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A systematic review of the evidence that swimming pools improve health and wellbeing in remote Aboriginal communities in Australia

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Abstract

Objective: To provide an overview of the evidence for health and wellbeing benefits associated with swimming pools in remote Aboriginal* communities in Australia.

Methods: Peer-reviewed and grey literature from 1990 to 2014 was searched to identify studies set in remote Australia that evaluated health and wellbeing benefits that have been associated with swimming pools. Studies were categorised using an evidence classification scale.

Results: Twelve studies met our search criteria. All prospective studies that collected data on skin infections found access to swimming pools to be associated with a drop of skin sore prevalence and -where measured- severity. Studies documenting ear and eye infections showed mixed outcomes. Many wider community and wellbeing benefits were documented in various studies, although many of these were primarily anecdotal in nature.

Conclusions: Although a case can be made regarding skin infections and the broader wellbeing benefits that swimming pools may bring to remote Aboriginal communities, the benefit to ear and eye health remains unresolved.

Implications: The decision to provide swimming pools to remote Aboriginal communities should not hinge on the demonstration of direct health benefits alone. Equity considerations and the potential broader benefits such amenities may entail are equally important.

Key words: swimming pools, skin infections, ear infections, Aboriginal health, rural health

**For the purpose of brevity, Aboriginal and Torres Strait Islander people are referred to as Aboriginal people throughout this paper.*

The health and wellbeing disparities between the Aboriginal and Torres Strait Islander people and other Australians are well documented.[1–5] Young Aboriginal people in particular suffer a disproportionately high burden of infectious diseases,[6] with respiratory, ear and skin infections being the most common reasons for children living in remote Aboriginal communities to present to clinics.[7,8] About one-quarter of Aboriginal Australians live in remote or very remote areas,[9] with poor housing conditions and limited access to various amenities considered a given in regional and urban areas.[10]

The National Partnership Agreement on Remote Service Delivery, a key component of the Council of Australian Governments 'Closing the Gap' strategy,[11] aims to provide a framework for ensuring that Aboriginal families have access to more equitable services consistent with those provided to other Australians.[12] Since aquatic sports and leisure activities are a staple of Australian life, it has been argued that remote Aboriginal communities should also have access to safe and well-maintained swimming pools. This is especially relevant considering the potential for community swimming pools to address most of the seven building blocks of the 'Closing the Gap' strategy (early childhood; schooling; health; economic participation; healthy homes; safe communities; governance and leadership).[13]

Advocates argued that the health and wellbeing benefits associated with providing communities with well-managed swimming pools include improved health outcomes by possibly reducing the prevalence of skin and ear infections (by cleaning the skin and flushing bacteria from the middle ear, respectively); a safe place for leisure activities and teaching swimming and water safety skills; and additional employment and personal development opportunities.[13]

Swimming pools may provide a way of addressing Aboriginal people's holistic understanding of health that encompasses the social, emotional and cultural wellbeing of the whole community.[14]

The potential health benefits of swimming pools in remote Aboriginal communities were first suggested in a research paper in 1984.[15] This study showed that the presence of a swimming hole, pool or ocean was associated with lower prevalence rates of otitis media

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(OM). Since then, various studies have set out to evaluate the effectiveness of swimming pools as a way to improve various health outcomes in remote Aboriginal communities, including reducing rates of infectious diseases in school and pre-school children. This paper presents an overview of those studies, while also exploring evidence for other wellbeing and community benefits that may be gained through swimming pools.

The review's particular aim is summarised in two linked research questions: i) What evidence does the existing literature provide in support of improved health and wellbeing outcomes that have been associated with swimming pools in remote Aboriginal communities in Australia; and ii) Which evidence gaps (whether methodological or in relation to particular potential benefits) currently exist in the literature?

Methods

Initial searches for relevant publications were carried out using online bibliographical databases. Bibliographies of publications included in the review were systematically searched for additional relevant references, a process that was repeated for every publication identified through this procedure (snowballing). Where references could not be located online, we contacted the authors directly to request access to the publication. We used the PRISMA Statement as a guide for performing this review.[16] A copy of the completed PRISMA checklist can be found in Supplementary File 1.

Search strategy

The following online databases were systematically searched for relevant publications from 1 January 1990 to 9 November 2014: Pubmed (Medline), EMBASE, Scopus, Web of Science, AustHealth and the Australian Indigenous HealthInfoNet. The latter two include grey literature references that are particularly relevant to the Australian context. We applied a broad key word search strategy using the following search string: (swimming pool* AND community) OR (swimming pool* AND benefit). The search was last performed on 9 November 2014.

