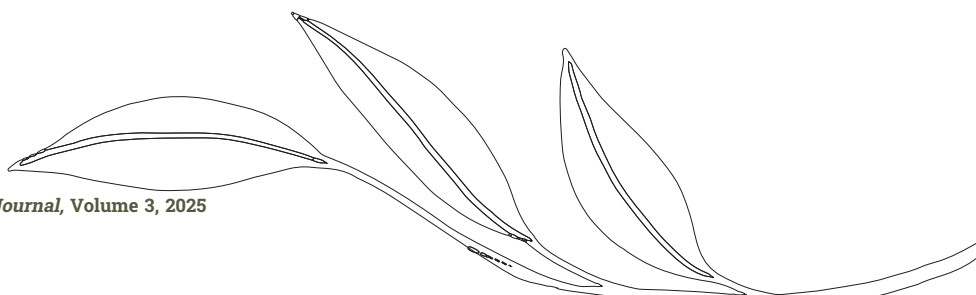
environmental and cultural determinants of health emerged as a key theme across the identified programs. Such an approach often involved multidirectional referral systems, whereby primary healthcare providers and the environmental health workforce were able to interact. These linkages support social and emotional wellbeing, particularly where programs strengthen connection to Country





Lead author surname, year, country	Program linking environmental and primary healthcare	Key findings
Howell, 2004, United States (Howell and Russette, 2004)	Lead screening program integrated with women, infants and children and Head Start services to reach nearly all young children, involving blood tests and follow-ups for elevated lead levels.	The program screened over 90 per cent of children, finding average blood lead levels comparable with national averages, with no children requiring medical intervention.
Ali, 2007, Indonesia (Ali and Jacobs, 2007)	Monthly mobile health clinics providing immunisations, health education and supplemental food for children. Training programs for village health workers and nurses. Installation of clean water systems and medicinal gardens in villages. Health services were integrated with conservation efforts, emphasising community-managed healthcare, capacity building and participatory planning.	Significant improvements were observed in maternal and child health, including increased immunisation rates and reduced vitamin A deficiency as well as community capacity and engagement in both health and conservation activities. Strengthened relationships between conservation organisations and local government, leading to greater support for conservation initiatives, were also observed.
Wooden, 2022, United States (Wooden et al. 2022)	The Northwest Portland Area Indian Health Board's Environmental Public Health Program integrates traditional ecological knowledge with modern public health strategies to address environmental health issues. The Albuquerque Area Southwest Tribal Epidemiology Centre's Tribal Healthy Homes Project focuses on indoor air quality and housing safety.	Programs successfully improved health outcomes by incorporating traditional ecological knowledge into environmental health strategies. These programs enhanced community healthcare by training local health workers and involving community members in environmental health initiatives.
Gelting, 2019, United States (Gelting et al. 2019)	The Sanitation Facilities Construction Program within the Indian Health Service constructs sanitation facilities for American Indian and Alaska Native communities, ensuring access to safe drinking water and sewage disposal systems, which are integral to primary healthcare delivery.	The Sanitation Facilities Construction Program is an extension of the Indian Health Service's primary healthcare delivery model and has significantly improved health outcomes in American Indian and Alaska Native communities. Improvements include reducing gastrointestinal diseases and other infections. The program demonstrates the importance of linkage between environmental engineering and primary healthcare.
Gowda, 2008, New Zealand (Gowda and Thomas, 2008)	The program successfully engaged the community and stakeholders, reflecting the principles of the Treaty of Waitangi. Community action projects and media advocacy significantly influenced the decision to fluoridate water in Kaitia and Kaikohe. Primary health organisations played a crucial role in advocating for water fluoridation as a public health measure and collaborated with Māori health providers, community organisations and other stakeholders to promote oral health.	The program successfully engaged the community, stakeholders and public health organisations. The combined 'top-down' and 'bottom-up' approach was effective. Community action projects and media advocacy significantly influenced the decision to fluoridate water in Kaitia and Kaikohe.
Kegler, 2010, United States (Kegler et al. 2010)	The intervention involved training lay health advisors on lead poisoning prevention, who then disseminated information through social networks and community events, aiming to improve primary prevention behaviours. Primary healthcare services, including the Indian Health Service and County Health Department, contributed by offering community education and blood lead screening.	Significant improvements were observed in hand washing before meals and snacks among Native American children, and in blood lead testing for both Native American and White children. These changes highlight the value of community-based education for primary prevention of lead poisoning.
Subica, 2016, United States (Subica et al. 2016)	Interventions focused on various themes, including increasing access to healthy food, safe recreational spaces, quality healthcare and improving access to healthcare (i.e. through the Chinese Progressive Association). These interventions informed policy changes through community organising and advocacy.	The interventions achieved 72 policy wins, improving children's access to nutritious food, recreational spaces, healthcare and clean environments. This demonstrated that community organising can effectively address structural health inequities.
Kipp, 2019, Canada (Kipp et al. 2019)	The study reviewed 18 monitoring programs using information and communication technologies, emphasising community leadership and integrating environmental and human health indicators to address climate change impacts.	Programs such as the eNuk program highlight the importance of community-led monitoring. The eNuk program engages Inuit community members in recording environmental climate and health data, using mobile technology to facilitate real-time data collection and sharing. This facilitates linkage between environmental observations and primary healthcare, to address physical and mental health outcomes.

