

# Physical activity interventions to prevent and manage type 2 diabetes in Aboriginal and Torres Strait Islander people: a systematic review

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The age-adjusted prevalence of diabetes among Aboriginal and Torres Strait Islander people (Indigenous Australians) is almost three times that for non-Indigenous Australians;<sup>1</sup> rates of acute and chronic diabetes complications are also higher.<sup>2</sup> Type 2 diabetes leads to other health conditions, poorer quality of life and shorter life expectancy.<sup>3</sup> The first national report on Aboriginal health (1979) noted that Indigenous people “were generally in good health and that most of the disorders which commonly affect them today were non-existent in Australia.”<sup>4</sup> A 1970 study had noted that type 2 diabetes was considered rare among Indigenous Australians not living in urban environments.<sup>5</sup>

Diet and physical activity play primary roles in the prevention and management of type 2 diabetes and are recommended as first line management.<sup>6-8</sup> Physical activity interventions improve blood glucose and glycated haemoglobin (HbA<sub>1c</sub>) levels,<sup>9,10</sup> triglyceride and high-density lipoprotein (HDL) cholesterol levels,<sup>11</sup> and insulin sensitivity in muscle and liver.<sup>12,13</sup> Physical activity is effective for mobilising visceral fat,<sup>14</sup> although the reasons remain unclear, aerobic exercise is more effective than resistance training.<sup>15</sup>

In clinical practice and in research investigations, people may be advised to increase their physical activity, but often without structured physical activity education and only limited direction.<sup>16</sup>

In light of the high prevalence of diabetes and poor diabetes-related outcomes for Indigenous Australians, we conducted a systematic review to guide future strategies for the prevention and management of type 2 diabetes. A preliminary search of the PROSPERO, Cochrane Library, Scopus, MEDLINE, SPORTSDiscus, PsycINFO, and Informit databases identified no current or planned systematic reviews of physical activity interventions for preventing and managing type 2 diabetes in Indigenous Australians. We therefore reviewed the evidence regarding the effect of physical activity for preventing and managing type 2 diabetes in Aboriginal and Torres Strait Islander Australians.

## Methods

The protocol for our systematic review has been published,<sup>17</sup> and the review was prospectively registered with the PROSPERO International Prospective Register of Systematic Reviews (CRD42021247496; 12 May 2021). Our review conforms with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.<sup>18</sup>

## Abstract

**Objectives:** To review evidence regarding the impact of physical activity interventions for preventing and managing type 2 diabetes in Aboriginal and Torres Strait Islander Australians.

**Study design:** We searched for published reports of physical activity interventions for preventing and managing type 2 diabetes in Indigenous adults (18 years or older). There were no exclusion criteria regarding study type or duration, frequency, length, or intensity of physical activity, except that short term interventions were excluded. We assessed the quality of each study using the Joanna Briggs Institute (JBI) critical appraisal tools and the ethical and methodological quality of studies from an Indigenous Australian perspective with the Centre of Research Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange (CREATE) Critical Appraisal Tool.

**Data sources:** MEDLINE; Scopus, Embase (Elsevier); Cumulative Index to Nursing and Allied Health Literature (CINAHL), Sports Discus, PsycINFO (EBSCO); Informit Complete; ProQuest Dissertations and Theses, and ProQuest Health and Medicine; each from their inception to 30 October 2022.

**Results:** The database searches identified 703 potentially relevant records; after removing duplicates and initial screening, the full text of 27 articles was assessed for eligibility. Nine studies met our inclusion criteria: two randomised controlled trials, five cohort studies, one quasi-experimental study, and one repeated cross-sectional study. Eight studies were rated as being of low or medium quality (median JBI score, 54%; interquartile range [IQR], 36–64%); seven studies were rated as being of low to medium ethical and methodological quality from the Indigenous perspective (median CREATE score, 50%; IQR, 36–64%). Six studies reported changes in glycated haemoglobin (HbA<sub>1c</sub>) levels, of which two (both cohort studies) reported significantly lower mean HbA<sub>1c</sub> levels after the intervention, but only one publication provided detailed results. No randomised controlled trials that investigated the effect of a combination of physical activity and dietary change for Indigenous Australians diagnosed with type 2 diabetes were identified. Differences in study design, outcome variables, and the small number of studies precluded meta-analysis.

**Conclusions:** Quality research into the impact of physical activity interventions on type 2 diabetes in Indigenous people is sparse. To improve research translation, studies that involve Indigenous community members at all levels of the research process are needed.

