Risk communication of environmental contaminants in Indigenous traditional food sources in northern Canada: A systematic review

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ABSTRACT

Introduction: Environmental contaminants threaten northern Indigenous communities' traditional food systems. Risk communication informs people about specific risks associated with these contaminants. Therefore, it is essential to understand how risk communication is practiced in northern Indigenous communities and identify factors to consider when communicating with northern Indigenous Peoples of Canada about contaminants in traditional food.

Methods: A systematic review was conducted to gather peer-reviewed primary research articles on the risk communication of contaminants in traditional food with Indigenous communities in northern Canada. The review process involved searching four databases and hand searching article references up to September 23, 2021.

Results: Databases and hand searches yielded 680 potential articles. Five articles met the inclusion criteria. One article reviewed 58 newspaper articles, and four covered 2,066 participants. The five articles were examined for risk communication practices in northern Indigenous communities and for design factors in communication delivery with northern Indigenous Peoples of Canada. Risk communication is mainly practiced through traditional media and requires messaging: (1) to demonstrate evidence of self-efficacy to limit exposure; (2) that comes from trusted sources; (3) that tells people what contaminants are present and who they affect.

Conclusion: Traditional foods are important to Indigenous Peoples' health and can continue to be safely enjoyed. Risk communication should include Indigenous voices in designing and developing messages about environmental contaminants. Trusted Indigenous Peoples should help deliver the messages to ensure their communities understand them.

RÉSUMÉ

Introduction: Les systèmes alimentaires traditionnels des communautés autochtones du nord sont menacés par les contaminants environnementaux. La communication des risques sert à informer les peuples autochtones sur des risques spécifiques. Par conséquent, il est important de comprendre comment la communication des risques est pratiquée dans les communautés autochtones du Nord et quels facteurs devraient être pris en compte lors de l'élaboration de messages pour les peuples autochtones du nord du Canada sur les contaminants dans les aliments traditionnels.

Méthodes: Un examen systématique a été effectué pour recueillir des articles de recherche primaire examinés par des pairs sur la communication des risques de contaminants dans les aliments traditionnels avec les communautés autochtones du nord du Canada. Le processus d'examen comprenait la recherche dans quatre bases de données et des références d'articles à la main jusqu'au 23 septembre 2021.

Résultats: Les bases de données et les recherches manuelles ont produit 680 articles potentiels. Au total, cinq articles répondaient aux critères d'inclusion. Un article comprenait 58 articles de journaux et les quatre autres avaient un total de 2,066 participants. Les cinq articles ont été explorés pour les pratiques de communication des risques dans les communautés autochtones du Nord et quels facteurs devraient être pris en compte dans la conception et l'élaboration de messages pour les peuples autochtones du nord du Canada. La communication des risques est principalement pratiquée à travers les médias traditionnels et les considérations qui devraient être incluses dans le message sont: (1) l'auto-efficacité pour limiter l'exposition; (2) les messages doivent provenir de sources et de personnes de confiance; (3) S'assurer que les peuples autochtones soient conscients des contaminants et les personnes qui en sont affectées.

Conclusion: Les aliments traditionnels sont importants pour la santé des peuples autochtones et devraient continuer à être appréciés. Les communicateurs des risques devraient inclure les voix autochtones dans la conception et l'élaboration des messages, les messages devraient inclure l'auto-efficacité et soit transmis par des personnes de confiance et c'est pertinent de s'assurer que les personnes comprennent ce que sont les contaminants.

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LIST OF ABBREVIATIONS

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QuADS	Quality Assessment for Diverse Studies

1 INTRODUCTION

Indigenous Peoples have always consumed traditional foods, especially in northern Canada, as there is limited access to crops and fresh produce, compared to their southern counterparts. In northern Canada, Indigenous Peoples have had access to terrestrial animals, arctic marine animals, freshwater fish, and plants for hunting, trapping, fishing and gathering. However, these food sources have been subject to environmental contamination. The contaminants travel from anthropogenic sources by atmospheric currents and bioaccumulate through the food chain and into Indigenous Peoples' food sources. Risk communication from Western health experts has informed Indigenous Peoples about contaminants in their traditional food sources. This communication has attempted to help them make appropriate decisions about their diet but lacks critical scrutiny. This thesis investigates risk communication practices about contaminants in the traditional food systems of Indigenous Peoples living in northern Canada. Its purpose is to strengthen the understanding of what to consider when designing the risk communication messages regarding contaminants in the traditional food systems of northern Indigenous Peoples of Canada. A systematic review of the peer-reviewed literature was undertaken to address this objective followed by an inductive thematic analysis of included articles to determine what factors to consider when developing risk communication messages for northern Indigenous communities of Canada.