(Table 4 continues on next page)





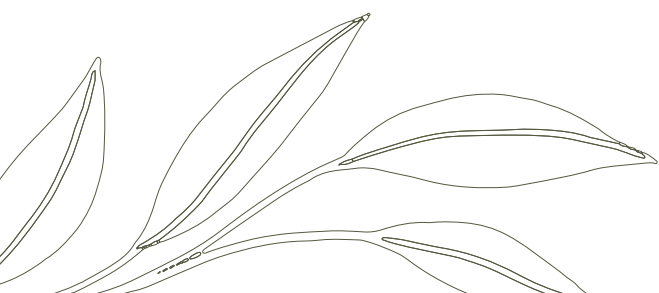
Lead author surname, year, country	Program linking environmental and primary healthcare	Key findings
(Continued from previous page)		
Pandey, 2022, India (Pandey et al. 2022)	Village health sanitation and nutrition committees aim to improve health, nutrition and sanitation services through decentralised planning and community engagement, involving the integration of organisations, including primary healthcare services, in monitoring and facilitating public health interventions.	Village health sanitation and nutrition committees are not uniformly following guidelines, with gaps in training, funding and supervision. Community-based monitoring has shown improved functionality.
Thomas, 2019, United States (Thomas et al. 2019)	The intervention involved arsenic mitigation through water testing, installation of arsenic removal devices and health promotion activities. It emphasised community engagement and education on water safety and arsenic risks. Results were disseminated among primary healthcare providers.	The study found that aesthetic qualities of water, such as taste and appearance, influenced water use preferences. Effective communication of water test results and home visits were crucial. The intervention showed promising acceptability and operability.
Kyoon Achan, 2022, Canada (Kyoon Achan et al. 2022)	Community-based primary healthcare delivery, as a healthcare model, emphasises and advocates for environmental determinants of First Nations health, such as connection to land, strengthening social determinants of health and fostering preventative measures.	Community-based primary healthcare delivery within the First Nations people displayed various strengths, including having a cooperative and engaged community, activities that support social and land connection and wellbeing and an accessible healthcare system including timely care, medical transportation and compassionate care.

Table 4: Overview of program linking environmental and primary healthcare, as well as key findings, focusing only on papers outside of Australia (n = 11)

and support cultural revitalisation, which are known protective factors for mental health and resilience (Larson et al. 2020). There was a strong focus on Indigenous community-led programs as a means of effectively establishing population involvement. Programs such as the eNuk initiative and various land management initiatives have demonstrated significant improvements in both physical and mental health outcomes through community engagement and incorporation of traditional knowledge. Additionally, the concept of Indigenous ‘caring for Country’ emerged as a recurrent theme, encompassing a holistic approach to Indigenous healthcare that incorporates elements of environmental, spiritual and physical health. The increase in literature over recent years is partially due to a focus on caring for Country as a means of linking environment with health promotion and primary healthcare, due to an increased understanding of the importance of Country as an essential part of Indigenous health and wellbeing. These programs demonstrate the potential for linkages between environmental and primary

healthcare to effectively address upstream determinants of health, mitigating a large proportion of chronic and infectious disease in Indigenous communities and improving the health of Country. Successful programs shared key features, including community control, cultural legitimacy and clear links to local priorities. Housing upgrades paired with health promotion showed strong uptake. Ranger and land management programs consistently improved wellbeing by strengthening identity, providing employment and restoring access to Country. Acceptability was highest where programs built on community strengths and respected Indigenous authority.

The findings of this review align with and complement broader pre-existing literature focusing on the critical role that environmental factors play in determining downstream health outcomes (Burgess et al. 2009; Furgal and Seguin 2006; McIver et al. 2017; Monroy et al. 2022; Ray et al. 2022). Much of this literature is focused around programs that solely address