**Registration:** PROSPERO CRD42021247496 (prospective).

## Search strategy

Our search strategy was developed in consultation with a research librarian. Nine databases were searched during

18 April 2021 – 31 October 2022, from their start dates to 30 October 2022: MEDLINE; Scopus, Embase (both Elsevier); Cumulative Index to Nursing and Allied Health Literature (CINAHL), Sports Discus, PsycInfo (all EBSCO); Informit Complete; ProQuest Dissertations and Theses, and ProQuest Health and Medicine. We searched for published reports in English of physical activity interventions for preventing and managing type 2 diabetes in Aboriginal and Torres Strait Islander adults (18 years of age or older). The key search terms were “type 2 diabetes”, “Indigenous”, “Australia”, and “physical activity” ([Supporting Information](#), table 1).

Studies that included participants other than Indigenous Australians were considered if more than 50% of participants were Indigenous Australians or results for Indigenous Australian participants were separately reported. Individual- and group-based interventions, programs, and activities were included, as were multicomponent interventions if they included exposure to physical activity. Studies without structured physical activity sessions were considered if advice on physical activity was mentioned.

All publications of studies that compared physical activity interventions with usual care or alternative treatments, and studies without comparison groups, were screened for relevance. Experimental studies, including randomised controlled trials and non-randomised controlled clinical trials, as well as quasi-experimental, observational, cohort, case-control, and analytical cross-sectional studies were screened for relevance. Programs, activities, and interventions in any geographic areas or regions of Australia (urban, rural, remote) and setting (clinic, community) were screened for relevance if the participants continued living in their usual environment during the intervention. There were no exclusion criteria based on type, frequency, length, or intensity of physical activity. However, short term events (eg, duration of 1–14 days) were excluded; such interventions may have short term effects, but reports on longer term interventions provide more information about sustained benefits.

The primary outcome of interest for our review was mean change from baseline in glycated haemoglobin (HbA<sub>1c</sub>) level. Secondary outcomes of interest were changes in physical activity levels, weight, waist circumference, blood pressure, fasting plasma glucose, blood lipid and fasting insulin levels, quality of life, psychological wellbeing, and medication use.

### Data extraction and critical appraisal

All records identified in the database searches were imported into Covidence (<https://www.covidence.org>) and duplicates removed. The titles and abstracts of each article were independently screened by two authors (RJK, RM). The full text of publications that met our inclusion criteria or required further examination to determine their eligibility was retrieved; the two reviewers independently determined whether the articles met our inclusion criteria. Differences between reviewers regarding eligibility were resolved by discussion and consensus. One reviewer (RJK) extracted data from two-thirds of the reports, and the second reviewer (RM) extracted data from one-third. The reviewers worked independently to extract key characteristics of the included articles: author, publication year, location, Aboriginal nations of the participants, study aim, study design, study duration, sample size, mean age, male participant proportion, intervention measures, outcome measures, and

We assessed the quality of each study, including risk of bias, using the Joanna Briggs Institute (JBI) critical appraisal tools<sup>19</sup> and the ethical and methodological quality of studies from the Indigenous Australian perspective using the Centre of Research Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange (CREATE) Critical Appraisal Tool.<sup>20</sup> In each case, outcomes were classified as low (0–33%), medium (34–66%), or high quality (67–100%). The reviewers worked independently and differences between reviewers in ratings were resolved by discussion and consensus. The ratings did not influence study inclusion in our review; this deviation from the published protocol was made because of the small number of relevant studies. We assessed the certainty of evidence with the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) assessment tool (<https://www.grade-workinggroup.org>).

## Results

The database searches identified 703 potentially relevant records; after removing 408 duplicates, the titles and abstracts of 295 publications were screened. A total of 268 records were excluded, most because the participants were not Indigenous Australians, or because no physical activity component was reported (eg, nutrition counselling only). The full text of 27 articles was assessed for eligibility, of which 18 were excluded: seven did not report outcomes related to type 2 diabetes, three did not report relevant interventions, two did not separately report data for Indigenous participants, two did not include Indigenous Australians, two were reviews that provided no original data, one did not include physical activity in the intervention, and one was an abstract ([Box 1](#)).

Nine studies met our inclusion criteria ([Supporting Information](#), table 2). One study was published before 2000,<sup>21</sup> five during 2000–2010,<sup>22–26</sup> and three during 2011–2021.<sup>27–29</sup> Two were randomised controlled trials,<sup>27,28</sup> five were cohort studies,<sup>21,22,24,25,29</sup> one a quasi-experimental study,<sup>26</sup> and one was a repeated cross-sectional study<sup>23</sup> ([Box 2](#)). One of the cohort studies utilised a mixed methods design but only the quantitative data was relevant to this review.<sup>29</sup> The GRADE assessment determined that the studies in this review provide a low certainty of evidence (data not shown). As differences in study design, outcome variables, and the small number of studies precluded meta-analysis, we provide a narrative summary of their findings.

