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Mobile Health interventions for modifying indigenous maternal and child-health related behaviours: a systematic review

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Ola Ela[1]; Sana Ishaque[1*]; Anna Dowling[1*]; Chris Rissel[1]; Karla Canuto[1*]; Kerry Hall[2*]; Niranjan Bidargaddi[1*]; Annette Briley[1*]; Claire T Roberts[1*]; Billie Bonevski[1*]

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Abstract

Background: The transition to motherhood is a pivotal time for promoting healthy behaviours, particularly among indigenous women, who encounter significant barriers to accessing health information. Mobile health interventions (mHealth) promoting healthy lifestyle changes, offer an adaptable and inexpensive method for improving access health information but require cultural appropriateness and suitability for acceptance and effectiveness in indigenous populations. No systematic review on effective mHealth interventions for indigenous women during pregnancy and the early childhood years has been conducted.

Objective: This study evaluated the effectiveness of mHealth interventions, promoting healthy lifestyle changes, for indigenous mothers and children from conception to five years post-partum. It explored the effectiveness differences based on participant engagement, intervention nature, and provision of context.

Methods: A systematic search of five databases; SCOPUS, MEDLINE, CINAHL, PsycINFO, and ProQuest (Dissertation or Thesis); was conducted to identify studies focusing on maternal and child health, indigenous populations, and mHealth following a pre-registered PROSPERO protocol (CRD42023395710). HealthInfoNet was searched for grey literature and the reference lists of included studies were hand searched. Randomised controlled trials and other interventional study designs including pre-post comparison and cohort studies were eligible for inclusion. Quality of studies was evaluated by two independent reviewers using the Mixed Methods Quality Appraisal Tool and the Centre of Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange tool. Details from the studies was extracted using a predeveloped extraction form and a descriptive synthesis of the data was performed.

Results: Of the 688 articles screened, only three met the eligibility criteria. Each paper evaluated a different mHealth intervention. The three mHealth interventions identified were: Remote Prenatal Education, the Short Messaging System (SmS) Parent Action Intervention, and the Screening, Brief Intervention and Referral to Treatment eCHECKUP To Go.
All included studies had a small sample size, and none provided a rationale for the power calculation of the sample size for the outcomes reported. Therefore, it was not possible to establish whether the differences in the effectiveness were due to the interventions.

Conclusions: The current literature does not have any evidence of the effectiveness of mHealth interventions for maternal and child health behaviour change. A thorough evaluation with consideration of cultural contexts and user preferences during intervention design and development is crucial for maximizing their potential. Despite scant evidence, mHealth interventions, hold promise for enhancing indigenous mothers' health.

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Prepared for the Journal of Medical Internet Research

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Authors would like to acknowledge Josepine McGill the research librarian for her assistance with developing the search strategy for this review.

Abstract (450 words – structured; current 385 words)

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Abbreviations

- CREATE – the Centre of Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange
- mHealth – Mobile health technology/intervention
- PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses
- PROSPERO – Prospectively registered systematic reviews
- RCT – randomised controlled trial

Keywords

Indigenous, co-design, maternal, children, digital health, mobile health.

Current length of manuscript (4068 words)

Background

Globally, indigenous populations share experiences of devastating disruptions to development due to violent settler colonial practices which persisted well into the twentieth century and continue to impact today[1]. This historical suffering and the consequent vestiges are inextricably linked to current overrepresentation of indigenous people in population statistics relating to avoidable mortality, disease burden, and social and economic disadvantage[2]. To note, in this review, the term indigenous is used for indigenous populations across the globe.

Adverse health outcomes including low birth weight, preterm birth, stillbirths, and perinatal mortality rates disproportionately affect indigenous families [3, 4]. Indigenous women are more likely to experience domestic violence, have high levels of psychological distress and exhibit a higher prevalence of behavioural risk factors including tobacco, alcohol and other drug use in comparison with non-indigenous women[5-7]. Disparities between indigenous and non-indigenous maternal and child health outcomes highlight the need for urgent and specialised support [3]. The perinatal period offers a unique opportunity for women to adopt healthy behaviours for the benefit of both themselves and their baby [8]. In addition, experiences during the first 2000 days of a child’s life have a significant lasting impact on cognitive, physical, social, and emotional health[9, 10]. Therefore, interventions applied during the perinatal period and early childhood are more successful than those implemented at a later stage of life[9].

Of relevance is the geographic impact on health inequities experienced by indigenous populations. Compared with urban or regional populations, communities in rural and remote regions experience higher mortality [11]. The disparity is attributed to barriers associated with high cost, poor access and culturally inappropriate service provision, as well as employment, education, and income disadvantages [12].