2 LITERATURE REVIEW

2.1 Demographics

Canada's population is 38,005,238 people (Statistics Canada, 2020a), of whom 1,673,785 (4.4%) identify as Indigenous, comprising 977,230 people as First Nation, 587,545 as Métis, and 65,025 as Inuit (Statistics Canada, 2020b). The Constitution Act of 1982 officially acknowledged these three groups (King, Smith, & Gracey, 2009), guaranteeing them constitutional protection through new and existing Treaty rights, such as Aboriginal title (ownership of land), annuities, hunting and fishing, self-governance, and cultural and social rights (Government of Canada, 2020). This thesis uses the term Indigenous Peoples to describe First Nation, Métis, and Inuit. Indigenous Peoples living in communities above the 60th parallel are located in the Yukon, Northwest Territories, Inuvialuit Settlement Region, and Nunavut. Furthermore, the Northern Contaminants Program also considers Indigenous communities in Nunavik in northern Québec, and Nunatsiavut in northern Labrador also part of Canada's North (Indian and Northern Affairs Canada, 2003), which this thesis takes into account. These provinces, territories, and regions make up the Subarctic and Arctic that this thesis will call the North or Arctic. Figure 1 and Figure 2 provide visual representations of these provinces, territories, and regions.

Figure 1 Map of northern communities in the West of Canada (Indian and Northern Affairs Canada, 2003)

Figure 2 Map of northern communities in the East of Canada (Indian and Northern Affairs Canada, 2003)

Northern Canada is a vast body of land and water consisting of the boreal forest, dense with evergreens, with locations north of the tree line where barren tundra and permafrost allow only short plants, such as moss, to grow. The coastline in the North is longer than that of Canada's Pacific and Atlantic coasts combined (Canadian Northern Economic Development Agency, 2020). Winters are long and harsh, while summers are short and cool. The three Territories of Yukon, Northwest Territories, and Nunavut roughly constitute 40% of Canada's landmass (Canadian Northern Economic Development Agency, 2020). This estimate does not account for the lands of Nunavik and Nunatsiavut in the northern parts of Québec and Labrador, respectively, or Baffin Island and the remainder of Inuit Nunangat, which means land, water, and ice (Inuit Tapiriit Kanatami, 2019). The North is thinly populated with about 114,000 people residing within the three Territories of Yukon, Northwest Territories, and Nunavut (Canadian Northern Economic Development Agency, 2020), 12,000 in Nunavik across 14 communities (Nunavik Regional Board of Health and Social Services, 2020), and some 2,285 living in Nunatsiavut (Inuit Tapiriit Kanatami, 2018). Of the three Territories, Indigenous Peoples make up 86% of the population in Nunavut, 51% in the Northwest Territories, and 23% in the Yukon (Canadian Northern Economic Development Agency, 2020).

2.2 Indigenous health

Indigenous Peoples of Canada are among the most disadvantaged populations in developed countries and experience more significant health concerns than non-Indigenous Canadians (Waldram, Herring, & Young, 2006). Indigenous Peoples experience higher prevalence of preventable chronic diseases compared to non-Indigenous Canadians, and their life expectancy, whether in rural or urban settings, is approximately 12-years less than the national average

(King, 2011; Tjepkema, Wilkins, Senécal, Guimond, & Penney, 2011; Wilkins et al., 2008). The 2017 life expectancy of Inuit men was 64 years, and 73 years for women (Government of Canada, 2017), while First Nation and Métis men's life expectancy was 73-74 years, and 78-80 years for women (Government of Canada, 2017). In contrast, the 2017 life expectancy of the total Canadian population was 79 years for men and 83 years for women (Government of Canada, 2017).

Indigenous Peoples' health inequalities stem from colonization and government efforts to assimilate Indigenous Peoples, who were deemed uncivilized and unwanted (Lavallee & Poole, 2010; MacDonald & Steenbeek, 2015). Actions included forced migration and settlement, the loss of culture and language, and detachment from the land (King et al., 2009). Indigenous Peoples were and continue to be marginalized, face racism, discrimination, exclusion, and harmful stereotypical representation relative to the rest of the population (Kirmayer, Dandeneau, Marshall, Phillips, & Williamson, 2011; Reading & Wien, 2009), as recently seen in the Canadian health care system (Wylie, McConkey, & Corrado, 2021). Additionally, residential schools used physical, emotional, and psychological abuse (Antone & Hill, 1992), harming survivors and the generations after them (Reading & Wien, 2009). All these factors impact the social determinants of health specific to Indigenous Peoples (Richmond & Ross, 2009), perpetuating health disparities such as higher suicide rates among Indigenous Peoples than non-Indigenous Peoples (Inuit Tapiriit Kanatami, 2016; Kirmayer et al., 2007). Suicide rates are two to 11 times higher for Indigenous Peoples than non-Indigenous people (Kirmayer et al., 2007). Inuit are on the highest end of the spectrum (Kirmayer et al., 2007).

