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Review Article

A systematic review and meta-analysis of cardiorespiratory fitness among Indigenous populations in North America and circumpolar Inuit populations

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ABSTRACT

Indigenous populations experience health disparities including increased obesity, diabetes and cardiovascular disease rates. Cardiorespiratory fitness is beneficial for maintaining positive health outcomes. The objective of this systematic review is to evaluate cardiorespiratory fitness among Indigenous populations including comparisons across genders, Indigenous identities, age groups, decades, socio-demographic variables and in comparison to non-Indigenous groups. Included articles reported various cardiorespiratory fitness measures using maximal treadmill or cycle ergometer tests, 20 m shuttle run, 1 mile run/walk test and 6 min walk test. From 14 databases searched in March 2017, including MEDLINE, EMBASE and Scopus, 1069 citations were evaluated and 39 articles included, representing 32 investigations and 10,579 individuals. First Nations/American Indian (FN/AI) adults have greater cardiorespiratory fitness than Inuit. Inuit and FN/AI men and boys have higher cardiorespiratory fitness than women and girls. Lower cardiorespiratory fitness is associated with obesity, metabolic syndrome and a western lifestyle. Cardiorespiratory fitness has declined among Inuit adults, averaging $51.7 \pm 7.9\ mL{\cdot}kg^{-1}{\cdot}min^{-1}$ in 1970 to $37.7 \pm 6.9\ mL{\cdot}kg^{-1}{\cdot}min^{-1}$ in 2000. Among men, FN/AI have greater cardiorespiratory fitness compared to European-descents, and European-descents have greater cardiorespiratory fitness compared to Inuit. The 1 mile run/walk time showed that FN/AI boys, girls, and youth had faster times compared to European-descendants, but 20 m shuttle run showed that European-descent boys and youth advanced to further stages compared to FN/AI populations. Cardiorespiratory fitness is declining, and among some Indigenous populations to lower levels than European-descent populations. Improving cardiorespiratory fitness for Indigenous populations should be considered a primary health strategy.

1. Introduction

Cardiorespiratory fitness, also known as aerobic capacity, cardiorespiratory fitness, maximal oxygen consumption, aerobic power, and aerobic fitness (VO2 max), is a vital part of a person's ability to perform tasks and activities of everyday living, and is closely related to overall health and quality of life (Myers et al., 2015; Porcari et al., 2015; Swift et al., 2013). There are many reliable proxies of cardiorespiratory fitness including but not limited to: maximal oxygen uptake, the 6 min walking test, and the 20 m shuttle run (Burr et al., 2011; Flouris et al., 2005; Swift et al., 2013). Loss of cardiorespiratory fitness is associated with increased cardiovascular disease-related and all-cause mortality (Myers et al., 2015; Swift et al., 2013; Taylor, 2008). Obesity is associated with a poor cardiovascular risk profile, and obese individuals have lower cardiorespiratory fitness when compared to healthy individuals (Martin et al., 2012). Cardiorespiratory fitness is a direct and modifiable contributor for decreasing obesity, metabolic abnormalities and cardiovascular disease (Gates et al., 2016; Heyward and Harris, 1988). Cardiorespiratory fitness is also identified as a more clinically important indicator of cardiovascular disease and mortality outcomes than physical activity (Swift et al., 2013).

Indigenous people in North America include First Nation (FN), Métis, and Inuit populations in Canada, and American Indian (AI) and Alaskan Native populations, known collectively as Native Americans (NA), in the USA (Barnes et al., 2010; Garner et al., 2010). Obesity prevalence and many other health disparities are prevalent among Indigenous peoples, including abdominal obesity, diabetes, and other metabolic abnormalities (Gates et al., 2016; Pirisi, 2015; Thompson et al., 2007). Decreased physical activity and cardiorespiratory fitness can be greatly affected by social structural factors including socioeconomic status, availability of resources and geographic remoteness (Gates et al., 2016). Interestingly, despite many barriers to physical activity, many FN people still acquire large amounts of physical activity (Barnes et al., 2010; Dogra et al., 2010; Findlay, 2011; Foulds et al., 2013; Garner et al., 2010; Gates et al., 2016; Holm et al., 2010; Kirby et al., 2007).

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While Indigenous populations are found to have higher levels of physical inactivity and sedentary behaviour, limited research is available on Indigenous populations' cardiorespiratory fitness (Barnes et al., 2010; Dogra et al., 2010; Findlay, 2011; Foulds et al., 2016; Foulds et al., 2013; Garner et al., 2010; Gates et al., 2016; Holm et al., 2010). Increased cardiorespiratory fitness and physical activity levels are vital for prevention and management of diabetes and metabolic syndrome (Thompson et al., 2007). More research is needed to understand health disparities among Indigenous populations. The primary objective of this review and meta-analysis is to examine maximal and submaximal cardiorespiratory fitness testing outcomes including maximal aerobic capacity, 6 min walking test, 20 m shuttle run, 1 mile run/walk, cycle ergometer submaximal test, and the Bruce maximal or submaximal treadmill test among North American Indigenous populations from all study designs, and compare cardiorespiratory fitness across subgroups. Specifically, we evaluate and compare cardiovascular fitness across sexes, Indigenous groups, obesity categories, ages, countries, education levels, metabolic syndrome and impaired fasting plasma glucose status, traditional and western lifestyles, hunter status and across decades. We also compare cardiorespiratory fitness between Indigenous and North American European-descent ethnic groups. It is hypothesized that cardiorespiratory fitness is greater among North American Indigenous populations compared to European-descent populations, and cardiorespiratory fitness has declined among North American Indigenous populations over recent decades.