Mobile Health interventions offer an alternative option for the provision and dissemination of health information, particularly for communities outside major cities where health services reach is reduced. Health service providers are increasingly using digital technology for health promotion due to its practicality, reach and accessibility [13]. mHealth is being used for education, behaviour modification, data collection and tracking, point of care diagnostics, health decision support and record keeping [14, 15]. This coincides with the increased use of mobile technology and specifically,

its utilisation for health and social and emotional wellbeing (SEWB) purposes by indigenous women [16, 17].
It has been established that indigenous women are likely to successfully engage in services during the antenatal period when they feel empowered through education, family/community support and cultural connectedness[4, 6, 18, 19]. Effective health promotion are accessible, empowering, respect the values of indigenous family structures and kinship systems and most critically, are indigenous-led [20]. Like any other intervention, mHealth when used for indigenous populations requires the intervention to be culturally appropriate and acceptable[21].

There are very few studies that have reported the benefits of culturally responsive mHealth interventions specifically developed to support the healthy lifestyle choices for indigenous women[22-24]. Research that fails to consult with indigenous communities has shown to provide little benefit [10]. The homogenisation of applying mainstream health interventions risks perpetuating inequities, hindering engagement and discounting the legacy of historical atrocities [25]. It is critical that mHealth are culturally safe and acceptable and their evaluations consider differences in participant characteristics, features of the intervention and the context of delivery [26].

Objectives

The primary objective of this systematic review is to assess the effectiveness of mHealth interventions designed for use by indigenous mothers of children (conception to five years post-partum) that seek to modify maternal and child health behaviours. Additionally, this review aims to examine observed differences in effectiveness of the intervention, participant engagement, and the programmatic and community context in which the intervention is implemented. This review will also examine if the mHealth intervention has been designed or adapted specifically for indigenous populations.

Methodology

A detailed systematic review protocol outlining the search strategy, methods for relevance and full-text screening, data extraction template, quality assessment methods, data analysis methods, synthesis and statistical issues, publication bias and any conflicts of interest was developed and registered with the international database of prospectively registered systematic reviews (PROSPERO), registration number: (CRD42023395710) [27]. The review followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline for the conduct and reporting [28].

Eligibility criteria

A publication was eligible for inclusion if it reported findings from a randomised controlled trial (RCT), pseudorandomised controlled trial, comparative study with concurrent controls, and pre-post studies that applied a user operated digital health intervention as an intervention. Population included was self-identified indigenous women in the antenatal period and/or with children aged 0 to 5 years of age. The outcomes eligible for inclusion were health behaviours during pregnancy, which related to diet, use of tobacco, alcohol, other drugs, physical activity; and behaviours performed by mothers and/or other caregivers during the early childhood period, including behaviours related to health and hygiene care, feeding, stimulation, responsiveness, and safety. The review was restricted to publications reported in English. There was no restriction on the type of control, type of digital health intervention, country, setting in which the study was conducted, nor date of publication.
Studies were excluded if they reported on the development or design of a digital health intervention without reporting on its effectiveness on the behavioural outcomes of indigenous women/children,

reported on mixed indigenous and non-indigenous populations without reporting subgroup data, or applied the intervention directly to children with the intention to change maternal behaviour.
In this review, user-operated digital health technologies are regarded as any form of computerised technology that the intended (beneficiary or target) audience interacts with in a way that is not mediated by a third-party (e.g., by a healthcare provider). This includes mobile/cellular phone technologies (or mHealth); web 2.0 technologies (inclusive of social media); websites and web-based applications; and non-web applications (e.g., delivered via offline electronic devices).

Search Strategy

With the assistance of a research librarian, a systematic search was performed in SCOPUS, MEDLINE, CINAHL, PsycINFO, and ProQuest (Dissertation or Thesis) in Oct 2022 and was updated in Dec 2023. The search was conducted using controlled vocabulary and keywords related to the terms: maternal, child/family health, indigenous populations, and mobile health. Specially designed search filters have been used to identify terms for indigenous populations [29]. Details of the Medline database search strategy is given in the Supplementary file. The search strategy was modified to adapt to variations in indexing among the other databases and complete search strategy is available on request. Additionally, Health*Info*Net website and reference lists of the included studies were hand searched for relevant grey literature and any additional relevant studies respectively.

Relevance and full-text screening

The literature screening was performed using the Covidence systematic review software. After removing duplicate articles, three independent assessors (SI, OE, AD) screened the title and abstracts of retrieved literature against the eligibility criteria, with questions and conflicts managed with discussion and with the assistance of a fourth expert reviewer (BB). Full-text screening was performed independently by the same assessors.

