




REVIEW

Is open defaecation in outdoor recreation and camping areas a public health issue in Australia? A literature review

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Abstract

Issue addressed: In Australia, natural areas used for outdoor recreation activities or camping often have limited or no sanitation infrastructure. Recreationist and campers may use open defaecation practices where toilets are not provided. Contaminated soils and watercourses are associated with gastrointestinal illnesses. This review aims to determine if open defaecation is a public health issue in outdoor recreation and camping areas in Australia.

Method: A literature review was conducted using the following search engines: CINAHL, Informit Database, Scopus, ProQuest Science & Technology, Medline (Ovid) and EBSCOhost. Inclusion criteria for this review were both experimental and observational research designs for studies describing the public health issues associated with open defaecation practice.

Results: Out of 12 147 papers identified, only three studies met the inclusion criteria, showing a lack of research into this area. Included were two studies that addressed human waste management practices in outdoor environments and the breakdown of human waste in alpine regions of Tasmania. The third study measured water contamination at a freshwater beach on K'gari-Fraser Island, Queensland. Visitors to natural areas are potentially at high risk of illness due to exposure to faecal contamination from other visitors using unsafe open defaecation practices in high-use camping areas.

Conclusion: The limited number of studies addressing open defaecation in the outdoor recreation and camp areas in Australia indicates this review is a starting point to identify critical areas that may be of concern when managing visitors in an outdoor recreation setting. This review recommends investigating barriers and enablers motivating human disposal waste in these settings to help formulate health promotion content; environmental management policies related to sanitation and hygiene should be also underpinned by public health policy; and providing appropriate sanitation options depending on the ecological and visitor numbers to natural areas.

So what-relevance of findings: Outdoor recreation activities offer physical and mental health benefits for communities. The popularity of outdoor recreation activities is

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on the increase in Australia. With the rise in visitation to natural areas, management of human waste needs to be addressed to reduce the public health risk of illness.

KEYWORDS

environmental health, healthy environments, sustainability

1 | INTRODUCTION

Worldwide, poor sanitation is a major risk factor for death and disability.¹ Poor sanitation is addressed by ensuring access to safe and clean water to maintain hygienic conditions and adequate disposal of human waste.² Good sanitation is vital to good health.³ Lack of safe human waste disposal infrastructure is known to facilitate the transmission of pathogens, causing sicknesses, which equates to 6.8% of the total burden of gastrointestinal illnesses in developing countries.³ Good sanitation is achieved when populations have access to a range of safe disposal of human waste sanitation facilities including flush toilets connected to sewers or septic systems, ventilated improved pit latrines, latrines with a slab or composting toilets.⁴

Australia has good sanitation practices, and the World Health Organization (WHO) considers Australia to have universal access to sanitation.⁴ Generally, the risk of contracting gastrointestinal illnesses due to exposure to human faecal matter is low in Australia, however, some populations have considerably higher incidence of human intestinal illnesses compared to the general population.⁵⁻⁷ The populations identified as most likely to be susceptible to gastrointestinal illnesses include young children (0-5 years of age), young adults (20-30 years of age), Indigenous Australians in remote communities and refugees.⁵⁻⁷ Young children are more susceptible because of their inquisitive and mouthing behaviours or underdeveloped hygiene practices.^{8,9} In adult populations, poor sanitation or human waste disposal and water contamination in urban areas and remote communities are often considered to be the most likely cause of exposure to nonfoodborne gastrointestinal diseases.^{3,10-13}

Gastrointestinal illnesses caused by pathogens contained in human faecal waste include parasitic illnesses such as strongyloidiasis,¹⁴ Giardiasis, hookworm infection¹⁵ or bacterial illnesses due to *Escherichia coli* sp for example.¹⁶ Gastrointestinal illnesses caused by pathogens contained in human waste can be transmitted either via (a) faecal-oral route, (b) contaminated soil from faecal deposits or (c) water contaminated with faecal matter.¹⁷