2. Methods

2.1. Search strategy and selection criteria

A thorough, systematic approach, following the PRISMA guidelines, was used to identify peer-review original research articles reporting cardiorespiratory fitness among North American Indigenous populations. The Medline search strategy was developed in consultation with a librarian experienced in systematic review searching (Fig. S1). A prior review protocol was not available. The searches were conducted on March 17, 2017, including electronic databases: MEDLINE (1946-March Week 2 2017); EMBASE (1947-March Week 2 2017, OVID Interface); CINAHL (1937-March Week 2 2017, EBSCO Interface); PEDro (1929-March Week 2 2017); PsycINFO (1806-March Week 2 2017, OVID Interface); Cochrane Library (1900-March Week 2 2017, Wiley Interface); SPORTDiscus (-March Week 2 2017, EBSCO Interface); Sociological Abstracts (1952-March Week 2 2017, ProQuest Interface); SocINDEX with full text (-March Week 2 2017, EBSCO Interface); Scopus (1966- March Week 2 2017, Scopus Interface); Social Services Abstract (1979-March Week 2 2017, ProQuest Interface); Academic Search Complete (-March Week 2 2017, EBSCO Interface); and Web of Science (1900-March week 2 2017, WOS Interface). Relevant MeSH terms, supplemented by keywords were used to search Medline, and the Medline strategy (Fig. S1) was adapted for other databases. Keywords included: Aerobic capacity, VO_2max, Walk Test, Aerobic Fitness, Maximal Aerobic Power and Bruce Treadmill. To target studies of this population, we used Indigenous Peoples Filters in the MEDLINE Database: (http://guides.library.ualberta.ca/content.php?pid=448005&sid=3671231). Results were downloaded to Endnote 7.0 (Thompson Reuters, Philadelphia, USA) software-based reference management system. Reference lists of articles that were deemed appropriate were scanned to find any additional studies.

We included any English language study reporting cardiorespiratory fitness specifically among FN/AI, Métis, or Inuit/Alaskan Native, referred to as Inuit, either as the sole participant group or reported among this subset of participants from any years and any study design. Excluded studies were those not reporting cardiorespiratory fitness, not reporting to FN/AI, Métis, or Inuit populations or combining Indigenous cardiorespiratory fitness with other ethnic groups. Key outcomes included maximal or submaximal cardiorespiratory fitness, 6 min walk test distances, 20 m shuttle run laps and/or times, 1 mile run/walk times and President's Fitness and Progressive Aerobic Cardiorespiratory fitness Run Health test categories.

2.1.1. Study selection and data extraction

A multi-stage process as outlined in Fig. 1, was used to screen all identified studies. Two independent reviewers (L.H. and C.M.) conducted the screening with discrepancies addressed by a third reviewer (H.F.). Compiled results from thirteen databases after removing duplicates were screened first by reviewing titles, then abstracts, followed by full-text reviews. Causes for exclusion of full-text articles were recorded. Throughout the screening process, reviewers were not blinded to authors and journals. When multiple companion studies were identified in the search strategy, multiple articles were included to provide the greatest breadth of measures, on the largest sample size, while only including a single measure from a study once. A standardized data extraction sheet was used by two independent reviewers to identify pertinent data, with discrepancies addressed by consensus. Data extracted included study years, Indigenous group, number and sex of participants, country, ages, cardiorespiratory fitness, and Indigenous nations, as reported on Fig. S1. Data were reported by specific Indigenous groups, sex, ages, body mass index and waist circumference categories and countries as available and combined through meta-analysis as necessary to produce overall averages.

2.1.2. Data synthesis

Main outcome measures included means and standard deviations of cardiorespiratory fitness, or proportions of participants meeting fitness standards. Measures of cardiorespiratory fitness were evaluated as reported in respective articles. Included evaluations of maximal cardiorespiratory fitness as estimated from submaximal testing was estimated or converted in the original article and the reported values were included in this evaluation. Cardiorespiratory measures were evaluated as either adults (18 yr and older) or children/youth (under 18 yr). Overweight and obesity measures among adults, as reported among included articles, defined obesity as body mass index values $\geq 30.0\ kg{\cdot}m^{-2}$ and overweight $\geq 25.0\ kg{\cdot}m^{-2}$ and abdominal obesity as a waist circumference $\geq$ 102.0 cm among men or $\geq$ 88.0 cm among women. Among children/youth, overweight was determined using criteria specific to each article, including the 85th, 90th and 95th percentile of body mass index by age (James et al., 2001; World Health Organization, 2000). The European obesity definitions have been found to correlate with body fat measures among North American Indigenous populations (Lear et al., 2007). Compiled averages were weighted to sample sizes. Cardiorespiratory fitness was evaluated by Indigenous identity, sex, country, age group, metabolic syndrome status, fasting plasma glucose status, obesity category, education level, traditional/western lifestyles and hunter status, and compared across decades and between Indigenous and North American European-descent ethnicities as available. Comparisons of Indigenous and North American European-descent cardiorespiratory fitness were conducted using only those articles which reported cardiorespiratory fitness for both ethnic groups, with meta-analysis performed when multiple articles were identified. Comparisons of compiled averages were conducted using meta-analysis comparison of means (MedCalc Version 12.7.0.0, Belgium). Forest plots were created using Microsoft Excel 2010 with a modified forest plot template (Neyeloff et al., 2012). All results are presented as means ± standard deviations. Statistical significance was set at $p < .05$. p-Values are reported as calculated or as reported in articles where only one article is presented; where multiple groups are compared, p-values for post-hoc comparisons between individual groups are included.

2.1.3. Quality of methodology and risk of bias

Quality of methodology of included articles was determined using the Downs and Black scoring system (Downs and Black, 1998). Each article was assessed individually for quality and given a score out of 26.