Data Extraction and Analysis

Data extraction was performed by one assessor (either OE or AD) using a template designed to extract information about the study methodology, population characteristics (including self-identification of indigenous status), behavioural target, intervention characteristics, intervention context, and reported outcomes. Another reviewer (SI) checked the extracted data for accuracy and completeness.
The data is presented descriptively and in narrative form, where applicable. The planned analysis to perform meta-aggregation of qualitative data and meta-analysis of quantitative data was not feasible due to the small number of included studies.

Risk of Bias Assessment

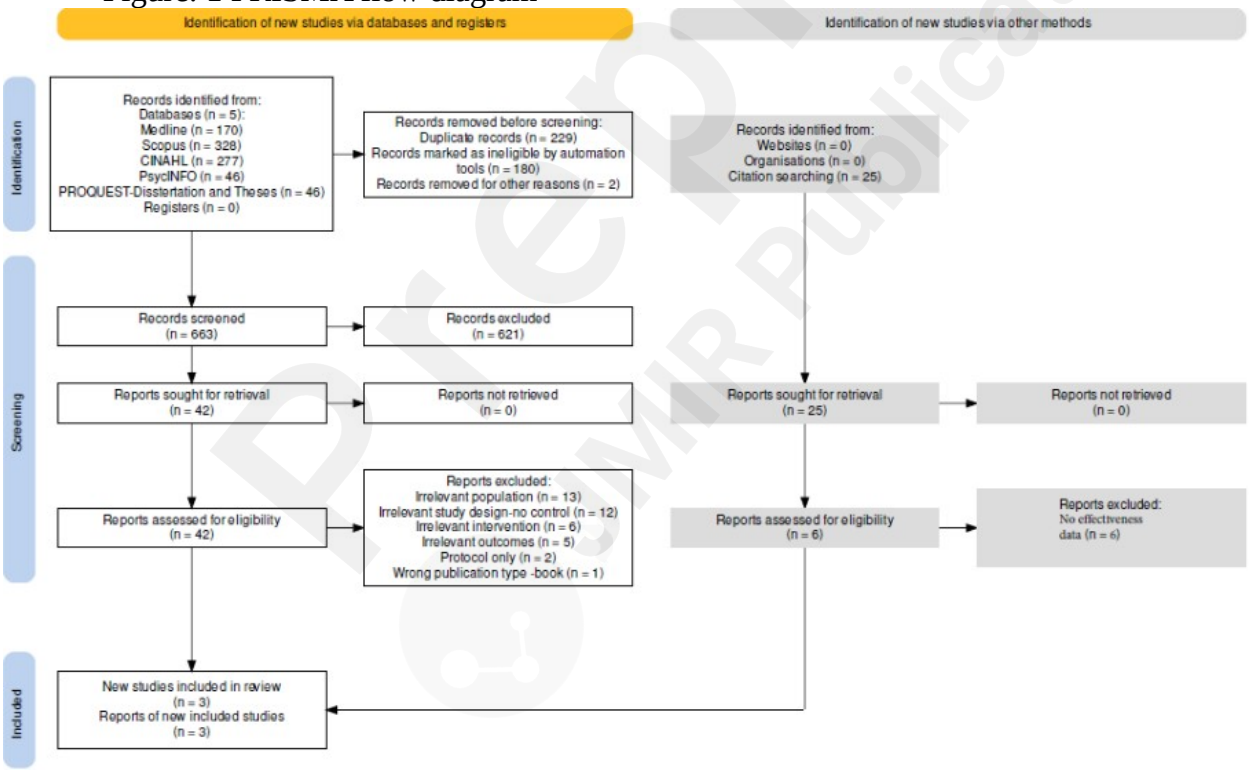
An assessment of the risk of bias for included studies was performed independently by two reviewers (OE, AD) using the Mixed Methods Appraisal Tool [30] and the Centre of Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange (CREATE) tool [31]; with a third assessor (SI) managing conflicts. Anticipating a relatively small body of literature, risk of bias assessment

was not used to exclude otherwise eligible literature but is presented and discussed alongside the review results. The CREATE tool was developed with indigenous and non-indigenous experts and utilises a 14-question checklist which assesses community engagement, consultation, research governance, and intellectual property to evaluate methodology of studies conducted in the Australian Aboriginal and/or Torres Strait Islander population groups[31]. However, the tool has been widely used in research involving global indigenous populations [32-38].