Outdoor recreation and camping areas often have minimal sanitation infrastructure¹⁸ which may increase the likelihood of contracting gastrointestinal illnesses in these settings. In the absence of such infrastructure, documents such as the "Minimal Impact Bushwalking" (MIB) and "Leave no trace" guidelines recommend bushwalkers and campers use a "cat-hole" method for faecal disposal. "Cat-holing" is carried out by digging a hole, making a faecal deposit, and then covering the deposit (including toilet paper) with the soil that was excavated. The hole should be dug between 50-200 m away from campsites, paths and streams and faeces buried at least 15 cm deep.¹⁹⁻²¹ These recommendations are promoted by many hiking and camping organisations from government departments

to small hiking groups with the aim of reducing their environmental impact; lowering the risk of other visitors coming into contact with faecal deposits and decreasing the risk of soil and water contamination.²⁰⁻²²

Nature-based tourism and local participation in outdoor recreation activities are growing worldwide and in Australia.^{23,24} With more people using poorly appointed sanitation facilities in outdoor recreation and overnight camping areas, there is a risk of increase of gastrointestinal diseases acquired through exposure to water and soil contaminated with human faecal matter. However, general practitioners rarely ask their patients who present with gastrointestinal illnesses if they have recently visited natural outdoor areas.²⁵ Consequently, sickness due to pathogens acquired from exposure to faecal deposits during nature-based activities is often not captured in health records and are poorly reported in health literature.²⁵ Thus, the risk of acquiring gastrointestinal illnesses through exposure to human waste while pursuing outdoor recreation activities in Australia is unclear.

So, we ask, is open defaecation in outdoor recreation and camping areas a public health issue in Australia?

2 | METHODS

2.1 | Data sources

Search engines used included CINAHL, Informit Database, Scopus, ProQuest Science & Technology, Medline (Ovid), EBSCOhost with searches completed in August 2018 (by LS, TA, DS). Reference lists of eligible studies were searched for additional publications. Due to the topic being relevant to both public health and environmental management literature, two sets of search terms were created to ensure all relevant papers were identified in the search process.

The following keywords were used to search the literature:

Search terms 1: Australia* AND (human feces OR human faeces OR human defecat* OR open defecat*) AND management AND (behaviour OR practices)

Search term 2: Australia* AND (human feces OR human faeces OR human defecat* OR open defecat* OR cat-hole OR faeces disposal OR Faecal contamination OR urine) AND (camping OR back-country OR bushland OR camping impacts)

2.2 | Inclusion and exclusion criteria

Peer-reviewed articles written in English language that addressed or described open defaecation behaviours in outdoor recreation and camping areas in Australia were included. No date limit was used for the search. Full-text of the study or document was required – the

studies needed to indicate that faecal contamination occurred due to open defaecation practices. All study designs were accepted.

Papers relating to managing formal sanitation standards or identifying only water or zoonotic faecal waste that did not identify the source of contamination were excluded. Literature reviews were not included.

2.3 | Review process

The review process involved three of the authors (LS, TA, DS) searching the five designated search engines for possible suitable titles. Authors assessed 12 274 study titles for suitability according to inclusion/exclusion criteria (Figure 1). Of these, 142 were retained, and the abstracts were assessed for suitability according to the same inclusion/exclusion criteria. Twenty-two articles were identified through the reference lists of related studies. Authors (LS, TA) read 10 full articles to confirm eligibility. A form was developed in Microsoft Excel (2015) to extract relevant data from the three included papers (Table 1). Extracted data were organised according to themes.

3 | RESULTS

Three papers, two experimental studies and one observational study, met the inclusion criteria and were incorporated into this review (Table 1). All three papers were written by environmental science professionals and published in environmental management journals. All

three were quantitative studies relating to human faecal contamination in camping areas or near long-distance bushwalking trails in alpine and sub-alpine regions in Tasmania and the coastal regions on the east coast of Queensland, Australia.²⁶⁻²⁸ Two papers identified human behaviours that increased water or soil contamination which may result in potential public health issues.^{26,28} A third study examined the breakdown of toilet papers, tissue and tampons in various environmental conditions (from alpine to sea level).²⁷ An overarching theme identified in all three papers was that human waste management behaviours could represent a public health risk to visitors to camping areas. Three themes were identified in the review: (a) Lack of adherence to basic sanitation techniques; (b) Soil and water contamination with or without visible faecal deposits and; (c) A lack of public health research into the issue of defaecation in outdoor settings.