All publications that presented first-hand data on the potential health and wellbeing benefits of swimming pools to remote Aboriginal communities in Australia were included. In order to ascertain eligibility for inclusion in our review, publication titles and abstracts were screened for references to: i) various infectious diseases and the possible beneficial effects swimming pools may have in reducing their burden in remote Aboriginal communities; ii) social and emotional wellbeing outcomes that may be associated with swimming pools in these settings; and iii) other potential benefits swimming pools may bring to communities. Where eligibility was unclear on this basis, the full text was considered. If no abstract was available – as was the case for some grey literature publications – the full article or report was screened. No restriction was placed on the study or publication type to ensure the included studies reflected the broad spectrum of research questions and approaches that have been applied to evaluate possible benefits associated with swimming pools. Conference research papers offering detailed accounts of work were considered, although published conference abstracts were not. Articles discussing issues such as water quality, water-borne pathogens, disinfection by-products and other health risks were excluded. Using these selection criteria, two researchers (DH and AS) performed the systematic search independently. Disagreements between both reviewers were resolved by consensus.

Appraisal of included studies

The level of evidence provided in the studies included in this review was described by employing an evidence classification scale adapted from National Health and Medical Research Council guidelines[17] and a similar review that was published previously.[18] The main change we introduced was to include qualitative studies as a distinct study type and differentiate between *anecdotal* and *rigorous* qualitative studies to underline the methodological nature of the latter and make it clearly distinct from purely anecdotal data. This classification is summarised in Table 1.

Data extraction

A study information sheet consisting of 15 discrete study descriptors and characteristics – including details regarding research methods, measures and study outcomes – was prepared for every publication that was included in our review. Key information taken from these study information sheets for each reviewed study has been summarised in Table 2. An extended version of this table is available as Supplementary File 2. It includes details on study design and methodological considerations for each included study. These are not intended to be exhaustive evaluations of the included studies, but instead aim to highlight some of the major methodological considerations we have come across in our review. The study information sheet template is also available (see Supplementary File 3).

Table 1: Evidence classification scale used to describe study types included in review.

Classification	Definition
A	**Systematic review** – systematic location, appraisal and synthesis of evidence from scientific studies.
B1	**Randomised controlled trial** – subjects are randomly allocated to intervention and control groups, outcomes are compared.
B2	**Pseudorandomised controlled trial** – subjects are allocated to intervention and control groups using a non-random method, outcomes are compared.
C1	**Pre/post intervention case series** – A single group of subjects are exposed to intervention, outcomes are measured before and after for comparison.
C2	**Post intervention case series** – A single group of subjects are exposed to an intervention, only outcomes after the intervention are recorded, no comparison can be made.
D1	**Representative survey study** – A representative sample of a population is surveyed, generalization of outcomes is possible.
D2	**Key informant survey** – Opinions and experiences of key subjects are recorded in a survey.
Q1	**Methodological qualitative study** – qualitative data is methodologically collected, analysed and reported.
Q2	**Anecdotal qualitative study** – qualitative data is collected and reported without methodological rigor. No formal data analysis was undertaken.

Results

Figure 1 summarises our search process. After reviewing publication titles and abstracts, nine publications were selected for inclusion in this review. An additional three studies were included through snowballing. Table 2 provides a snapshot of all included studies, as described above.

Benefits to ear health

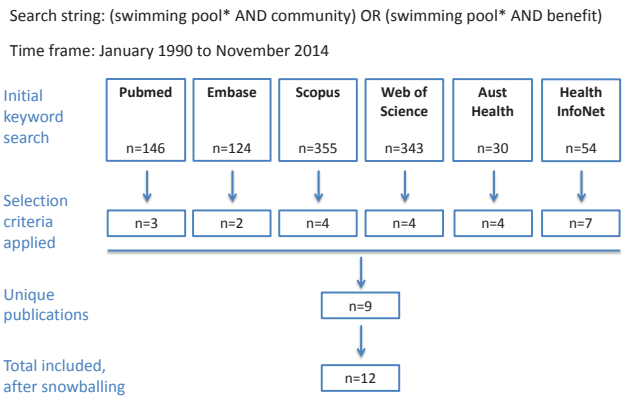
We identified 10 studies that considered the potential association of ear health with swimming pools. A 1998 audit report by Peart & Szoeke for the National Centre for Epidemiology and Population Health (NCEPH)

indicated the possible role of swimming pools in reducing the prevalence of ear infections in remote Aboriginal communities.[19] The study consisted of a key informant survey in 39 remote Aboriginal communities throughout Australia. A reduction of ear infections after installation of a community pool was mentioned in two of 13 communities that had a swimming pool at the time. Although anecdotal in nature, it was reports such as these that spurred more in-depth studies.

