



Needing indigenous biometrics for health in Canada

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ABSTRACT

This article presents a critical analysis of the use of biometrics in clinical practice and their inadequacies for Indigenous populations in Canada and globally. Misclassifications of health status based on biometrics have health implications across the lifespan, from gestation to older adulthood, which are also examined. The social determinants of health and of Indigenous health compound the impact of inaccurate biometrics on First Nations, Inuit and Métis populations. Moving forward, biometric use should be done in partnership with Indigenous peoples and with consideration of the surrounding context. Future research should consider bridging existing gaps in knowledge on this topic in culturally safe ways, to improve the quality and depth of information available and inform more equitable health care for Indigenous populations.

1. Introduction

Measurements of human characteristics, or biometrics, have been used for decades in clinical health practice as a way to identify illness, categorize anomalies, and evaluate treatment. Western biomedicine often emphasizes biometrics as an objective, quantitative measure against which to compare patient populations to a peak standard of health. However, this standard is often based on white populations of European descent and is often inadequate for First Nations, Inuit, and Métis peoples (FNIM) in Canada. The comparison contributes to colonial and racist notions of inadequacy and deficit focuses among FNIM populations compared to non-Indigenous populations. FNIM populations have definitions of health that encompass physical body, mind, spirit, and emotion, and community health inextricably connected to individual health, going beyond physical measurements. Furthermore, data gaps for FNIM populations at local or Nation-specific level preclude the establishment of relevant biometrics. This review pulls together primary research biometrics, critical commentaries, and international reports spanning 54 years to portray the combined impact of inadequate biometrics of all types, for FNIM populations throughout a person's life cycle. There is a need to examine the presence and impact of biometric-driven misdiagnosis and misclassification of the health status of FNIM peoples across lifespans, from gestation to elderly.

2. What does this paper add?

To date, no research has pulled together a comprehensive narrative of all the biometrics that are inadequate for FNIM populations, and the ways in which they are, nor has this been done internationally.

The primary research into individual biometrics (e.g. birthweight), for FNIM populations, focuses on individual communities and metrics or life stages (Brennand et al., 2005; Katzmarzyk & Malina, 1999; Partington & Roberts, 1969; Potvin et al., 1999; Willows et al., 2011).

Other primary research shows correlations between biometrics and later health status in various populations internationally (Hoffman et al., 2017; Sheppard et al., 2017; Sjöholm et al., 2021), though rarely with specific results for Indigenous populations (Young, 1996).

Still other primary research has taken a solutions-based approach, such as Lavalley (1988) creating the only growth charts for FNIM children to date, from measurements of Cree children in 8 communities in James Bay, but these are also location and metric-specific.

Critical commentaries (Cyr & Riediger, 2021) and reviews (Charbonneau-Roberts et al., 2005) on individual biometrics for FNIM populations in relation to health (e.g. obesity) have been published, but there are no reviews spanning more than a handful of highly related biometrics, or focusing on biometrics across the lifespan.

This review builds upon previous research by pulling these in-depth pieces together into the larger whole – of FNIM peoples, involving many

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biometrics, throughout one's lifespan, and located across Canada, as published throughout the past half century. We then use the sum and interactions of this information to draw conclusions, some similar to previous published research and some different.

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3. How are biometrics inadequate across lifespan for FNIM populations? and What are the consequences?

3.1. Before Birth: Prenatal care and gestation

The average birth weight of FNIM babies differs from the general Canadian population, thus size during gestation can and does differ as well (Lavallee, 1988; Willows et al., 2011; Wright et al., 2019). A fetus being large for gestational age or small for gestational age (LGA and SGA, respectively) can directly, or indirectly through potential incorrect estimation of fetal gestational age, create long lasting effects for FNIM parents and children as key developmental milestones may also differ (Wright et al., 2019). There is a need for earlier size-for-gestational age data on FNIM fetuses, to understand if LGA or SGA differs around the time of fetal gestational age estimate, which could compromise the accuracy of the ultrasound measurement (Lavallee, 1988).

In pregnant people, pre-existing diabetes, gestational diabetes mellitus (GDM), inadequate prenatal care, and the parent themselves being either preterm or LGA are additional risk factors that can affect growth during gestation (Sheppard et al., 2017). Pressure to maintain weight or limit weight gain to prevent GDM may also lead to unnecessary stress during pregnancy that can lead to food restriction (Brennand et al., 2005). Decreasing food intake mirrors the malnutrition that was rampant in the Indian Residential School System (IRS) which has led to long-term health complications in IRS survivors and their descendants (Mosby & Galloway, 2017).

In remote communities across Canada, people must travel (typically by plane) to Southern hospitals for many procedures, including labour and delivery, often at 36- to 38-weeks. Overestimation of gestational age, based on fetal size measurement (Lavallee, 1988), can lead to unnecessary early medical evacuations of pregnant Indigenous peoples from remote communities, causing them to be without support during the perinatal period (Sheppard et al., 2017). Isolation can also raise pregnant peoples' stress levels. High cortisol levels for a prolonged period may affect birthweight and have a negative outcome on the unborn child's cardiovascular risk later in life (Hoffman et al., 2017).