### Study types and intervention components

The repeated cross-sectional study of a community-wide intervention for preventing and managing diabetes collected data at baseline and seven years.<sup>23</sup> We included this study because it was conducted at the community level, but it provided no information about the impact of physical activity at the individual level.

The two randomised controlled trials, of 12-week structured physical activity programs, did not report outcomes for Indigenous participants diagnosed with type 2 diabetes. One trial recruited people with pre-diabetes,<sup>28</sup> the other included participants with type 2 diabetes but did not separately report their outcomes.<sup>27</sup> One trial — 51 women in the active group, 49 in the comparison group — evaluated the effectiveness of a 12-week structured physical activity and nutrition program on biomedical markers of metabolic functioning.<sup>27</sup> The second — 16 people in the exercise group, ten in the control group — measured the impact of physical activity change on glucose regulation and

inflammatory markers associated with type 2 diabetes in men at risk of type 2 diabetes.<sup>28</sup>

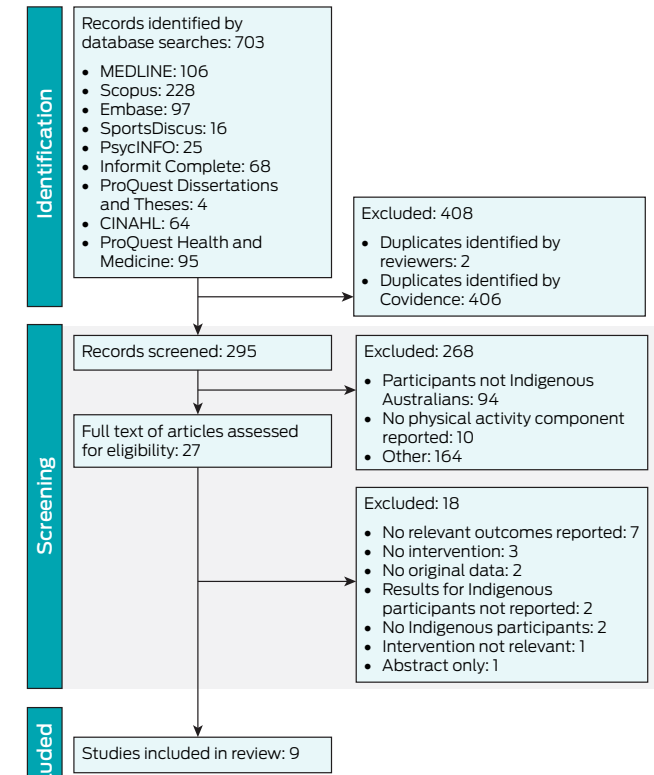
One cohort study reported changes in type 2 diabetes and heart disease after reverting to a more traditional lifestyle for seven weeks.<sup>21</sup> One cohort study assessed the impact of a lifestyle intervention on risk factors associated with type 2 diabetes.<sup>25</sup> Two cohort studies examined the prevention and management of diabetes with community-wide interventions.<sup>22,24</sup> One cohort study investigated the effect on diabetes management of the Flinders Model of self-management care, with trained Aboriginal health workers to assist participants.<sup>26</sup> The most recent cohort study evaluated an Aboriginal health care worker-led, ten-week diabetes lifestyle program for urban Aboriginal people in an Aboriginal organisation.<sup>29</sup>

Two studies (both randomised controlled trials) included structured physical activity sessions. One study included two supervised 45–60-minute physical activity sessions per week, including both aerobic and resistance training, with 30 minutes of each session at medium to high intensity;<sup>27</sup> the second study began with two physical activity sessions per week, increasing to three per week from week 6.<sup>28</sup> Two studies encouraged participants to increase the number of steps taken each day and provided them with pedometers.<sup>25,27</sup> Two cohort studies provided physical activity advice, but did not check the activity of participants; one advised participants to walk each day,<sup>29</sup> the other walking, team sports, and hunting.<sup>22</sup> Hunting was a component of physical activity in three studies.<sup>21–23</sup> Two cohort studies mentioned that a physical activity component was involved but provided limited detail.<sup>24,26</sup>

### Diabetes-related physiological assessments

Six studies reported changes in HbA<sub>1c</sub> levels. Neither randomised controlled trial reported statistically significant