The first systematic study of health benefits of community swimming pools in remote Aboriginal communities over a longer period of time was performed by a research team at the Telethon Kids Institute (then the Telethon Institute for Child Health Research). Several papers published between 2003 and 2010 reported on the effect that the opening of swimming pools in two West Australian remote communities (Jigalong and Burringurrah) had on the prevalence of tympanic membrane perforations due to OM in under 17-year-olds.[20–22] Comparing screening data collected before the pools opened to data collected at multiple 6-monthly intervals afterwards, they found the prevalence of perforations to be variable. In Burringurrah (n=83), the prevalence of perforations had dropped by more than half during the period of 2000 to 2005 when compared to the pre-pool baseline (down from 33% to 15%). No p or χ^2 values were provided for this particular trend from 2000 to 2005, although Lehmann et al. 2003 do report p=0.04 and χ^2=4.32 for this trend up to 2002, where the prevalence of perforations had dropped to 13%.[20]

In Jigalong (n=79), the prevalence of perforations had returned to pre-pool levels (32%) after an initial drop to 18% (χ^2=2.18 ; p=0.14). The authors suggested the variable outcomes may have been due to unforeseen pool closures and population mobility.

Figure 1: Summary of the search strategy performed for this review.



A second Telethon Kids Institute study by Silva et al. in two remote Aboriginal communities in Western Australia (Jigalong and Mugarinya, published in 2008) performed a retrospective review of outpatient clinical records from 1998 to 2005, comparing mean morbidity rates throughout that period.[22,23] In Jigalong (n=131), they found a 61% decrease in ear infections reported in the outpatient data compared to the pre-pool baseline, with an annual decline of 15% in the morbidity rate (p<0.05; 95%CI: -21 to -8). On the other hand, no significant changes were documented in Mugarinya (n=128), which the authors suggest may be due to differences in

Table 2: Summary of health and wellbeing benefits reported in studies included in this review (detailed table available online as supplementary material).

Reference	Evidence level	Study area	Health and wellbeing outcomes reported
Carapetis et al, 1995	C1/B2	Northern Territory	**reduction in prevalence (when comparing regular swimmers to non-regular swimmers) and overall severity of skin sores; no difference found in overall skin sore prevalence, type or distribution**
Peart & Szoeke, 1998	D2	Northern Territory, Western Australia, Queensland	*reduction in skin, eye and ear infections, improvement in overall hygiene, children no longer swimming in hazardous environments, beneficial to social and emotional wellbeing**
Lehmann et al, 2003	C1 + Q2	Western Australia	**reduction in prevalence of tympanic membrane perforations and skin infections; measured improvement of school attendance**; *beneficial to social and emotional wellbeing; reduction in petty crime, kids learn to swim, safe environment for children to play**; **no significant change in prevalence of otorrhoea**
TICHR, 2006	C1 + Q2	Western Australia	**measured reduction in prevalence and severity of skin sores; measured reduction of tympanic membrane perforations; decrease in clinical presentations and antibiotic prescriptions for skin, ear and respiratory infections**; *beneficial to social and emotional wellbeing; reduction in petty crime, kids learn to swim, safe environment for children to play**
Silva et al, 2008	C1	Western Australia	**measured reduction in clinical presentations for ear, skin and respiratory infections; drop in antibiotic prescription rates***
Sullivan et al, 2008	C1 + Q2	Northern Territory	**measured reduction in prevalence of trachoma follicles, ENT referrals, failed audiometry tests and skin sores**; *children getting more exercise, beneficial to social and emotional wellbeing; improved school attendance, professional development, employment opportunities*
Rubin et al, 2008	Q2	Northern Territory	*anecdotal improvement of school attendance, hygiene and skin health; children demonstrated an increased level of physical activity; improved water safety competence*
Mathew et al, 2009	C1 + Q2	South Australia	*anecdotal evidence for improved school attendance; provides an opportunity for exercise*; **unchanged prevalence of trachoma; increasing trend of infection and antibiotic prescriptions**
Lehmann et al, 2010	C1 + Q2	Western Australia	**measured reduction in prevalence of tympanic membrane perforations and skin infections; measured improvement of school attendance; measured reduction in clinical presentations and antibiotic prescriptions for ear, skin and respiratory infections**; *beneficial to social and emotional wellbeing; reduction in petty crime, kids learn to swim, safe environment for children to play**
HPE, 2010	C1/C2 + D2	South Australia	**measured reduction in prevalence and severity of skin sores**; *children getting more exercise, pools provide alternative to other hazardous swimming environments; pool as incentive to attend school, may decrease petty crime, safe and healthy environment for children to interact, skills development in young people, provides employment opportunities; no change in school attendance rates;* **no change in prevalence of tympanic membrane perforations**
Sanchez L et al, 2012	B2	South Australia	**no evidence of improvements in any ear health outcomes or school attendance indicators**
Stephen et al, 2013	B1	Northern Territory	**no evidence of improvements in any ear health outcomes**