3.1 | Lack of adherence to basic sanitation techniques

Visitors to popular camping sites had poor sanitary behaviours for faecal disposal as evidenced by the visible presence of faecal matter and toilet paper as well as poor water quality in the vicinity of the camping areas examined.^{26,28} A study in Tasmania found that there were significant numbers of inappropriate waste disposal in a popular National Park.²⁸ Faecal deposits were identified in a 120 m radius from camping huts with clusters of faecal deposits within 30 m.²⁸ The researchers observed that the closer to the hut areas,

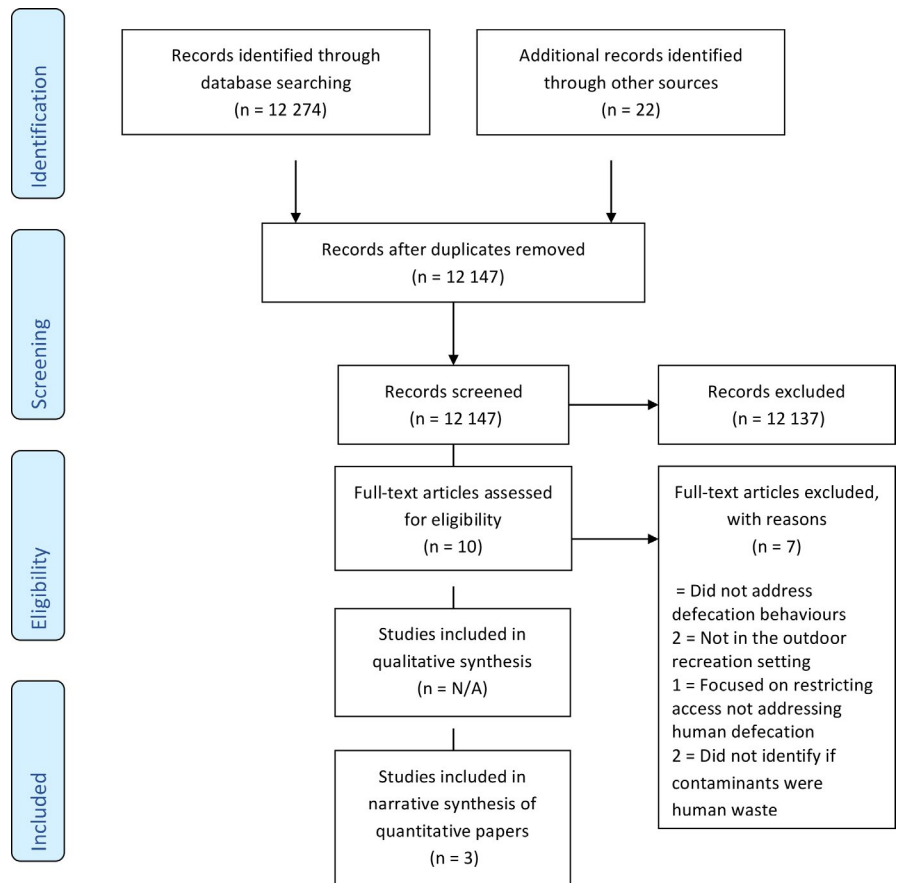


FIGURE 1 Summary of the article selection process as recommended by the PRISMA statement