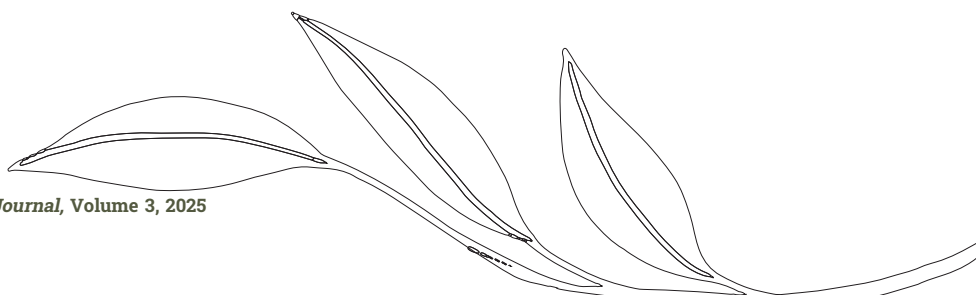


environmental factors, with limited examination of how environmental health initiatives can be integrated with primary healthcare. It is therefore vital to the health and wellbeing of Indigenous communities that the initiatives linking environmental determinants to primary healthcare within Indigenous populations are documented and analysed, to identify existing best practices and how these initiatives can be sustained.

To judge the value of addressing these gaps, it is important to assess the current impact that these environmental factors have on Indigenous health. Such an analysis was provided by [McMullen et al. \(2016\)](#), who interrogated 12 separate environmental risk factors derived from the WHO model of environmental health ([Table 1](#)). These risk factors were cross-examined with data from 17 primary healthcare facilities spanning the Kimberley region, and including 150,357 patient presentations over the past two years ([McMullen et al. 2016](#)). Here, the most commonly contributing environmental factors to various diseases in Indigenous populations were water quality, sanitation and hygiene (21%), home condition (19%), climate (10%), occupational factors (10%) and built environment and land use (10%) ([McMullen et al. 2016](#)). Other factors, such as environmental noise, chemical exposure and public water resources, were found to only make a relatively small contribution towards Indigenous health outcomes. It was found that there was generally good correspondence between environmental health and primary healthcare integrated programs identified within this scoping review to the demand for such services identified by [McMullen et al. \(2016\)](#). Notably, unmet 'demand' for environmental and health programs exist in areas such as 'occupational factors', 'indoor/outdoor air pollution' and 'recreational environment', which includes access to various outdoor recreational facilities. It should be noted that the study by [McMullen et al. \(2016\)](#) was

conducted within the Kimberley region solely using primary healthcare presentations, meaning that the proportion of disease burden due to these environmental factors may not be completely representative of the broader Indigenous community within Australia. For example, in many other remote Indigenous communities, drinking water contamination presents a major problem, with significant downstream health impacts ([Balasooriya et al. 2023](#)). Therefore, to improve understanding of the link between environment and Indigenous health it would be of interest to replicate this study in other locations.

Broader literature on environmental determinants of Indigenous health captures the importance of environmental programs, as exemplified by [Schultz et al. \(2018\)](#), who reported that Indigenous land management programs within Western Australia and the Northern Territory provide multifaceted health benefits, including strengthened cultural identity and reduced substance abuse. Additionally, other studies on Indigenous land management have documented improvements in environmental sustainability but also enhanced physical activity, dietary habits and mental wellbeing, aligning with the results of this study ([Burgess et al. 2005](#); [Schultz et al. 2018](#); [Kingsley et al. 2009](#)). These parallels reinforce the notion that healthy environments and Country are crucial to the improvement in Indigenous health. Furthermore, having local Indigenous control over these programs enhances the benefit through community participation and, in the case of Indigenous land management initiatives, strengthening traditional knowledges. This review complements the findings of [McMullen et al. \(2016\)](#) and [Melody et al. \(2016\)](#), which have shown that the improvement in various environmental health factors and community structures could prevent a large portion of disease in Indigenous populations.





A key strength of this review, and a large part of its purpose, was identifying programs that provide linkages between environment and primary healthcare, thereby identifying characteristics that enable effective and pragmatic approaches to improving environmental factors. However, it should be noted that this review also had some limitations, including the potential for publication bias and the exclusion of non-English papers, which may have resulted in the omission of important studies. Additionally, given the recent influx in literature, the temporal relevance of the presented data may be brief, due to new studies being produced that have not been captured here. Furthermore, the varied methodologies of the included studies posed some challenges in comparison and in assessing the effectiveness of different approaches toward integrated environmental health and primary healthcare programs.