### 1 Identification and selection of publications of studies of physical activity interventions for preventing and managing type 2 diabetes in Aboriginal and Torres Strait Islander Australians



CINAHL = Cumulative Index to Nursing and Allied Health Literature. ♦

### 2 Assessment of study quality, and ethical and methodological quality from the Indigenous perspective, of the nine included publications: summary findings\*

Publication	Criteria met	
	Risk of bias (JBI)	Ethical/methodological quality (CREATE)
Randomised controlled trials		
Canuto et al, 2012 <sup>27</sup>	8.5/13 (65%; medium)	9/14 (64%; medium)
Mendham et al, 2015 <sup>28</sup>	7.5/13 (58%; medium)	5/14 (36%; medium)
Cohort studies		
O'Dea, 1984 <sup>21</sup>	6/11 (55%; medium)	5/14 (36%; medium)
Rowley et al, 2000 <sup>22</sup>	7/11 (64%; medium)	11/14 (79%; good)
Gracey et al, 2006 <sup>24</sup>	2/11 (18%; poor)	3/14 (21%; poor)
Chan et al, 2007 <sup>25</sup>	5/11 (45%; medium)	5/14 (36%; medium)
Power et al, 2021 <sup>29</sup>	5.5/11 (50%; medium)	14/14 (100%; good)
Quasi-experimental study		
Battersby et al, 2008 <sup>26</sup>	2/9 (22%; poor)	9/14 (64%; medium)
Cross-sectional study		
Rowley et al, 2000 <sup>23</sup>	6/8 (75%; good)	7/14 (50%; medium)
Qualitative component of cohort study		
Power et al, 2021 <sup>29</sup>	10 (100%; good)	—

CREATE = Centre of Research Excellence in Aboriginal Chronic Disease Knowledge Translation and Exchange critical appraisal tool;<sup>20</sup> JBI = Joanna Briggs Institute critical appraisal tools.<sup>19</sup> Complete assessments for each set of appraisal tools are included in the Supporting Information, tables 4 to 7. ♦

changes in mean HbA<sub>1c</sub> levels;<sup>27,28</sup> one study did not separately report results for participants with and without diabetes.<sup>27</sup> Two cohort studies reported statistically significant changes in mean HbA<sub>1c</sub> level; from 8.15% (65.4 mmol/mol; standard deviation [SD], 1.61%) at baseline to 6.29% (45.2 mmol/mol; SD, 1.04%) at ten weeks,<sup>29</sup> and from 8.79% (72.0 mmol/mol; SD not reported) at baseline to 8.09% (64.9 mmol/mol) at twelve months.<sup>26</sup> One cohort study reported a slight increase in mean HbA<sub>1c</sub> level six months after the intervention, but, as diabetes medication use did not change, the increase may have reflected differences in seasonal food intake during the recent holiday season.<sup>25</sup> One study reported that HbA<sub>1c</sub> levels improved but did not report relevant data.<sup>24</sup>

Improvements in other diabetes-related measures were reported by some studies: reduced mean fasting plasma glucose (−5.0 mmol/L at seven weeks; SD not reported);<sup>21</sup> −0.9 mmol/L at six months (SD not reported);<sup>22</sup> −0.3 mmol/L in people without diabetes at seven years (SD not reported);<sup>23</sup> reduced mean fasting plasma insulin levels (−11 mU/L at seven weeks; SD not reported);<sup>21</sup> reduction in insulin area under the curve (−25% in the intervention group at twelve weeks, no change in the control group<sup>28</sup>); improved glucose tolerance (community-wide reduction across the seven years between tests);<sup>23</sup> and reduced insulin resistance (greater improvement in Matsuda Insulin Sensitivity Index score for physical activity group than control group between baseline and twelve weeks).<sup>28</sup>

### Study quality, and ethical and methodological quality from an Indigenous perspective

Eight of the nine studies were rated as being low or medium quality (median JBI score, 54%; interquartile range [IQR], 36–64%). The JBI scores for the two randomised controlled trials were 58%<sup>28</sup> and 65%,<sup>27</sup> those for the five cohort studies ranged from 18%<sup>24</sup> to 64%,<sup>22</sup> the score for the cross-sectional study was 75%,<sup>23</sup> and that for the quasi-experimental study 22%<sup>26</sup> (Box 2).