TABLE 1 Summary of characteristics of 3 included studies

Author date [Ref]	Study type and aim	Participants or experiment location	Methods of data collection and analysis	Summary of key findings
Bridle et al 2005	Experimental study— Measure the length of time it takes for toilet papers, tampons and tissue to break down in different natural environments	Multiple National Parks throughout Tasmania from alpine to sea level	Buried 750 items at different levels in different terrain and measurements of degeneration at 6 and 12 mo.	Most items had significant decay within 12 mo except in alpine areas with little change noted. Faecal bacteria were identified at the 6-month test.
Bridle et al 2007	Observational study— Determine if visitors to National Parks were following Minimal Impact Bushwalking guidelines	Bushwalkers, Mount Field & Cradle Mountain- St Clair National Parks, Tasmania	Measure the degree of compliance of visitors with MIB guidelines. Faecal, toilet paper, sanitary product and soil sampling was conducted.	Faecal deposits located up to 120 m radius away from the huts. 65.4% of deposits were within 30 m of the huts. Cluster deposits were found around bushes. No deposits were found at the overnight huts where a toilet had been installed.
Carter, et al 2015	Experimental study- Determine if human waste on foredunes is likely to cause risk to human health	25 ground water and soil samples (18 camping and 7 noncamping) and 28 beach flow water samples (18 camping and 10 non-camping) on K'gari-Fraser Island, Queensland	Soluble nutrient and faecal sterols including Coprostanol was selected to indicate human waste contamination	Camping intensity did not have a direct correlation with water quality parameters. Groundwater in camping zones—thermotolerant coliforms exceeded Qld water quality standards in 56% of the sites. Groundwater in non-camping zones—phosphorous, ammonia and total nitrogen levels exceeding Qld water quality standards in all samples. Coliform and total phosphorus levels were more than double in camping zones.

the shallower the burial of faecal deposits.²⁸ Thirty-two per cent of all faecal deposits were appropriately buried; 47% of faecal deposits were shallowly buried; 16% under rocks; and only 1% of toilet paper, tissues or tampons were deeply buried.²⁸ There were no faecal deposits where a toilet was installed; however, faecal deposits were found along walking trails between hut sites.²⁸ This study in alpine and Sub-alpine conditions of Tasmanian outdoor sites showed a perceived significant lack of knowledge for basic sanitation approaches by visitors when there was no access to toilet facilities.²⁸

3.2 | Soil and water contamination with or without visible faecal deposits

Soil or water contamination from human waste was reported in all three studies.²⁶⁻²⁸ Bridle et al²⁸ detected human faecal contamination in small pools of water near camping huts. Bridle & Kirkpatrick²⁷ found pathogens from human waste deposited in cat-holes could survive in alpine soils for 6 months or longer. Human faecal waste contamination was also the case in camping areas on K'gari-Fraser Island.²⁶ The groundwater near camping zones showed signs of contamination with 10 out of 18 sites recording thermotolerant coliforms exceeding Queensland's water

quality standards.²⁶ Carter & Tindale²⁶ described that groundwater quality and beach flows were compromised with faecal coliforms and faecal sterols in camping zones and noncamping zones near a campsite. Where water quality was compromised in non-camping zones, the authors concluded that campers moved into the noncamping zones for defaecation.²⁶

Bridle & Kirkpatrick²⁷ measured the length of time required for items such as toilet papers to decay in different environments in Tasmania. Half were buried with a nutrition solution to mimic nutrients found in faeces or urine was added. Overall, bleached and unbleached toilet papers broke down quickest followed by tissues, while tampons took considerably longer to show signs of decay. Items with the nutrient solution were found to increase the decay of the item.²⁷ Breakdown of products was greatest in warm, relatively dry and nonacidic conditions.²⁷ The depth of the burial was not as important to the decay process as the other environmental conditions; wetter areas where the water tables are within 15 cm of the surface, shallow burials depths of 5 cm are more likely to decay more readily. 34 out of 750 bags were dug up by animals.²⁷ This study showed that inappropriate disposal of faeces meant that bacteria from faeces could stay alive on disposed of toilet paper for over 6 months in some environments and conditions.²⁷

3.3 | A lack of public health research into the issue of defaecation in outdoor settings