2.3 Indigenous Peoples' perspectives on health

Indigenous Peoples' traditional approach to health is a wholistic concept. It contrasts with the Western biomedical problem-solving that manages disease without considering spiritual matters (King et al., 2009), commonly guided by the social determinants of health framework (Solar & Irwin, 2010). It does not encompass Indigenous Peoples' health and well-being perspectives, worldviews, and concepts. The First Nations Health Authority (2021a) depicts Indigenous Peoples' perspective on wholistic health as having many layers of fluidity, as shown in Figure 3.

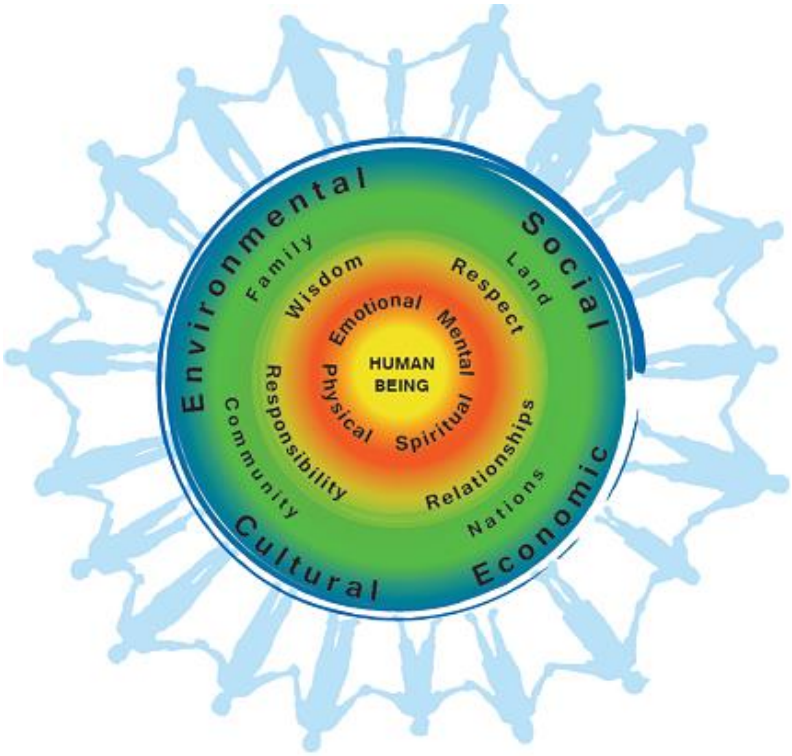

Figure 3 Indigenous perspectives on health (First Nations Health Authority, 2021b)

Health begins with the individual (First Nations Health Authority, 2021a). Leading Earth Man, Elder Dave Courchene, explains:

> To get to the root of the problem, you must understand the Spirit and live within one's true identity found in the Spirit. If a person is not living within their true identity, they remain imbalanced, as the Spirit is where healing and health begin (Turtle Lodge, 2017).

It is important to balance spiritual, emotional, physical, and mental health (First Nations Health Authority, 2021a; King et al., 2009; Robbins & Dewar, 2011). Weakness in any of these interconnecting factors may lead to an individual's unwellness (King et al., 2009; Robbins & Dewar, 2011; Turtle Lodge, 2017). Therefore, it is essential to nourish them together for strong healthfulness (First Nations Health Authority, 2021a). Another priority for Indigenous well-being is cultivating wisdom by passing traditional knowledge from generation to generation (First Nations Health Authority, 2021a; Hausknecht, Freeman, Martin, Nash, & Skinner, 2021). Traditional knowledge includes knowledge of culture, language, traditions, the land, and medicine (Robbins & Dewar, 2011). Respect for and responsibilities to all relationships with family and community are important for health, as family extends beyond the immediate family and encompasses the greater community where reciprocity occurs and fosters closeness and love (Cancer Care Ontario, 2017; First Nations Health Authority, 2021a; Turtle Lodge, 2017).

Respect and responsibility for the land are significant for Indigenous Peoples' health. Health and wellness are rooted deeply within the land and environment, founded on a deep reciprocal and spiritual connection (Assembly of First Nations, 2021; First Nations Health Authority, 2021a; Robbins & Dewar, 2011; Turtle Lodge, 2017). When Mother Earth and all living things are healthy, Indigenous Peoples are healthy (Assembly of First Nations, 2021). The land provides the materials needed to live, such as food, water, and natural medicines, to help heal and find balance in life (Assembly of First Nations, 2021; First Nations Health Authority, 2021a; Turtle