Seven of the nine studies were rated as being of low to medium ethical and methodological quality from the Indigenous perspective (median CREATE score, 50%; IQR, 36–64%). The CREATE scores for the two randomised controlled trials were 36%<sup>28</sup> and 64%<sup>27</sup>, those for the five cohort studies ranged from 21%<sup>24</sup> to 100%,<sup>29</sup> the score for the cross-sectional study was 50%,<sup>23</sup> and that for the quasi-experimental study 64%.<sup>26</sup> The quality of the mixed methods study, assessed with the JBI qualitative assessment tool, was rated as 100% (Box 2).

## Discussion

Our review identified few high quality studies of interventions for preventing and managing type 2 diabetes in Indigenous Australians that included physical activity; further, the value of the findings of many studies were affected by shortcomings in design, power, and input from Aboriginal communities and researchers. Our findings suggest areas for improvement in gathering evidence for future strategies for preventing and managing type 2 diabetes in Indigenous Australians.

Despite the increasing prevalence of type 2 diabetes among Indigenous Australians, only two randomised controlled trials included physical activity as a component for its prevention and management. One of the trials assessed the impact of physical activity on men at risk of type 2 diabetes, and did not include participants with diabetes;<sup>28</sup> the second did not include any male participants and did not report results by diabetes status.<sup>27</sup>

Our review of intervention studies that included physical activity for preventing or managing type 2 diabetes, a key lifestyle change, found no randomised controlled trials that reported outcomes by type 2 diabetes status, and identified that the design of many studies was inadequate. Further, no randomised controlled trials have included both dietary interventions and physical activity, the cornerstone of diabetes type 2 management by general practitioners.<sup>8</sup> Inadequate experimental research design in Indigenous health research is not restricted to diabetes research. A review of medical research involving Indigenous Australians completed since the first *Closing the Gap* report (2008) found that only 57 of 2150 published studies (2.7%) were randomised controlled trials, and that 58% were descriptive studies,<sup>30</sup> which may be of questionable validity if Indigenous researchers were not involved. While other research types are important, the outcomes of randomised controlled trials inform guidelines and change clinical practice.<sup>31</sup>

Only two publications included in our review had Indigenous people as first authors;<sup>27,29</sup> none of the other publications identified an Indigenous research team member. More rigorous research is needed, led by Indigenous people, to advance the study of type 2 diabetes in Indigenous people. Well designed randomised controlled studies are needed to evaluate the impact of clinically relevant exercise interventions that prevent type 2 diabetes or improve metabolic control in people with type 2 diabetes, with clearly defined outcomes meaningful for Indigenous Australians. Research led by Indigenous researchers and communities could achieve this aim, as the need to improve health outcomes is best recognised by those who are directly affected.<sup>32</sup>

Drivers of physical activity at the population level include the availability of safe, accessible, family-friendly, and inexpensive locations for physical activity. Simple, effective advice and support from health professionals, based on the current level of fitness of the individual, could also improve physical activity levels. Appropriate locations and advice are both often limited in regional and remote communities. Interventions that can lead to a healthy, supporting environment include those in which family members are involved, and advice and support is provided by a trusted health professional who understands the barriers faced by the local community.

### Limitations

The findings of our review are limited by the differences in the interventions, their duration, and the assessments described in the nine included publications. The Indigenous peoples of Australia are heterogeneous, with more than 250 language groups (Supporting Information, figure 1), and one cannot assume that the findings of the few studies we included apply to all Indigenous people. Although two authors reviewed the publications at each stage, a risk of bias affecting study inclusion remains. While there is some evidence linking physical activity with improved health for Indigenous Australians with type 2 diabetes, intervention studies that are meaningful, well designed, and provide unambiguous outcomes are still needed.

### Conclusion

We have identified that quality research into the impact of physical activity on type 2 diabetes in Aboriginal and Torres Strait Islander people is sparse. To improve research translation, studies that involve Indigenous community members at all levels of the research process are needed, especially during

data interpretation and writing. Although advice on diet and physical activity is a cornerstone of the management of type 2 diabetes, rigorous research in this area for Aboriginal and Torres Strait Islander people is limited, and more is required.

**Acknowledgements:** We thank Helen Chan (Information Services Department, University of Technology Sydney) for her assistance with the design of the search strategy.

**Competing interests:** Elif I Ekinçi receives research funding from Eli Lilly, Novo Nordisk, Amgen, Versanis, Endogenex, Novartis, Astra Zeneca; she is on advisory

boards and gives presentations for Eli Lilly, Astra Zeneca, and Boehringer. These funds are donated to diabetes research at her institution. ■

Received 17 July 2023, accepted 27 March 2024

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## Supporting Information

Additional Supporting Information is included with the online version of this article.