Defaecation in outdoor settings is a public health issue. Authors in all three studies were concerned about the spread of gastrointestinal illnesses where there were high numbers of campers using camping areas.^{26,28} There were public health concerns for bushwalkers where camping huts were available without toilet facilities or where the threshold for the environmental conditions to break down the human waste had been reached.²⁸ All three papers identified poor human waste management as a public health risk.²⁶⁻²⁸

4 | DISCUSSION

The three studies in this review, based on observations made in Tasmanian National Parks and Fraser Island in Queensland, Australia, have highlighted the potential public health risk for campers and visitors of these outdoor sites due to inadequate human waste disposal.²⁶⁻²⁸ Findings from this review suggest that there may be a potential public health risk of acquiring diseases from exposure to human faecal contamination when visiting wilderness areas in Australia, particularly when camping overnight.²⁶⁻²⁸ This review has identified three key issues: (a) a lack of adherence to basic sanitation techniques; (b) soil, water contamination with or without visible faecal deposits; and (c) a lack of public health research into the issue of defaecation in outdoor settings.

4.1 | Lack of adherence to basic sanitation techniques

Lack of adherence to basic sanitation techniques in outdoor recreation areas was noted in two of the Australian studies.^{26,28} Visible faecal deposits were noted in the study by Bridle, et al 2005.²⁸ International literature similarly reports faecal matter deposits were on top of the ground or poorly buried.²⁹⁻³¹ Visible faecal matter was also reported in two studies of high-altitude climbers on Mt Aconcagua, Argentina and on Denali, the highest peak in North America, Alaska, United States of America (USA). In both cases, there were reports of direct human exposure to faecal deposits.^{29,31} Climbers around the tent sites saw faeces, and the longer climbers stayed at these campsites, the more they reported of gastrointestinal illnesses.³¹ These studies suggest that the lack of adherence to basic sanitation techniques in these settings is not only unsightly but also increases the risk of illness among recreationists. Although the prevalence of gastrointestinal illnesses was not examined in the included Australian studies, the report of the presence of visible faecal deposits and contamination of the environment with thermotolerant coliforms seem to indicate that a similar risk of exposure to gastrointestinal exists at these Australian outdoor sites. All three Australian studies suggested that popular camping areas posed a risk of gastrointestinal illness for visitors.²⁶⁻²⁸

Sanitation guidelines used for outdoor recreation are available to visitors in Australian National Parks via websites to ensure

recreationists do not dramatically impact the natural environment during their stay.^{21,32} However, the information about sanitation used for outdoor recreation is unlikely to be available once accessing natural settings. Water quality may also be affected when visitors do not practice effective sanitation practices.^{26,33} Visitors may not commonly use personal sanitation techniques such as the MIB guidelines in wilderness areas, and educational strategies may be needed to remind visitors about appropriate waste disposal. However, without monitoring the prevalence of gastrointestinal diseases acquired through exposure to faecal deposits or contamination of the environment, it is difficult to gauge the extent of this public health risk. When health professionals report gastrointestinal diseases, perhaps the case history should include an enquiry about the potential path of exposure. Warwick, 2004 suggested a similar approach to capturing the incidence of zoonotic gastrointestinal diseases in humans.³⁴

4.2 | Soil and water contamination with or without visible faecal deposits

Pathogens from human waste deposited in cat-holes could survive alpine soils for 6 months or longer.²⁷ Similar studies in the USA confirmed that bacteria in human cat-hole deposits could exist for at least a year.³⁵ High traffic areas that do not have toilet facilities are a concern because future visitors to the area might unknowingly unearth deposits and risk potential exposure to faecal matter and pathogens contained within. Wild animals can also unearth faecal deposits exposing contaminated material but also become contaminated themselves further extending the public health issue via the zoonotic route.³⁶