Lodge, 2017). Indigenous Peoples only take from the land what they need and use it with care and minimal waste (Assembly of First Nations, 2021; Turtle Lodge, 2017; Van Bruggen & Dash, 2018). For example, the inedible parts of the animal can be sustainably manufactured into clothes, tools for hunters to use or sell, or as a heat source (Robinson, 2018). The economic strategy within Indigenous worldview is to only take the resources for what is needed at the time so that future generations will also be able to access those resources (Assembly of First Nations, 2021; First Nations Health Authority, 2021a). Harvesting from the land means hunting, fishing, trapping, and gathering, which are considered integral parts of Indigenous cultural practices (Kumar, Furgal, Hutchinson, Roseborough, & Kootoo-Chiarello, 2019). These activities provide a good source of physical activity, significant to Indigenous Peoples' health. They reconnect people with their traditional knowledge of the land (Kumar et al., 2019; Turtle Lodge, 2017) and the food it provides, which is deemed healthier than store-bought foods (Assembly of First Nations, 2007). As depicted in Figure 3, an outer layer of Indigenous perspectives is the health and well-being of elders and children. Elders pass down traditional knowledge to the future leaders and parents, which in turn is the health of communities' futures (First Nations Health Authority, 2021a; Greenwood & de Leeuw, 2012; Hausknecht et al., 2021).

2.4 Indigenous food systems

2.4.1 Traditional food

The food harvested through subsistence hunting, fishing, trapping, and gathering is called country or traditional food. This thesis will use the term traditional food to encompass Indigenous Peoples' consumption of various plants and animals harvested from the land and environment (Assembly of First Nations, 2021; Center for Indigenous Peoples' Nutrition and

Environment, 2005; Van Oostdam et al., 2005). Indigenous communities in northern Canada have recognized over 250 different types of plant and animal species as traditional foods (Van Oostdam et al., 2005) that vary by season and location (Delormier & Kuhnlein, 1999). Before contact with European settlers, Indigenous Peoples' diet comprised of only traditional food (Kuhnlein, Receveur, Soueida, & Egeland, 2004) whose consumption was directly related to health and well-being (Van Oostdam et al., 2005). All people have an intimate relationship with food, however, for Indigenous Peoples, this relationship is more profound, as traditional food is harvested from the land and environment (Friendship & Furgal, 2012; Kuhnlein et al., 2004).

The process of harvesting and eating traditional foods is significant to the cultural values of Indigenous Peoples, adding to the physical and spiritual health of both individuals and communities (Assembly of First Nations, 2007; Kuhnlein, Loring, Receveur, & Chan, 2000; Van Oostdam et al., 2003). Through feasts and ceremonies, traditional foods bring communities together, which is positive for sociocultural significance and mental health (Assembly of First Nations, 2007). Traditional foods also play an economic role, as they can be more affordable than store-bought foods and be used for trading with other communities (Assembly of First Nations, 2007; Van Oostdam et al., 2005). Nutritionally, traditional foods contain substantial micro-and macro-nutrients, antioxidants, omega-3 fatty acids and are believed to prevent chronic diseases, such as cardiovascular disease, obesity, and diabetes (Assembly of First Nations, 2007; Cordain, Eaton, Miller, Mann, & Hill, 2002; Egeland et al., 2009; Mulvad et al., 1996).

2.4.2 Market food

The term market food is used in this thesis to encompass the food that can be bought at a retail store, such as a supermarket. It includes commercially produced processed foods, such as cereals, canned goods, frozen goods, bread products, fruits, vegetables, dairy, meat, and eggs produced through commercial farming. Since contact with European settlers, Indigenous Peoples have experienced a rapid change in their diet (Assembly of First Nations, 2007; Kuhnlein & Receveur, 1996). With this change in food systems, some Indigenous communities rely more on store-bought foods than hunting and fishing for their sustenance (Assembly of First Nations, 2007). More store-bought foods have led to a shift to a high calorie, low nutrient diet, with higher intakes of refined carbohydrates and saturated fat. This change has been identified as a risk factor for diabetes, obesity, and cardiovascular disease, removing vital nutrients from traditional food consumption (Assembly of First Nations, 2007; Eaton & Konner, 1997; Egeland et al., 2009; Kuhnlein et al., 2004). Physical activity is also negatively affected, as store-bought food is less physically demanding to obtain than is finding nourishment from the land (Assembly of First Nations, 2007).

2.4.3 Food security in the North

According to the Food and Agricultural Organization, as cited by Chan et al. (2019), food security is reached "when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Food security, or lack thereof, is another concern for many northern Indigenous communities.