Results

From database search 867 articles were retrieved, of which 229 were duplicates. After removal of duplicates, 663 were screened for relevance, of which 42 were found eligible for full text screening. After full-text screening of 42 articles, three met the inclusion criteria and were included in this systematic review (Fig. 1) [39-41]. The were n=39 excluded studies due to irrelevant population (13 studies), inappropriate study design where there was no control group (12 studies), irrelevant intervention (6 studies), irrelevant outcomes (5 studies), protocol only without reporting any results (2 studies), and wrong publication type (1 study).
An additional six articles were found eligible for full text screen on hand search of reference lists of the included studies, none of them were included in the review as the study design was inappropriate for this review.

Figure. 1 PRISMA flow diagram



The characteristics of included studies and quantitative comparative data on the effectiveness of the mHealth interventions used in the included studies are summarised in Table 1 with additional summary details on the characteristics/type of digital health interventions used in the studies presented in Table 2 and Supplementary file. Details of the data on the cultural appropriateness of the interventions for indigenous population are provided in Table 3. Finally, data on the quality appraisal of the included studies are shown in the Table 4 and 5.

Table 1 Study Characteristics and Outcomes

Study ID	Study aims	Indigenous population and Availability of Internet	Country	Setting	Study design	Participant engagement	Participant characteristics Total participants	Behavioural target	Outcomes reported
Hui et al. [35]	To assess the impact of community-based remote prenatal education on the participation rates of pregnant women in the prenatal program, breastfeeding and pregnancy outcomes	Sagkeeng and Sandy Bay (two rural Ojibwe First Nation communities) Garden Hill (a remote Anishininew First Nation community) Internet available at all locations; Speed of Wifi at Garden Hill unable to transfer high quality video images	Canada	Community based	Pre-post comparison	42% attendance (n=53) in the communities for the social media assisted prenatal chat group	Total number of participants not reported Pregnant women	Breastfeeding initiation, Breastfeeding duration, Parental participation in parental education program	Outcomes compared 1-year pre and post intervention (remote prenatal education program): Participation rate of FN pregnant women in prenatal program in Sagkeeng area significantly increased (9.2% versus 38.1%*P <0.0001)*, Moderate evidence of increase in the participation rate of FN pregnant women in prenatal program in Sandy Bay area (28.1% vs. 46.7%, *P= 0.02)*, No significant difference in the participation rate of FN pregnant women in prenatal program in Garden Hill, Significant increase in breastfeeding initiation rate in Sagkeeng area 23% to 67% (*P< 0.0001)*, Significant increase in

									exclusive breastfeeding between 2 to 12 months of age in Garden Hill area (p=0.03) and moderate evidence of increase in mixed breastfeeding duration between 2 to 12 months of age in Garden Hill area (*P = 0.07)**, No significant difference in breastfeeding initiation rate in Sandy Bay and Garden Hill areas
Brown et al. [34]	This study investigated the feasibility of delivering health-related short text messages to parents to reduce obesity risk among children aged 3 to 5 years	American Indian reservation	USA	Community based	Pre-post comparison	17/17 completed 5 weeks study	Parents of children 3 to 5 years of age American Indian (47%), mean age 34 years, female (15/17, 88%), households with annual incomes greater than $30,000 (59%), college graduates with an associate's degree or higher (71%)	Child behaviours related to sleep, diet, physical activity, screen time, and intake of sugary beverages	Outcome compared pre and post intervention: Significant change in favour of the intervention in overall child behaviour (*P = 0.051)* Significant difference in child behaviour related to physical activity and sleep (*P= 0.046)* No significant difference in child behaviour related to diet
Montag et al. [36]	To develop and test an adaptation of an online intervention for reducing risky drinking in Native women of childbearing	American Indian/Alaska Native women	USA	Community based	Randomised controlled trial	263 recruited, 16 (6.1%) lost to follow up	Total n=263 Sample size for which demographics were reported n= 247 Age: 28.6 _ 0.5 (28.6 _ 0.5) Intervention n = 129 Control n = 134	Binge drinking, Weekly drinking	No significant difference between I and C for alcoholic drinks/week and binge episodes/two weeks Alcoholic drinks/week and binge episodes/two weeks significantly reduced due to time effect

Study characteristics

The publication dates of the three included studies were 2021, 2019, and 2015 [39-41]. Two of the studies were conducted in USA with American First Nation populations [39, 41] and one was conducted in Canada [40] and included three First Nation communities of Canada (Sagkeeng, Sandy Bay, and Garden Hill). The study designs were pre-post comparison (n=2), and randomised controlled trial (n=1) respectively. The health conditions around which behavioural changes were sought included: participation in the prenatal program and breastfeeding initiation [40], childhood obesity [39], and alcohol addiction (or problem drinking)[41]. The outcomes included: breastfeeding initiation, breastfeeding duration, parental participation in parental education program [40],[39] and [41]; child behaviours related to sleep, diet, physical activity, screen time, and intake of sugary beverages [39]; and binge drinking and weekly drinking[41]. The interventions were applied in community settings in all three included studies.