3.2. At Birth: Perinatal

There has been a general lack of consistency in data published looking at preterm births, SGA and LGA births, stillbirths, and mortalities among Indigenous peoples across Canada, as well as the United States, Australia, and New Zealand, resulting in varying estimates for birth outcomes (Sheppard et al., 2017). Child growth standards for normal birth weight, and thus cutoffs for LGA and SGA, developed by the World Health Organization and adopted by the Canadian Pediatric Society, were found to deviate from the average birth weights of some First Nations populations (Willows et al., 2011). A study of births in rural and remote Cree communities in Quebec between 1994 and 2000 found higher median birthweights, birth lengths, and head circumferences among Cree newborns (Willows et al., 2011).

Both low and high birth weights are associated with higher non-communicable disease risk later in life (Wright et al., 2019). Adverse events that may occur in utero (such as malnutrition, high stress) can manifest in a lower or higher birth weight which predisposes the infant to health complications in later years. This correlation has been found across populations with varying socioeconomic and cultural backgrounds internationally (Sjöholm et al., 2021). First Nations infants have

been found to have lower rates of SGA births and the higher rates of LGA births, even when excluding for gestational diabetes (1, 2). Given the ability of birthweight to indicate potential underlying health issues, there is a need for accurate SGA and LGA parameters for FNIM populations or to consider additional factors in their health. Without this, FNIM infants who are heavier at birth in comparison to the Canadian population may be misdiagnosed as overweight with iatrogenic consequences and SGA FNIM infants may be missed for health intervention, given that they are closer to the Canadian average than the Canadian SGA cutoff.

3.3. In childhood

From birth into early childhood, growth charts are used in clinical practice despite inaccuracies for FNIM populations. The current Canadian birth weight charts, created by Kramer et al. (2001) from Canadian national data on singleton births between 1994 and 1996, result in considerable false positive SGAs and false negative LGAs for South Asian and Filipino infants in Toronto (Melamed et al., 2014), and while similar analyses were not done for FNIM populations, as a minority percentage (Sheppard et al., 2017) of the overall population in Canada, differences from FNIM populations were likely obscured within the larger dataset and require further investigation.

While there is limited data on height and weight before aggregating into body mass index (BMI) for FNIM children, the studies available suggest distinct growth patterns from the Canadian population (Growth assessment in Aboriginal children: Is there need for change?, 2004; Potvin et al., 1999). Measurements of Inuit, Cree, and Mohawk children in James Bay, Hudson Bay and Tyendinaga in 1965 differed between groups, where Mohawk children were taller and heavier than Cree children, and Inuit were shorter but not always lighter (Partington & Roberts, 1969). To date, Lavallée has developed the only growth charts for FNIM children, from measurements of Cree children in 8 communities in James Bay (Lavallee, 1988). These charts show Cree children tend to be taller and heavier from birth until 27 months, at which point height begins to approach that of American children while weight differences persist (Lavallee, 1988). These have remained in use in Northern Quebec (Growth assessment in Aboriginal children: Is there need for change?, 2004) but evaluation has yet to be done.

Growth charts have important implications for the health of FNIM children. Height, weight and BMI measurements are a routine part of pediatric check-ups and facilitate the identification of abnormalities for further examination (Growth assessment in Aboriginal children: Is there need for change?, 2004). FNIM children of average size for their population may be classified as overweight and increase the likelihood of inappropriate weight-loss counselling leading to stigmatization, dieting, or risky experimental weight-loss drugs (Lau et al., 2007). Similarly, FNIM children of low weight for height by the norms of their FNIM population may be missed. Clinical intervention around nutritional deficiencies or pathologies may be delayed or absent, with long-term health and financial consequences. For example, FASD diagnosis is based on a 10th percentile cut-off for growth retardation (Dietitians of Canada, 2013), which FNIM children are unlikely to meet. While some organizations have discouraged the creation of FNIM group-specific growth curves due to lack of sufficient population size to achieve statistical reliability and the need for different curves for each Nation/group (Growth assessment in Aboriginal children: Is there need for change?, 2004), the impact of misclassification on the health outcomes for FNIM children should be considered.

3.4. In adulthood

There is ample literature on the limitations of BMI for non-white populations, and FNIM populations are no exception. BMI assumes a heavier body mass is due to excess fat, however, some Inuit populations have been found to have a shorter leg-to-torso length, causing BMI to

overestimate body fat (Charbonneau-Roberts et al., 2005) and studies with Maori and Pacific Islander populations show lower body fat at a given BMI (Duncan et al., 2004). Studies with Ojibwe First Nations and Inuit women have noted a higher prevalence of centralized body fat distribution compared to populations of European ancestry (Katzmarzyk & Malina, 1999; Young, 1996). But the relationship between central adiposity, often measured by waist circumference, and health risk also shows variation with ethnicity (Duncan et al., 2004), thus more research is needed.