2.4.4 Barriers to food security in northern communities

There are several barriers to food security in the North. Income levels among the Indigenous Peoples living in northern regions of Canada are typically inadequate to purchase food, given the high cost of living (Chan et al., 2006; Lambden, Receveur, Marshall, & Kuhnlein, 2006). Furthermore, hunting equipment is expensive, and the cost of market foods can be two to three times more expensive than in southern urban communities (Chan et al., 2006; Laberge-Gaudin, Receveur, Girard, & Potvin, 2015). For those employed, hunting is limited to weekends (Chan et al., 2006; Laberge-Gaudin et al., 2015). Some households do not have an active hunter. Not everyone possesses the ability, knowledge, or skills to hunt or prepare food (Chan et al., 2006), leading to restrictions on accessing traditional foods. Meanwhile, climate change and industrial activity on peoples' lands drive wildlife away, limiting traditional food access (Chan et al., 2019). Besides the high cost of market foods, the selection in-store is limited, and the quality often less than reasonable for the price, with nutritious fresh produce generally spoiled upon arrival, due to the difficulty in transporting it to remote communities in the North (Chan et al., 2006; Fieldhouse & Thompson, 2012).

2.4.5 Facilitators to food security in northern communities

Arguably, the most significant facilitator for ensuring food security is a large disposable income that enables people to purchase both the equipment needed to hunt traditional foods and market foods (Chan et al., 2006). Interestingly, a large portion of people describe fishing as affordable (Lambden et al., 2006). When a family has the skills and equipment to hunt, fish, and/or trap, the cost of traditional foods is less than that of market foods (Chan et al., 2006). If there is no active hunter in the household, families may share the costs or even provide the supplies to a hunter in

return for traditional foods (Chan et al., 2006). Sharing traditional food among family and friends is common (Laberge-Gaudin et al., 2015). Either way, eating traditional food stretches family income by reducing reliance on market food (Chan et al., 2006; Van Oostdam et al., 2005). It also costs less to buy traditional foods from individual hunters or hunter-trapper organizations (Chan et al., 2006; Laberge-Gaudin et al., 2015). Although the time to hunt and prepare traditional food for employed individuals is a barrier (Chan et al., 2006), people can pay elders to butcher, clean, and prepare traditional foods if needed (Laberge-Gaudin et al., 2015). In addition, the communal preparation of traditional food is a type of knowledge transfer and cultural practice important for individuals and cultivating community (Van Oostdam et al., 2005).

2.5 Contaminants in traditional foods

Environmental contaminants in the land, water, and air threaten Indigenous Peoples' health and traditional food systems (Assembly of First Nations, 2007; Furgal et al., 2005). Contaminants such as heavy metals, persistent organic pollutants, and polychlorinated biphenyls are introduced to northern Canada through long-range atmospheric and ocean currents from anthropogenic sources and enter the environment through condensation, rain, snowfall, and runoff into bodies of water (Assembly of First Nations, 2007; Braune et al., 1999; Lehnherr, 2014; Van Oostdam et al., 2003). Owing to the unique geographic and atmospheric characteristics of the Arctic, long-range transport chemicals tend to accumulate here (Van Oostdam et al., 2003). These contaminants are taken up into plants and animals and bioaccumulate through the food chain into Indigenous Peoples' traditional food sources (Assembly of First Nations, 2007; Braune et al., 1999; Lehnherr, 2014). For example, mercury contaminants, which originate from volcanic sources, fossil fuels, and mining (United States Environmental Protection Agency, 2020), are

generally found in freshwater fish and marine animals (Assembly of First Nations, 2007; Chan et al., 2019). Due to the nature of the food chain, methylmercury, the most toxic form of mercury, is created by bacteria, as a by-product of cellular respiration in the sediment of bodies of water and taken up by zooplankton, fish, and marine animals (Winner, 2010). Terrestrial animals, such as moose, are primarily affected by cadmium contamination, which comes from coal-fired power plants, mining, and fertilizers (Assembly of First Nations, 2007; Chan et al., 2019; Manitoba Health and Senior Care, 2010). On the other hand, hunting supplies such as lead bullets can leave residual contaminants in meats. A program to phase out lead bullets has been recommended for consideration (Chan et al., 2019; Krüemmel & Gilman, 2016). Such a program would align with the phase-out of leaded gasoline and the removal of lead from water pipes and paint due to lead's adverse health effects.

Indigenous Peoples can be at increased risk of exposure to high levels of contaminants owing to the high proportion of traditional food that may make up their diet (Van Oostdam et al., 2005). Studies of the human health effects of contaminants reveal possible negative outcomes such as decreased birth size, adverse impacts on Indigenous babies' immune systems, and compromised neurodevelopment in children (Mergler et al., 2007; Van Oostdam et al., 2005). However, micronutrients, such as the vitamins, minerals, and fatty acids found in traditional foods like seafood, may indicate the possibility of mitigating, preventing or reducing adverse events from contaminant consumption (Van Oostdam et al., 2005). For example, Dewailly et al. (2001) found that long-chain fatty acids in fish and marine animals may have a protective role against cardiovascular disease. Beluga, narwhal skin, and ringed seal liver provide high levels of the

element selenium, which may be beneficial in mitigating methylmercury toxicity (Ayotte et al., 2011; Van Oostdam et al., 2005).