Study Interventions

The eHealth intervention, Remote Prenatal Education, in the pre-post, Hui et al. (2021) was a sub-study of a large intervention that also included some face-to-face components. The eHealth component consisted of traditionally/culturally tailored web-accessible educational material on pregnancy, prenatal, and postnatal period related topics such as healthy eating, recipes, traditional foods, food label reading, and nutrition content for common foods and a social media assisted prenatal chat group operated through Facebook messenger. The chat was moderated by community Elders, Canadian Prenatal Nutrition Program (CPNP) workers or the study coordinator. The intervention was accessible via computer/smartphone and could be opened via Facebook. The educational material on the website was available as readings, audios, and videos; news on the prenatal or postnatal programming in the communities and traditional knowledge regarding a healthy pregnancy was also available. Traditional methods including prayer, sharing circles, and storytelling, were incorporated in breastfeeding education. While the total number of participants was not reported, the participation rate for the social media prenatal group was at 42% (n=53).

The intervention, the Short Messaging System (SmS) Parent Action Intervention, in the pre-post, Brown et al. (2019) study consisted of three short text messages per week for five consecutive weeks sent between 30 Jan to 17 March 2017 for n=17 families. The messages were tailored for age and gender of participating parents and children, sent on the phone at individualised times of the day using an online text automation platform, Mosio. The text messages provided information around recommended healthy child nutrition, physical activity, sleep, and screen time behaviours of preschool children. The text message topics were derived from the, ‘Let’s Go! 5–2–1–0’ US national campaign and recommendations for sleep in children.

The intervention in the randomised-control trial, Montag et al. study (2015); the Screening, Brief Intervention, and Referral to Treatment eCHECKUP To Go; was an online intervention that screened participants for their use of alcohol and based on their answers provided feedback about participants’ risk of an alcohol exposed pregnancy and its effect on the foetus. After the initial screening, resources and information on support services were provided to participants. The intervention took approximately 20 minutes to complete. There were 129 women in the intervention group and 134 women in the control group that received ‘usual care’ which included non-specific educational resources available in waiting areas.

Table 2 Intervention characteristics

Study ID	Intervention Name and details Is the intervention live and any links	Was the digital health intervention being part of a bigger intervention (e.g. there were some	How was the intervention delivered? (e.g. computer, tablet, phone) and Accessed	Intervention Context	Name of Indigenous Nation/Country	How many times the participant did interact with the intervention. E.g. Text messages	Who (if anyone) delivered/moderated the intervention?

		face-to-face components)	via			sent thrice a week etc.	
Hui et al. 2021 [35]	Remote Prenatal education via an educational website and social media-assisted prenatal chat groups (Facebook or Messenger) Live website (https://momsinmotion.ca/)	Yes	Computer and smartphone Facebook link with website	community-based remote and some face to face components	Sagkeeng and Sandy Bay: two rural Ojibwe First Nation communities, Garden Hill: Anishininew First Nation community	Not reported	Community Elders, Canadian Prenatal Nutrition Program workers, or the study coordinator served as the hosts of the Facebook chat groups
Brown et al. 2019 [34]	Two-way text messaging the Short Messaging System Parent Action Intervention The text message topics were derived from the, 'Let's Go! 5–2–1–0' US national campaign and recommendations http://sleepforkids.org/	No	Text messages were sent using Mosio, an online platform for text message automation	Community	American and non-American Indian residing on American Indian Reserves	Three text messages each week for five consecutive weeks	Messages appeared to be sent from a local paediatrician or a tribal health dietitian
Montag et al. 2015 [36]	Screening, Brief Intervention, and Referral to Treatment eCHECKUP TO GO, a web-based brief assessment and intervention tool Participants received individualized web-based feedback at the end of the session regarding their risk for an AEP, the impact of alcohol exposure to the fetus, the physical and financial cost of their alcohol consumption, and how their drinking compared with that of other Native women. approximately 20 minutes to complete. https://www.echeckuptogo.com/	No	Computer, phone, tablet Could be accessed by the website	Participants were recruited from health American Indian/Alaska a Native health clinic Intervention delivered in community setting	American Indian/Alaska Native women in Southern California	1, 3 and 6 months	Not applicable

Study Outcomes

In the Hui et al (2021) study, a significant increase was reported in the participation of pregnant women in a face-to-face prenatal program 1 year after the start of intervention in two of the study sites compared with pre-program participation rates. Furthermore, a significant increase was reported in the breastfeeding initiation rate at one of the study sites and exclusive breastfeeding between 2 to 12 months was also significantly increased at another study site.