This review has numerous implications that are relevant to policymakers, healthcare providers and Indigenous communities. The gaps identified in the literature highlight several areas that may benefit from program implementation. The findings presented here may promote inter-sectoral partnerships, and inform the development of community-led, sustainable and systemically integrated environment and primary healthcare programs in Australia, especially within rural and remote settings. Such strategies include grassroots community involvement and the integration of traditional knowledge in health programs, which can lead to more culturally appropriate and effective care. Additionally, two-way referral systems can be considered, whereby clinicians may initiate referral for environmental health screening and the environment health workforce may refer to clinicians for health screening. Further research exploring the sustainability and long-term

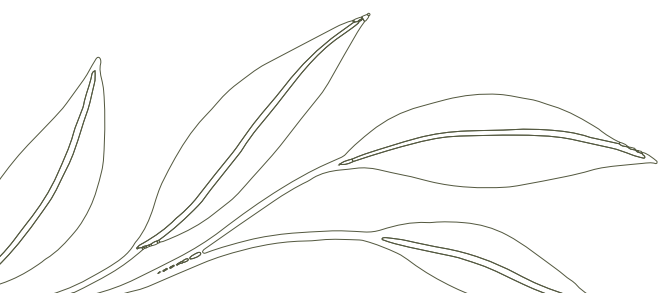
impact of these integrative approaches, as well as into the areas of environmental health with the most unmet need would be of high value. Such research could be conducted via a combination and range of modalities, including interviews with community, healthcare staff and patients, systemic reviews and analysis of clinical data.

Conclusion

This scoping review focused on programs and initiatives that provide linkages between environmental determinants of health and primary healthcare within Indigenous communities. Holistic approaches that targeted environmental determinants of health were found to provide marked improvements in Indigenous health. Successful strategies included intersectoral partnerships, community-led programs, incorporation of traditional knowledge and Indigenous caring for Country.

The findings presented here offer a foundation for guiding the design, funding and implementation of integrated and culturally responsive programs. They can particularly assist policymakers and healthcare providers in supporting more effective collaborations between primary healthcare services and environmental health initiatives in rural and remote Indigenous communities, where such integration is most often needed.

Further work is required to document and evaluate Indigenous-led models and to address existing literature gaps. Evaluating the long-term impact of these programs and identifying community-defined priorities for environmental health action will be critical to building the evidence base. This review can serve as a practical resource to support the co-design and delivery of sustainable, place-based approaches





that strengthen both health systems and cultural wellbeing.

Author contributions

J. Wells: conceptualisation, methodology, investigation, data curation, writing – original draft, visualisation. V. Matthews: conceptualisation, writing – review and editing, supervision, project administration. A. Chakraborty: conceptualisation, writing – review and editing, supervision, project administration.

Declaration of interests

The authors declare no competing interests.

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Supplementary material

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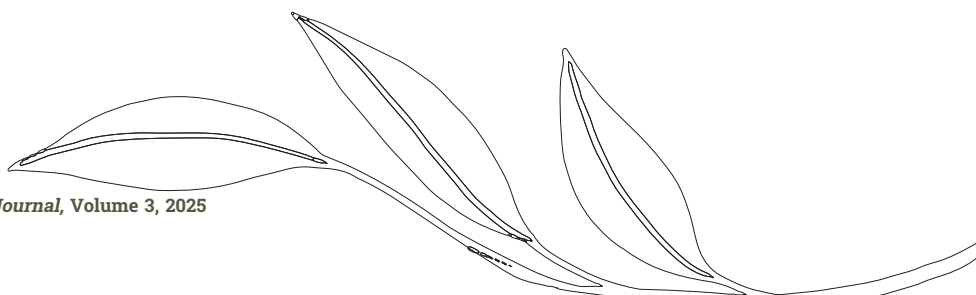
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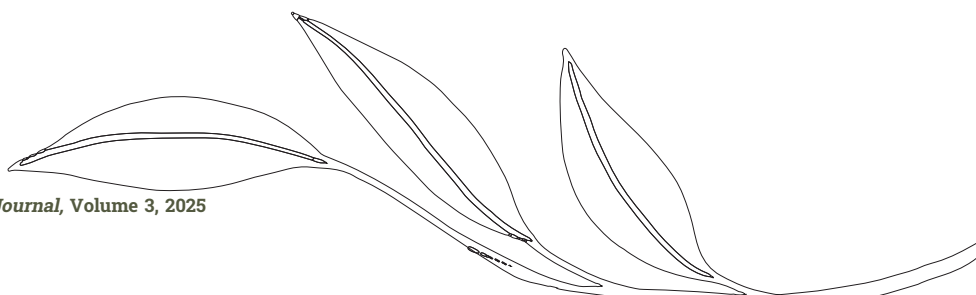
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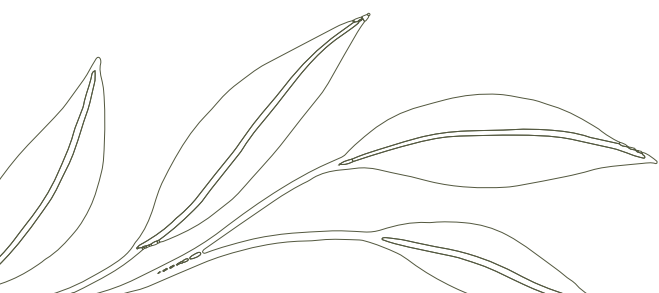


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