Most Indigenous Peoples who often eat traditional food are concerned about contaminants yet have not changed their eating habits (Friendship & Furgal, 2010). This inertia may be attributed to their high levels of trust in their traditional knowledge and their learnt capacity to assess the safety of traditional food based on its appearance, taste, and feeling, despite Western claims that contaminants in food are undetectable (Friendship & Furgal, 2012). Indigenous Peoples also consider how the time of year and geographical location of the animal inform the safety of its consumption (Friendship & Furgal, 2010). If the animal's behaviour appears off or seems sick, Indigenous Peoples see the entire animal as unsafe to eat (Friendship & Furgal, 2010).

2.6 Risk communication of contaminants in traditional food

Risk communication is information provided by health experts to a targeted population to inform decision-making to mitigate potential threats to health (World Health Organization, 2021). Information is commonly disseminated in a one-way, 'information-out' approach or as an interactive dialogue between the experts and targeted population, the latter being preferred as it allows for questions and answers, feedback, and clarity (Driedger, Cooper, Jardine, Furgal, & Bartlett, 2013; Furgal et al., 2005; Gamhewage, 2014a; Krüemmel & Gilman, 2016). Current media for risk communication include radio and television broadcasts, newspapers, brochures, community posters, community meetings, and, more recently, the Internet and social media (Arctic Monitoring Assessment Program, 2015; Henri et al., 2020). Risk communication should be appropriate to a population's social and cultural structure (Krüemmel & Gilman, 2016).

Communicating risk to Indigenous Peoples is challenging because it requires understanding the impacted populations' worldviews and a great deal of trust (Arctic Monitoring Assessment Program, 2015; World Health Organization, 2021). Elders are the best Indigenous sources of information about risk and food safety since they hold the highest level of trust, knowledge, and credibility within communities (Friendship & Furgal, 2010). Messages about contaminants in traditional food may be disregarded if they come from outsiders, especially from governing bodies due to the longstanding historical oppression of Indigenous Peoples. The claim that contaminants cannot usually be seen or detected by human senses increases the challenges for risk communicators (Friendship & Furgal, 2012; O'Neil, Elias, & Yassi, 1997). Further, there are no similar words or terms for 'contaminant' in Indigenous languages such as Inuktitut (Leiss & Powell, 2004). The closest terms for 'contaminant' in Inuktitut translate in English to "something that can ruin or spoil" and "the consequence of something dangerous" (Myers & Furgal, 2006).

Communicating risk about contaminants in traditional food to Indigenous Peoples is a delicate act of balancing the risk-benefit ratio and/or providing a safe alternative. Not meeting these needs may cause more harm than good (Donaldson et al., 2010). Past risk communication strategies only focused on the negatives, leaving communities confused and fearful. People ceased consuming traditional foods (Krüemmel & Gilman, 2016; Usher et al., 1995) that supported their physical, mental, spiritual, emotional, economic, and sociocultural health. Messages about environmental contaminants should not downplay the benefits of traditional food consumption, rather there should be a balancing of the adverse effects of contaminant consumption in traditional foods and include alternative species that are safe for consumption to

mitigate exposure (Chan et al., 2019; Laird, Goncharov, Egeland, & Chan, 2013). For example, women of childbearing age in northern Canada would benefit most from targeted risk communication of the potential effects of contaminants on fetal and child development (Boyd & Furgal, 2019; Chan et al., 2019).

For risk communication to be effective with Indigenous Peoples, it is suggested that communication align with Indigenous Peoples' worldviews, come from trusted sources, and involve Indigenous Peoples in developing and distributing messages (Boyd & Furgal, 2019; Cummings, 2014; Driedger et al., 2013; Friendship & Furgal, 2012; Little et al., 2020). In northern Canadian, each region has its own Regional Contaminant Committee with different memberships and Indigenous Research Advisors for developing and disseminating risk communications to communities (Krüemmel & de Leon, 2017). However, even these committees have their challenges. In Nunavik, lead bullets for hunting were contaminating game meat (Krüemmel & Gilman, 2016). In 1999, The Nunavik Regional Board of Health and Social Services responded by recommending the removal of lead bullets and replacing them with alternatives such as steel (Krüemmel & de Leon, 2017). To raise awareness and limit lead exposure from hunting activities, the Regional Coalition for the Banning of Lead Shots in Nunavik communicated to communities through radio broadcasts, written publications, posters, and pamphlets in three different languages (Kafarowski, 2006; Krüemmel & de Leon, 2017). Still, communication reached a limited number of people. Between 2004 and 2005, 69% of Indigenous hunter respondents to a survey were unaware of the ban on lead shots, and the messaging effectiveness has yet to be assessed (Kafarowski, 2006; Krüemmel & de Leon, 2017).