In the Brown (2019) study a pre-post comparison of the five-week text intervention, demonstrated that there was a significant increase in overall child behaviours related to sleep, diet, physical activity, screen time, and intake of sugary beverages in favour of the intervention. There was no change in child behaviour related to diet.

The Montag (2015) study, which was a randomised controlled trial from April 2011 to Sep 2012, did not find any significant differences in intake of alcoholic drinks per week and binge drinking episodes per week between the intervention and control groups.

Cultural Adeptness

The steps and strategies taken to ensure cultural appropriateness of the mHealth interventions were

extracted from the included studies, Table 3. Hui et al (2021) and Montag et al (2015) cited previous work that reported the interventions being co-designed for indigenous populations, and Brown et al (2019) used an intervention that was not reported to be co-designed or adapted for indigenous populations. In the instances when previous research was cited, those articles were retrieved, and relevant data were extracted in Table 1. Authors of the included studies were also contacted for information related to the co-design/adaptation.

Table 3 Cultural adaptation or community co-design approaches used in included interventions

Study ID	Was the intervention Culturally adapted (and/or co-designed)?	Is there any reference/citation provided about cultural adaptation/co-design of the intervention?	How was the cultural adaptation done (e.g. study design – processes/ co-design)	What features were included to make it culturally appropriate?	Were Indigenous people included in the design/adaptation	What other population(s) were included in the cultural adaptation/co-design process?	Theory (or framework) used for cultural adaptation/co-design	Evaluation of cultural appropriateness
Hui et al. 2021 [35]	Yes	Yes*	Not reported	The intervention was built on the previous work of the researchers that identified barriers to participation among the study population*	Yes	None	Not reported	Not reported
Brown et al. 2019 [34]	Not reported	No	Not reported	Research approved by the Institutional Review Board at the American Indian Tribal college on the reservation; the design,	Yes	None	Not reported	Not reported

				implementation, and interpretation were done in partnership				
Montag et al. 2015 [36]	Yes	Yes**	Qualitative research and Community outreach – reported in authors' pervious work**	Inclusion of pictures and personal stories, emphasize confidentiality, incorporate family and community orientation, information tailored to the local community	Yes Native women Native clinical staff who had familiarity and experience with the topic and population	Non-Indigenous clinical staff who had familiarity and experience with the topic and population	Participatory research	Not reported

Foot note:
* Reid, A. E., Back, L., Hui, A., Mcgavock, J., Dean, H., Ludwig, S., Sellers, E., & Shen, G. (2012). Reducing Barriers for Pregnant Women in Rural/Remote First Nations Communities to Participate in Lifestyle Intervention Program through Community-Oriented Approaches. Canadian Journal of Diabetes, 36(5), S74–S74. https://doi.org/10.1016/j.jcjd.2012.07.460

**Gorman JR, Clapp JD, Calac D, Kolander C, Nyquist C, Chambers CD (2013) Creating a culturally appropriate web-based behavioral intervention for American Indian/Alaska Native women in Southern California: the healthy women healthy native nation study. Am Indian Alsk Native:1–Ment Health Res 2015.

Methodological Quality

The included studies were assessed for their methodological quality from an indigenous perspective using the CREATE tool, and MMAT (Table 4 and Table 5). There was little information reported in the included articles that address the CREATE checklist. Authors of the included studies were contacted to obtain further information and, when provided (n=1), the information was used to appraise the studies. The following standards for measuring quality were applied based on the CREATE tool (Table 4); A study was considered high quality if 10 or more of 14 criteria were met, medium if 6-9 of 14 were met and low if criteria 5 or below were met. Only Hui et al (2021) met the standards for high quality using this tool while the remaining two studies met criteria for low quality evidence [39, 41]. The MMAT assessment (Table 5) returned a quality measurement of 43% (low-medium quality) for Hui et al (2021), 57% for Brown et al (2019) and 71% for Montag et al (2015) (medium quality). This assessment was based on methods used in previous studies which define the quality as low, medium, or high according to the number of 'Yes' answers to questions [42, 43]. If less than or equal to 25% of questions were in the affirmative it was a low-quality study, medium if 50% and high if >75% of questions were answered 'yes'[42, 43].