bold = empirical / italic = anecdotal

** positive outcomes listed were not consistently found in all communities included in the study*

disease burden and health service provision in the two communities.

Possible improvements to ear health outcomes were also suggested in a small study performed by Sullivan et al. in a remote Aboriginal community in the Northern Territory (Nauiyu Nambiyu), which evaluated various potential benefits associated with the implementation of a community swimming pool program that supposedly increased swimming pool exposure (although no data on the frequency of pool use was reported).[24] The study, published in 2008, consisted of two health screenings of school age children conducted one year apart. Ninety-two children were screened on the first occasion and 72 on the second, one year later. Although the prevalence of tympanic membrane perforations was not recorded, the study did report a 100% decrease in ENT referrals (from 6 to 0) and failed audiometry tests (from 2 to 0) when comparing data collected before the launch of the program with data collected one year later.

These positive findings contrast with several other studies that reported no ear health benefits of swimming pools. A study performed by Mathew et al. (published in 2009) in a South Australian community from 2007 to 2009 showed no decrease in ear infections after the opening of a community swimming pool, as reported in outpatient records (n=166; age range = 1 to 15).[25] Similarly, two studies in South Australia's Anangu Pitjantjatjara Yankunytjatjara lands found no improvements in ear health outcomes either.[26,27] The latter of these two studies, by Sanchez et al. and published in 2012,[27] was the most comprehensive and evaluated a combination of ear health outcome measures that are associated with OM. It consisted of screening for eardrum perforations, middle ear function and hearing acuity. The research team prospectively screened these outcome measures over three years (2009 to 2011; n=813; age range 5-18 years), comparing a group of four communities that had acquired a swimming pool to a second group of seven communities that did not have swimming pools. The study found no differences between these two groups of communities in terms of any of the considered outcome measures.

A recent randomised controlled trial (RCT) published in 2013 and performed in Australia's Northern Territory by Stephen et al. found no evidence that swimming is associated with short-term reductions in severe ear disease in remote Aboriginal communities.[28] A total of 89 Aboriginal children aged 5-12 years with a tympanic membrane perforation were randomised to receive daily swimming classes of 45 minutes or a swimming restriction for four weeks. At follow-up, there was no difference in the proportion of children with ear discharge between swimmers and non-swimmers (RD -8%; 95%CI -29 to 12). No significant difference between study groups was detected for the prevalence of bacteria associated with OM in the nose and the middle ear.

Benefits to skin health

Our search brought forward 10 studies that explored the potential benefit of swimming pools to skin-related conditions. A before/after comparison study by Carapetis et al. that was published in 1995 evaluated the effect the opening of a swimming pool in a remote Aboriginal community in the Northern Territory had on the prevalence, severity and distribution of skin sores in schoolchildren.[29] Skin checks using a standardised 'sore score' and performed several months after the opening of the swimming pool (n=54) showed sores to be generally less severe than prior to the pool opening (n=81). While the pre-pool skin check classified 90% of skin sore presentations as 'mild' (<5 lesions) and 10% as 'moderate' (5-20 lesions), all skin sore presentations were categorised as 'mild' during the post-pool skin check. Skin sore prevalence was lower for those children who reported swimming more than once per week than in those who reported swimming only once or less (30% vs 57%, χ^2=3.38, p=0.05). This difference was most pronounced in under-9-year-olds, the population at highest risk of skin sores prior to the swimming pool opening (22% vs 56%, χ^2=4.15, p<0.05). In just the older age group, however, there was no difference in the prevalence of lesions between regular and occasional swimmers.