In 2019, the recommendation of phasing out lead bullet use was still encouraged (Chan et al., 2019).

From 2007 to 2008, 25 Nunavut communities took part in the Inuit Health Survey to learn about health information in the region, including contaminants in traditional food (Chan, 2012). They discovered that the benefits of eating traditional food outweighed the risks, but women of childbearing age should avoid ringed seals because of high mercury levels (Chan, 2012). Following the Survey, the communication about contaminants in traditional food was assessed with 1,000 people from three communities within Nunavut (Furgal et al., 2014). Results from the assessment found that less than half the participants had heard messages about contaminants in traditional foods, but those that had heard them agreed with the messages (Furgal et al., 2014).

Complicating these difficulties of communicating risk information about contaminants in the North are other barriers such as language and the ways of knowing and doing in northern communities (Furgal et al., 2005). Indigenous Peoples employ their traditional knowledge within their world, acquired through lifetimes of observations and experiences passed down from generation to generation through oral teachings (Gadgil, Berkes, & Folke, 1993). Work that has involved contaminants in the North has focused mainly on identifying ways to inform communities for health protection (Krüemmel & Gilman, 2016). There has not been a dedicated effort to provide Indigenous Peoples in northern Canada an opportunity to lead contaminant research and knowledge translation, which would likely support risk communication occurring in a method more in line with traditional knowledge. Hence, the best risk communication practices with Indigenous communities of northern Canada are currently unknown (Boyd & Furgal, 2019).

2.6.1 International risk communication

There is a need for risk communication about contaminants in the traditional foods of Indigenous populations around the world. However, these messages need customizing to specific populations, regions, countries, and communities, rather than taking a one-size-fits-all approach (Boyd & Furgal, 2019) through means such as the media and Internet by persons in a similar situation. Findings from different environments can foster inappropriate alarms when they do not apply to another group or population (Arctic Monitoring Assessment Program, 2015; Krüemmel & Gilman, 2016). An example is described in the 2017 Northern Contaminants Program Canadian Arctic Contaminants Assessment Report. In brief, a Faroe Islands study presented recommendations at a conference for people in the archipelago to avoid pilot whale consumption (Arctic Monitoring Assessment Program, 2015; Krüemmel & de Leon, 2017). An Arctic newspaper misreported the recommendations and extrapolated their application to other areas in the Arctic, such as Canada. This behaviour caused concerns in Indigenous organizations that Indigenous Peoples might fear eating their traditional foods (Krüemmel & de Leon, 2017). Thus, to limit confusion from non-local messaging, constant communication with specific local populations is needed to strengthen local messages' legitimacy (Arctic Monitoring Assessment Program, 2015).

2.7 Rationale for systematic review

Numerous studies have investigated Indigenous Peoples' food systems, dietary changes, and contaminants in traditional foods (Braune et al., 1999; Chan, 2012; Chan et al., 2019; Kuhnlein & Receveur, 1996; Kuhnlein, Receveur, & Chan, 2001). However, few studies have focused on

communicating the risks of consuming contaminated traditional food in northern Canada to Indigenous Peoples. Even fewer have reviewed the literature on this topic in a systematic manner.

For example, McAuley and Knopper (2011) reviewed the impacts of risk communication of contaminants in traditional food on compliance, dietary changes, and loss of confidence in using traditional foods. The risk communication recommendations were most effective when Indigenous researchers and community members co-developed them. However, moving away from a traditional Indigenous diet and towards a more Western diet could squander sociocultural and nutrient-rich advantages of consuming traditional foods. Therefore, believing that traditional food benefits outweigh the risks, many northern individuals and communities disregarded the messages. This finding highlighted the need for risk communication recommendations to include the dangers and the benefits and/or a safe alternative. McAuley and Knopper (2011) acknowledged not producing a formal, comprehensive systematic review, likely omitting relevant studies.

In contrast, Boyd and Furgal (2019) completed a systematic review about the communication of environmental health risks with Indigenous Peoples globally. Their findings describe how to effectively design, develop, and disseminate environmental health risks with Indigenous populations. However, they did not focus solely on Canada's northern communities or contaminants found in traditional food. Both studies (Boyd & Furgal, 2019; McAuley and Knopper, 2011) discourage viewing risk communication from a one-size-fits-all perspective.

Messages need to be designed, developed, and disseminated differently for different regions and populations (Arctic Monitoring Assessment Program, 2015).

A systematic review by Little et al. (2020) explored dietary changes among Inuit in Canada. Although these authors concurred with Boyd and Furgal's (2019) recommendation to involve Indigenous Peoples in risk communication, their main aim was to understand the drivers of Indigenous People transitioning from a traditional diet to a Westernized diet. Risk assessment and communication were not part of their search strategy. Furgal, Powell, and Myers (2005) described case studies on risk communication of contaminants in traditional food and its outcomes, but not exhaustively. Krüemmel and Gilman (2016) reviewed current risk communication in the Arctic (including regions outside Canada), but was not systematically executed.