Table 4: Quality Assessment -CREATE Tool [31]

Study ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Hui et al. 2021 [40]	Y	Y	Y	Y	Y	U	U	Y	Y	Y	Y	Y	Y	Y
Brown et al. 2019 [39]	P	U	U	U	U	U	U	U	U	Y	U	Y	U	U
Montag et al.2015 [41]	Y	N	U	N	N	N	N	N	U	N	U	Y	N	N

The Centre of Research Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange (CREATE):
1. Did the research respond to a need or priority determined by the community? 2. Was community consultation and engagement appropriately inclusive? 3. Did the research have Aboriginal and Torres Strait Islander research leadership? 4. Did the research have Aboriginal and Torres Strait Islander governance? 5. Were local community protocols respected and followed? 6. Did the researchers negotiate agreements in regards to rights of access to Aboriginal and Torres Strait Islander peoples' existing intellectual and cultural property? 7. Did the researchers negotiate agreements to protect Aboriginal and Torres Strait Islander peoples' ownership of intellectual and cultural property created through the research? 8. Did Aboriginal and Torres Strait Islander peoples and communities have control over the collection and management of research materials? 9. Was the research guided by an Indigenous research paradigm? 10. Does the research take a strengths-based approach, acknowledging and moving beyond practices that have harmed Aboriginal and Torres Strait peoples in the past? 11. Did the researchers plan and translate the findings into sustainable changes in policy and/or practice? 12. Did the research benefit the participants and Aboriginal and Torres Strait Islander communities? 13. Did the research demonstrate capacity strengthening for Aboriginal and Torres Strait Islander individuals? 14. Did everyone involved in the research have opportunities to learn from each other? [31]

Table 5 Quality Assessment tool MMAT[44]

Citation	Study Design	SQ1	SQ2	Q1	Q2	Q3	Q4	Q5
Hui et al. A, 2021 [40]	Cohort	Y	Y	Y	N	U	U	N
Brown B 2019 [39]	Before-after comparison	Y	Y	N	Y	N	Y	Y
Montag et al. AC 2015 [41]	RCT	Y	Y	Y	Y	N	N	Y

MMAT: Screening questions (for all types of studies)- S1. Are there clear research questions? S2. Do the collected data allow to address the research questions?

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Discussion

This systematic review demonstrates that there is no evidence of effectiveness of any currently available mHealth intervention designed for indigenous women with young children (0 – 5 years of age) to help assist with behaviour change to healthy choices for themselves and their children. Only three articles found were relevant to be included in this systematic review. These studies aimed to change maternal and child behaviours in the prenatal period and pre-school age group, by provision of a mHealth Intervention. The three mHelalth Interventions that were identified included: a hybrid face-to-face and online prenatal education program; an automated, individualised, three weekly text messages on healthy lifestyle advice for targeting preschool children; and a web-based self-assessment followed by tailored advice related to maternal alcohol drinking. All interventions were applied in a real-life community setting. Statistically significant change was reported in some behaviours/ outcomes. However, in the absence of any reported sample size or power calculation; it was not possible to ascertain if significant positive results were due to an inflated Type I error, showing positive results in favour of intervention when in fact the interventions only work due to very large sample sizes.

A recent review on barriers and facilitators of engagement of indigenous peoples with mHealth interventions revealed themes which echo the need for effective and timely co-design practices in this field[45]. Researchers found that barriers to engagement included poor digital design, unreliable technology and internet, repetitive content with limited user input, language barrier, poor cultural representation, non-specific health information and privacy concerns[45]. Co-design has been identified as one of the most important factors determining the uptake of web based therapeutic interventions for indigenous communities/populations[46]. In our review it was deemed important to investigate/ascertain if the digital interventions used were either co-designed in partnership with indigenous communities or were adapted in consultation with the target population to ensure cultural appropriateness; or selected from a pool of previous research/literature on culturally appropriate interventions for the target populations. That information as reported in the included studies is presented in Table 3.

Of the three identified mHealth interventions, two were co-designed with an indigenous population and have shown some positive outcomes in favour of the interventions. Citations of their authors' previous work on co-designing the interventions with indigenous populations were reported for these two interventions in those studies[47, 48]. Although the current evidence on their effectiveness is limited, the authors of these studies are following the iterative process of evidence gathering as suggested in the guideline on the evaluation of complex interventions[49-51]. Therefore, it will be important to see future results on the use of these interventions. Also, due to the diligent process of co-design and insurance of cultural safety, these interventions may provide guidance on the planning and development of work with indigenous populations on provision of maternal behaviour support. The consultation and partnership with Communities reported about the two interventions are in line with the international guidelines on research with indigenous peoples[52].