Anecdotal evidence from the 1998 audit report by Peart and Szoeke seems to support this finding.[19] Seven of 13 audited communities that had recently acquired swimming pools reported seeing less skin infections. The series of studies performed by researchers at the Telethon Kids Institute provided more tangible indications that swimming pools may be beneficial to skin health. The series of papers published between 2003 to 2010 by Lehmann et al. that documented health check outcomes both prior to and at six-monthly intervals after the opening of community swimming pools showed a strong downward trend in the prevalence of skin infections in the community of Burringurrah (from 62% in 2000 to 12% in 2005). No p or χ^2 values were provided for this particular trend from 2000 to 2005, although Lehmann et al. 2003 do report p<0.0001 and χ^2=24.88 for this trend up to 2002, where the prevalence of skin infections had dropped to 18%.[20] Outcomes in Jigalong were more mixed.[20–22] As with ear disease, the authors suggested this may have been due to unforeseen pool closures and population mobility.

The second Telethon Kids Institute study, by Silva et al., showed a similar downward trend in mean rates of children presenting to the clinic with skin infections after the opening of a swimming pool in Jigalong (an overall prevalence drop of 68%, with an annual percentage change of -15% (p<0.05; 95%CI: -20 to -10). Mixed outcomes were reported in Mugarinya, with an initial reduction in skin infection rates of 53 to 77% annually relative to the pre-pool baseline until 2004, but no such difference in the final year.[23]

A study by Rubin et al. (published in 2008) performed in 11 Northern Territory communities, which consisted of a series of key informant interviews (n=13) on the topic of 'no-school-no-pool' programs anecdotally reported improvements in hygiene and skin health as one of the benefits associated with swimming pool use.[30] The Sullivan et al. study in the Northern Territory community of Nauiyu Nambiyu also documented a marked decrease in skin infections.[24] Health checks by the community clinic before (n=92) and within a year of the implementation of an intensive community swimming pool program (n=72) showed a drop in skin sore prevalence from 9.8% to 4.2%.

The study by Sanchez et al. that was performed in South Australia's APY lands also recorded reductions in the prevalence and severity of skin infections in the two communities for which pre-pool data were available.[26] In these communities, the proportion of children (age range: <1–≥19) presenting with no sores had increased from 32% to 78% one year after the opening of a community swimming pool (Z=3.362, p<0.001), while those presenting with severe skin sores had dropped from 25% to 6% over the same time period (Z=3.103, p=0.002).

In contrast, the Mathew et al. clinical audit study of outpatient records in a South Australian community did not find evidence of decreased rates of children presenting with skin infections at the community clinic after the opening of a community swimming pool.[25]

Benefits to eye health

We found only three studies that considered swimming pools in relation to possible eye health benefits, such as the reduction of trachoma prevalence. Anecdotal evidence from the 1998 audit by Peart and Szoeke suggests that access to swimming pools may be beneficial to eye health, as a reduction in eye infections was reported by two (out of 13) communities after the opening of community swimming pools.[19] Furthermore, the 2008 study by Sullivan et al. in the Northern Territory found the prevalence of trachoma follicles had dropped by 55% (from 17 to 6 cases) within one year of establishing an extensive community swimming pool program.[24]

However, the study by Mathew et al., which actively monitored the prevalence of trachoma in a remote Aboriginal community in South Australia over a period of two years[25] concluded that the proportion of children with follicular trachomatous inflammation had remained low and unchanged.

Other health-related benefits

We found a total of 11 studies that considered other health benefits of swimming pools, in addition to ear, health and skin disease. A number of the reviewed studies discuss additional health-related benefits. The Peart and Szoeke audit notes anecdotal indications that community swimming pools improved overall hygiene and stopped children from swimming in dangerous and possibly polluted swimming areas, such as dams, rivers and – in one case – sewage treatment ponds.[19] A 2009 study performed in South Australian communities highlighted similar benefits,[26] and several other studies noted community reports about children being more physically active due to the availability of a swimming pool.[24-26,30]