Water quality can be adversely affected by faecal contamination, posing a risk of disease transmission to those either consuming the water or those who are using the water for recreational purposes. Carter & Tindale²⁶ expressed concern about the potential public health risk from coliforms found on freshwater beaches in Australia. Researchers echoed concern for this public health risk at freshwater beaches in England. *E coli* and other coliforms were evident in the swash zone.³⁷ Carr et al²⁹ showed that many diseases in mountaineers were directly associated with exposure to faecal deposits left on the snow, which then contaminated water sources both at camps and en route. Similarly, 29% of climbers descending from Denali, Alaska had symptoms associated with acute gastroenteritis, which were likely due to exposure to contaminated water.³¹ Though the soil is a very effective pathogen filter, in areas of high rainfall pathogen transportation can still occur, which has the potential of contaminating high water tables.³⁸ High-use areas without sanitation may require additional monitoring to see if they are associated with an increase in the incidence of gastrointestinal illnesses.

4.3 | A lack of public health research into the issue of defaecation in outdoor settings

Environmental management groups have emphasised the need to improve sanitation in outdoor recreation settings in Australia since

the 1990s.^{22,39} All three papers included in this review were by authors working in the field of environmental management research. Notably, these authors all raised public health concerns and suggested better management of human waste in these natural settings.²⁶⁻²⁸ This drive was evident in all three articles, even though publishing articles in journals with a focus on environmental management. Human faecal contamination of natural recreational areas was recognised in all three articles as a public health risk issue, no articles were found to be published on this topic in journals within public health, or environmental health-focused journals. The lack of literature by public health and environmental health researchers may mean that the topic is going unnoticed as a public health issue in Australia.

The lack of concern for this public health issue may be because gastrointestinal illnesses are often not reported by outdoor recreationists,²⁹ or because the issue could be overlooked by clinicians and researchers.^{25,40} Carr et al²⁹ noted that many alpine climbers who experienced gastrointestinal illnesses during their expeditions did not seek medical attention. A study by Kettlewell²⁵ showed that Giardiasis was highly prevalent in the 20- to 30-year-old age group which was likely infected during bushwalking and outdoor recreation activities in wilderness settings.²⁵ The authors of this study discussed Giardia transmission as occurring between animals and humans through water contamination.²⁵ However, gastrointestinal illnesses may occur via human to human transmission or through environmental contamination occurring due to open defaecation practices. A study by Einsiedel et al, 2006⁴⁰ investigating cases of travellers and immigrants returning to Australia with *Strongyloides stercoralis* identified one patient who was excluded by the study as he believed he acquired the infection during a local camping trip to Eastern Victoria.⁴⁰ These studies highlighted that cases of gastrointestinal illnesses due to exposure to human waste in natural outdoor settings may be under-reported, and the scale and significance of this public health issue in Australia are poorly understood. Further research into this particular environmental and public health issue is urgently required.

4.4 | Additional considerations

Access to a toilet has shown to be the most effective way in reducing open defaecation in natural settings.²⁸ Different toilet infrastructure options are available, depending on the climate, fragility of the environment and management options to maintain an on-site facility.^{30,33} Methods have since been developed to calculate the volume of excrement,⁴¹ which can aid park managers in choosing the most appropriate toilet infrastructure needed. At Aconcagua, the highest peak of South America, 22 tonnes of human waste is transported by helicopter each season. Park managers charge mountaineers for this service. However, some mountaineers have shown an unwillingness to pay, and human faeces are often found on the mountainside.³⁰ The amount of human waste that can be collected can be considerable in high-use areas. In 1995, visitors filled two portable toilets on the first day in Kosciuszko National Park, requiring two more portable

toilets to be added to the national park.³⁹ Managers of Kosciuszko National Park have since deemed on-site facilities as inappropriate and commercial operators are to carry out human waste products and also encourage other park visitors to carry out their waste.²²

Self-haul devices have been made to transport solid human waste.^{22,42} Self-haul systems such as allocation and gelling (WAG) bags, containing an agent to break down the excrement have been used on Mt. Whitney and Mt. Rainier National Park, USA.⁴³ Another self-haul device is corn starch bags stored in a “transportable excretion can” until the bags can be discarded in hut toilets and are used on Mount Cook, New Zealand³⁰. Authors of a review of human waste disposal in natural areas in the United States recommended exploring options for self-haul systems for personal use.³⁸ However, it is not clear if visitors would voluntarily carry out their solid human waste. The studies in our review indicated that self-haul methods are not in common use in Australian camp areas.^{26,28} Further research would need to be conducted to evaluate the acceptability and feasibility of implementing the use of such devices.