Pregravid and pregnancy weight gain are subject to clinical guidelines from the Institute of Medicine and Health Canada, which are inversely related to BMI and include a maximum of 7.0 kg for individuals with pregravid BMIs over 30 (Brennand et al., 2005). Thus, many FNIM adults with high BMIs experience pressure from healthcare providers to lose weight (Cyr & Riediger, 2021) and restrict their food intake during pregnancy. In Cree communities near James Bay, health care providers were primarily concerned with inadequate weight gain during pregnancy and were not calculating BMI for risk of restricting weight gain, while researchers published concerns to the contrary (Brennand et al., 2005). This contention around BMI should be addressed due to the consequences to FNIM adults and children through the birthing process.

Overtreatment of obesity and weight gain restriction negatively impact the health of FNIM populations. Misclassification of BMI, as one in a combination of factors in clinical decisions, can predispose to undernutrition of adults through inappropriate dieting and weight loss programs and iatrogenic harms from medication and weight loss surgeries (Cyr & Riediger, 2021). Small decreases in food intake can lead to inadequate nutrient levels with the limited quantity and prohibitive cost of nutrient-dense food in many FNIM communities (Halseth, 2015). During pregnancy, this can lead to intrauterine growth restriction (Brennand et al., 2005), which increases risk of fetal and neonatal mortality, stillbirth, convulsions, and cerebral palsy at birth, impaired neurological development, wasting, and stunting in childhood, and hypertension, cardiovascular disease, insulin resistance, diabetes, depression, and respiratory disease into adulthood (Cyr & Riediger, 2021).

4. How are the consequences of biometric misclassification impacted by the surrounding environment?

Many of these health concerns and biometric inaccuracies are compounded by the social determinants of health (SDOH). Low income, inadequate and unsafe housing, food insecurity, climate change, land dispossession, intergenerational trauma, racism, and colonialism all contribute in multiple, interacting ways to health disparities between FNIM populations and the general Canadian population (Reading & Wien, 2009). It is impossible to separate the impact of each of these factors, or how FNIM groups are affected, but clinical measurements place blame on the individual level when a socio-ecological framing is equally relevant. Furthermore, the pathologization of anthropometric measurements outside the European-based standard is harmful and stigmatizing and lacks research on their link to health in FNIM populations (Cyr & Riediger, 2021). The focus of biometrics on classifying and denouncing deviations from the Canadian norm conflict with these realities faced by many FNIM communities.

The harm of over- or underdiagnosing is amplified for FNIM communities by the SDOH. Over-treatment incurs travel costs and lost wages for individuals in remote locations who must leave the community for diagnosis or treatment (Reading & Wien, 2009). anti-Indigenous racism is well-documented in the Canadian health care system and over-treatment increases the number of interactions that risk stereotyping, verbal abuse, medical malpractice, or death (Gunn, n.d.). Undertreatment, however, can cause the health issue to worsen, requiring more extensive, costly, invasive treatment and/or leading to secondary health issues. Remote communities may not have the infrastructure to support later-stage solutions or supportive measures for secondary issues,

forcing patients to travel long distances when the initial health concern could have been treated locally. In both cases, early, accurate diagnosis improves physical and mental health outcomes for FNIM peoples.

5. How do we move forward?

Moving forward, self-determination and governance, as called for in the United Nations Declaration on the Rights of Indigenous Peoples (United Nations, 2007), must be at the center of biometric use among Indigenous populations. Clinicians, researchers, and policymakers should partner with Indigenous communities and organizations when using biometrics in their work. Individual metrics should be contextualized within the social determinants of health and power structures, as well as health metrics at the community level. International research has called for large-scale longitudinal studies to determine average biometrics, such as birth weights, growth charts, and BMI cut-offs for Indigenous populations (Duncan et al., 2004). Data sovereignty should be at the forefront of this research, supporting Indigenous communities in obtaining a fuller data set from which to develop their own metrics and reflect local realities instead of pan-Indigenizing.

6. Conclusion

Current biometrics do not appear to work for Indigenous peoples in Canada or globally, and their ongoing use may negatively affect health across the lifecourse. Social determinants of health, racism, and colonialism compound these effects within Indigenous populations. Moving forward, approaches to biometrics should involve partnership with Indigenous communities, support Indigenous self-determination and data sovereignty, and consider the surrounding context of social determinants in the community, for a holistic view of health.

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CRediT authorship contribution statement

Emma J. Rice: Writing – original draft. **Angela Mashford-Pringle:** Conceptualization, Supervision, Writing – original draft. **Tammy MacLean:** Conceptualization, Writing – original draft. **Darci Belmore:** Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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