The study by Silva et al. in Western Australian communities[23] documented an overall decrease of 45% (with an annual percentage change of -11% [$p<0.05$; 95%CI: -15 to -7]) in antibiotic prescription rates following the opening of a swimming pool in Jigalong, but failed to observe a change in such rates in Mugarinya. The authors suggested that these mixed outcomes may have been due to varying prescription practices. This study found the mean rates of children presenting to the clinic with respiratory infections to have decreased by 52% in Jigalong (annual percentage change = -10% [$p<0.05$; 95%CI -16 to -3]), although no significant change was found in Mugarinya. Similarly, the study performed by Mathew et al. in a remote Aboriginal community in South Australia did not find a decrease in antibiotic prescription rates after the opening of a community swimming pool.[25]

Finally, we found five studies that touched on the broader social and emotional wellbeing benefits that may be associated with swimming pools and how such leisure facilities may take on the role of a social hub for the community, a place where families can come together and interact in a safe environment. However, these were documented purely anecdotally; no studies present any methodologically collected data – whether qualitative or quantitative – to support the described benefits.[19-22,24]

Other community-related benefits

Nine studies included in our review considered wider community benefits of swimming pools in their research. Several studies addressed the potential role of community swimming pools in improving school attendance. 'No-school-no-pool' policies require children to attend school in order to be allowed access to the swimming pool outside of school hours. The 2003 study by Lehmann et al. in Western Australian communities showed a significant improvement in school attendance rates in Burringurrah, where the proportion of enrolled children with an attendance rate of at least 70% rose from 42% in the pre-pool survey, to 51%, 65% and 67% during the consecutive surveys over a 21-month period ($\chi^2=8.70$, $p=0.003$). However, no real improvement in attendance was documented in Jigalong.[20]

The first of two swimming pool studies in the South Australian APY lands was not able to make any meaningful inferences with the limited school attendance data collected.[26] The second study compared the median school attendance rates of pool and non-pool communities and found no statistically significant difference between the two groups (student t-test, $p=0.994$).[27] Several other studies gathered anecdotal data that suggest no-school-no-pool policies could be effective and were well received in many, but not all, communities.[21,22,24-26,30]

Several studies highlighted how the swimming pool provided a safe, supervised area for children to play,[22,26] as well as swimming lessons, water safety training, professional development and employment opportunities[21,24,26,30] Finally, some studies suggested community swimming pools help kids stay out of trouble and may decrease petty crime.[20-22,26] However, none reported hard data to support these propositions.

Limitations to the review

The methods and outcome measures applied by the various studies included in this review differ too much from one another to perform a meta-analysis. Furthermore, this heterogeneity also limited the degree to which our review was able to systematically evaluate potential biases in a standardised manner. We instead opted to provide an overview of various methodological limitations of the reviewed studies in Table 2 and highlight a few key considerations in the discussion section.

This review included several grey literature publications that have not necessarily undergone the same scrutiny as would be expected from peer-reviewed literature.[19,21,24,26,27,30] Nevertheless, we have opted to include them in this review for the following reasons: i) they offer additional perspectives on issues that have not been covered much in peer reviewed literature; ii) these publications provide both quantitative and qualitative data that may otherwise go unnoticed in the debate surrounding the potential benefits of swimming pools; and iii) the grey literature provides cues for more systematic research into the 'other' benefits that swimming pools may provide.

Discussion

In terms of direct health benefits of swimming pools, the evidence around ear infections remains inconclusive with some small-scale studies suggesting a benefit and others – including a RCT – finding none. The same can be concluded in regards to the available data on eye infections, which is very limited. In contrast, all studies that prospectively documented the prevalence of skin infections reported a decline in skin sore prevalence and severity after the opening of swimming pools[20-22,26,29] or the

implementation of a strong community-based swimming program.[24] Although caution is advised in interpreting the outcomes of these studies, given their lack of true control groups, their shared conclusion is significant and begs to be evaluated in a more rigorous manner considering the burden of bacterial skin infections in remote Aboriginal communities and the long-term sequelae such infections may cause, including kidney and heart disease.[31-34] It is, however, also important to acknowledge the potential health risks that swimming pools may pose due to a potential increased risk of exposure to certain pathogenic organisms and disinfection agents and by-products.[35,36] These aspects were, however, not discussed in any of the reviewed studies.

Several studies suggested social and emotional wellbeing benefits of community swimming pools, including potential for improved school attendance, improved water safety and swimming skills and better socialisation.[19-22,24-26,30] However, these hypotheses were supported by limited data, so they remain largely conjectural or anecdotal observations that warrant further quantitative and qualitative study.