Hand hygiene practices can counteract the potential for exposure to faecal matter that might occur at camping sites; however, these were not addressed in the studies included in this review. Keeping hands clean is paramount to reducing the risk of illnesses. Handwashing or using alcohol wipes, where clean water is unavailable, is recommended after going to the toilet.⁴⁴ It is unlikely that sites with no sanitation facilities would have access to handwashing facilities⁴⁵ and in such cases, visitors may forego handwashing altogether, a common behaviour regardless of the setting. A study by McLaughlin et al³¹ of mountaineers climbing the west Buttress Route of Denali in Alaska found that only 41% of climbers always washed their hand after defaecation, but of more concern was that 27% reported never washing their hands. Alternatively, visitors may use a nearby body of water, thus further contaminating the environment, without necessarily achieving hand sanitation. However, this risk of transmission of diarrhoeal diseases can be minimised by as much as 23% by effective handwashing utilising soap and water or disinfectant solutions.⁴⁵ Soaps are not recommended for use in streams and waterways due to water contamination making disinfectant solutions the preferred option when camping. Furthermore, visitors staying for longer periods at a particular site may be involved in food preparation activities, which could further contribute to the possible exposure to faecal matter via the oral route. Access to safe handwashing in these settings is an issue that should be taken into consideration when examining the sanitary behaviours of members of the community using outdoor sites. Hand sanitising solution could be used to remedy this. However, the efficacy of such products in waterless food preparation conditions is not conclusive.⁴⁶ Currently, MIB guidelines do not encourage hand washing after cat-holing.¹⁹⁻²¹ Updating such guidelines to include hand washing, with an alcohol-based solution after defaecation is warranted, so as to not encourage visitors to use soaps in watercourses.

International and local travellers seek nature-based tourism experiences, bringing many visitors to natural areas throughout Australia.⁴⁷ Visitors to protected natural areas use only small

sections of nature reserves.⁴⁸ As visitor numbers increase, environmental management and public health leaders need to consider the impacts of open defaecation in recreation areas. There is a lack of research related to the management of human waste in outdoor recreation areas without sanitation infrastructure in Australian environmental conditions with only three research studies addressing limited aspects of this issue, which did not include hand hygiene.

A strength of this study was that it included a wide range of databases in the search strategy, and the search strategy was focused on Australia only as that was the context under study. A limitation was, despite the extensive use of numerous databases, it is still possible that not all relevant articles were found as the issue under consideration is at the crossroads of many disciplines such as health, public health, environmental management, environmental health.

5 | RECOMMENDATIONS AND CONCLUSION

Australia delivers a comprehensive sanitation system ensuring the population has a low risk of gastrointestinal illness. However, this literature review of three included studies from Tasmania and Queensland has shown that human waste management behaviours are likely to be poor in some natural areas in Australia, putting recreationists at risk of gastrointestinal illness.

With an increase in visitor demand for outdoor recreation activities and camping through nature-based tourism,⁴⁹ open defaecation practices and hygiene may need to be addressed as public health issues in Australia and perhaps elsewhere. Additional research investigating barriers and enablers motivating human disposal waste and hand hygiene in these settings might also provide a better understanding of the issue, and help formulate educational health promotion approaches. Environmental management policies related to sanitation and hygiene should not only consider environmental consequences but also be underpinned by public health policy. Sanitation infrastructure needs to be upgraded in high traffic nature settings, including environmentally appropriate sanitation solutions. Otherwise, self-haul human or large-scale transportation waste provisions need to be considered.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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