During the study selection process, eight articles on the development of mHealth interventions for indigenous women were identified that could not be included in this review[23, 24, 53-58]. Upon a further search with the name of the digital interventions reported in the study, no follow up studies on the evaluation of their effectiveness could be retrieved. Further to this, corresponding authors of these articles (n=8) were contacted to inquire of any ongoing studies to evaluate the effectiveness. Except for one, all authors replied to the initial email (n=7/8). Four authors (4/7) mentioned further evaluation work on

the identified digital interventions, of which only one has already been published [59]. However, the focus of the publication was not an indigenous population, therefore the study was not included in this review [59]. The other authors (n=3), with ongoing trials, were not able to share the unpublished data. Evidently nearly 40% (3/8) of these mHealth interventions did not evaluate their effectiveness and are no longer active [23, 24, 56]. Although, in response to personal communication, one of the authors [23] mentioned collection of qualitative data on the usage of the app designed for indigenous women [23]; the need for an RCT for the evaluation of effectiveness was also identified. Consistent with the findings of our review, the evidence on the effectiveness of digital health interventions in other populations/settings such as children and adolescents[60], patients with heart failure[61], self-management of chronic obstructive pulmonary disease [62], and sexual health promotion[63] is limited due to the lack of published findings of well-designed and conducted effectiveness evaluation research. There are some health conditions in which the use of mHealth interventions have been well studied, such as asthma[64, 65] and consumption of hazardous amounts of alcohol [66], in which the use of mHealth interventions has been shown to produce positive health outcomes in favour of the interventions[65, 66]. Also, the use of mHealth to promote behavioural change during prenatal care in the general population has been reported to result in significant improvement in behaviour risks, and improved healthy behaviours among pregnant women [67]. A current scoping review on the use and uptake of Web-based therapeutic interventions among indigenous populations across Australia, Canada, New Zealand and USA reported the use of these interventions for conditions such as cardiac care, diabetes, nutrition, mental health, asthma, neonatal care, otitis media, smoking cessation, and substance misuse [68]. For that review, a Web-based therapeutic intervention was defined as a therapeutic intervention that was self-guided, or a clinician assisted program delivered via the internet to provide guidance, support, and treatment for health conditions. While the evaluation of effectiveness was beyond the scope of that review, it was concluded that these interventions have the potential to improve health and overcome treatment barriers and reduce inequalities for indigenous populations [68].

There are several factors that could lead to the lack of effectiveness evaluation research and in turn scarcity of evidence on any mHealth interventions [69]. Some of these challenges pertain to interventions themselves, whereas some are related to designing a powered RCT with complex interventions which is the common/acceptable approach/method to effectiveness evaluation. Some of the challenges related to mHealth interventions are: rapidly changing technology and the need for intervention to evolve quickly to merely remain functional, let alone upgrade; accessibility of intervention across various operating systems and devices; acceptability and usability of the intervention by target population; real world usage of any intervention or implementation; burden on various stakeholders; adaptation of mHealth interventions to context and population; and their integration into existing healthcare systems. There are also challenges specific to the design of an RCT for mHealth intervention evaluation such as, selecting a suitable context for trial so that the findings are generalisable, choice between conducting a trial with high external versus internal validity, specification, and explanation of the components of the mHealth intervention under evaluation, choice of an appropriate control/comparator group, and data collection methods from mHealth interventions. Given all these, it is arduous to conduct powered RCTs of mHealth interventions [49, 69].

The included studies in this review were appraised for their quality with the CREATE and MMAT[44] tools. The CREATE tool was designed to ensure that the research conducted with indigenous populations is conducted from the perspective of indigenous peoples[31]. There are certain items that authors need to report for the assessors to mark the CREATE tool.

While, appraising the included studies in this review, many of those items have not been reported and a further inquiry with the corresponding authors was necessary to access that information. This could have been due to the lack of any guidance on reporting of indigenous research. Recently a guideline was published on reporting of observational studies in indigenous populations[70], however, the studies included in this review were of different methodological design. Another reporting guideline, CONSollDated CritEria or CONSIDER statement, developed by a review of available literature and meta-synthesis, was published in 2019. The guideline provides eight research domains and 17 criteria for the reporting of research involving indigenous peoples. However, except for one, the included studies in the review were published before this date so they cannot be discredited for not following the guideline.

Conclusion

Overall, the current evidence on the effectiveness of mHealth interventions use with indigenous women is limited. However, there is potential for mHealth to effectively support indigenous women with young children to improve their lifestyle choices for themselves and their children. The interventions that have been codesigned need to have further evaluation research for wider application. New interventions for different contexts and varied indigenous nations are required to be developed, tested for evaluation, and deployed for population use.
[Insert Table 4: Quality Assessment -CREATE Tool]
[Insert Table 5: Quality Assessment tool MMAT]
[Supplementary file]

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Multimedia Appendixes

Details of search strategy and digital health interventions.
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