Most studies investigating direct health benefits compared pre-intervention with post-intervention data in selected communities.[20-26,29] Because of the lack of control communities, this design is inherently unable to filter out possible confounding factors such as wider temporal trends or the effects of other ongoing programs or interventions. Only three of the studies in this review had some form of control groups,[27-29] two of which were non-randomised.[27,29] Furthermore, remote community heterogeneity throughout Australia implies that the generalisability of outcomes of any of the discussed studies is limited.

Only one RCT was identified in our review process,[28] but it took place over a short time period of one month and had a small sample size, limiting its ability to detect more modest benefits of swimming. The study design also did not assess whether swimming affects the transmission of bacteria causing OM disease (herd immunity). Changes in prevalence of acute OM and OM with effusion in relation to swimming were also not assessed.

With exception to the studies from WA, the majority of OM-focused studies in the review did not include children under 5 years of age. In the WA studies, up to 37% of participants were less than five years of age,[20-22] consequently, comparisons to studies with older cohorts may not be justified. Australian and international studies indicate that prevalence and incidence of OM is age dependent with peak risk occurring between two and five years of age.[37-41] Future studies investigating the relationship between swimming and OM should therefore also consider this important age group.

An additional challenge swimming pool studies have yet to address sufficiently is the issue of measuring actual swimming pool use. Having a swimming pool in the community does not necessarily imply regular use, as this may be affected by various factors including community policies (such as no-school-no-pool policies), pool maintenance and management, and the availability of other – natural – swimming locations nearby. The definition of swimming pool use is often based on proxies that do not necessarily accurately reflect actual use, such as school attendance[27] (following from no-school-no-pool policies) and self-reported swimming behaviour.[29] Direct measure of pool use is challenging, due to a general lack of existing record keeping systems that monitor swimming pool use up to a level of detail that would be useful to studies evaluating health benefits. The only study to directly observe swimming pool use was the study by Stephen et al.[28] Future studies should consider ways of measuring actual swimming pool use and the dose of the exposure, especially when studying the potential direct benefits to skin, ear or eye health. Other methodological limitations apply to the studies included in our review (see Table 2 and the extended version of this table provided online as Supplementary File 2), such as small sample sizes and variability in terms of data collection staff. Such methodological limitations should heed caution in interpreting outcomes and generalising the conclusions of any one study in particular.

We were surprised at the absence of any systematic and methodologically supported studies that explored possible benefits other than direct health effects of swimming pools in remote Aboriginal communities. At best, these aspects were briefly mentioned on the basis of anecdotal information. This stands in stark contrast with the holistic Aboriginal understanding of health and wellbeing, which goes far beyond a discussion focused on possible direct health benefits, but extends into the domains of community, culture and country.[14] Although the absence of disease is certainly a key factor that contributes to a sense of health and wellbeing, it is only one of many factors in which social and emotional wellbeing are just as important.

Only a wider literature search that included international literature revealed a study that considered in a methodologically underbuilt way the wider wellbeing benefits of community swimming pools. This qualitative study, in deprived neighbourhoods of Glasgow in Scotland, concluded that community swimming pools were important amenities in such settings, as they presented an opportunity for physical exercise, provided stress relief and were beneficial to mental health and wellbeing through the social role that the swimming pool fulfilled.[42] The lack of a community swimming pool was considered to compound other stresses associated with personal and area disadvantage. Given the importance of social and emotional wellbeing in the context of Aboriginal health, an in-depth study into these 'other' factors in the Australian context is long overdue.

We conclude that, although the effect on ear health outcomes remains debatable, there was a consistent finding of an association between swimming pools and reduced rates of skin sores in remote Aboriginal communities. Further studies that include well-defined control groups are needed to confirm this. Additional benefits of swimming pools for remote Aboriginal communities were also discussed and are another important incentive to continue to provide access to swimming pools to improve social and emotional wellbeing. Swimming pools are by no means a silver bullet, but should be considered as one part of a more comprehensive public health strategy to improve health and wellbeing in remote Aboriginal communities.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary File 1: PRISMA 2009 Checklist.

Supplementary File 2: Detailed version of Table 2 (Summary of health and wellbeing benefits reported in studies included in this review).

Supplementary File 3: Swimming pools literature review – study information sheet.