Thus, many current studies on environmental contaminants in traditional food in the Arctic do not provide how their results are communicated with Indigenous communities and even fewer concentrate on risk communication as the central focus. Previous literature reviews related to this topic are neither risk communication specific nor systematically undertaken.

2.8 Aims and Objectives

The overarching aim of this systematic review is to explore the current practices of risk communication about contaminants in the traditional food systems of Indigenous Peoples in the North of Canada. The purpose here is to describe what factors to consider when designing risk

communication messages. The study objective is to meet these research aims through conducting a systematic review and thematic analysis of relevant peer-reviewed literature.

3 METHODS

3.1 Study design

This systematic review of the peer-reviewed literature was designed, conducted, and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009) (Appendix III - 8.3). RF was the primary and principal reviewer, and KZ was the second reviewer. They independently conducted the title and abstract screening, full-text screening, and data extraction. If discrepancies arose, they resolved them through discussion to reach a consensus. Ethical approval was not applicable because this study is a systematic review containing secondary data from published peer-reviewed articles.

3.2 Search strategy

Systematic reviews by Boyd and Furgal (2019) and Little et al. (2020) informed the search strategy, such as the umbrella concepts for search terms. Additional search terms were pragmatically selected through consultation with a toxicologist in this field, who is also familiar with risk communication (JG), and a researcher with an educational background in neuroscience, family medicine, and Indigenous Peoples' health and wellbeing (RF). The final search terms were determined by consensus. RF and JG combined the subject headings and keywords listed below according to the requirements for each database.

Contaminant search terms included: contaminant, toxin, chemical, pollutant, poison, carcinogen, persistent organic pollutants, POPs, pesticide, dichlorodiphenyltrichloroethane, DDT,

dichlorodiphenyldichloroethylene, DDE, polychlorinated biphenyls, PCBs, hexachlorobenzene, HCB, polybrominated diphenyl ethers, PBDEs, dioxins, furans, toxaphene, heavy metals, mercury, Hg, lead, Pb, cadmium, Cd, arsenic, As, methylmercury, MeHg, Selenium, Se, per- and polyfluorinated alkyl substances, PFAS, and perfluorinated compounds, PFCs.

Search terms for traditional food included: traditional food, country food, subsistence, sustenance, nourishment, nutrition, nutrient, diet, energy, minerals, vitamins, fatty acid, protein, harvest, hunt, fish, gather, land animals, wild game, bison, buffalo, moose, caribou, elk, deer, muskox, bear, polar bear, porcupine, lynx, pig, rabbit, squirrel, beaver, fox, badger, muskrat, otter, sheep, birds, goose, grouse, ptarmigan, duck, mallard, wigeon, swan, pheasant, turkey, oldsquaw, canvasback, pintail, eagle, falcon, hawk, owl, loon, pelican, plants, fruits, vegetables, berries, blueberry, cranberry, raspberry, strawberry, knuckle berries, cloud berries, saskatoon berries, gooseberries, blackberries, currants, rosehip, rat root, Labrador tea, peppermint, mushroom, greens, onion, rhubarb, fiddlehead, beans, corn, squash, carrots, spruce gum, freshwater animals, pickerel, walleye cat fish, red sucker, minnow, perch, pike, jackfish, loche, burbot, trout, grayling, bluefish, whitefish, inconnu, herring, cisco, marine animals, artic char, seal, narwhal, whale, beluga, walrus, bones, organs, head, fish-pipe, skin, ribs, tongue, liver, kidneys, bone marrow, heart, stomach, brain, fat, blubber, eggs, gizzard, blood, cooking method, cooked, fried, roasted, baked, smoked, raw, boiled, soup, dried, fresh, frozen, camp fire, bottle, jam, ferment, igunaq, muktuk, mattak, maktaq, muktaaq, maktaaq, maktak, aalu, misiraq, nirukkaq, akutaq, and suaasat.

Communication search terms included: communication, message, advisory, advertise, information, dissemination, media, tv, radio, Internet, social media, Facebook, Instagram, SnapChat, TikTok, newspapers, posters, pamphlet, flyer, stories, teachings, meetings, word-of-mouth, and language.

Indigenous search terms included: Indigenous, Aboriginal, First Nation, First People, Indigenous Peoples, Aboriginal Peoples of Canada, Inuk, Inuit, Cree, Dene, Indian, Eskimo, Natives, elder, and knowledge keepers.

Geographic area search terms included: Circumpolar, northern Canada, Arctic Canada, 60th parallel north, Inuit Nunangat, Yukon, North West Territories, Inuvialuit Settlement Region, Nunavut, Nunavik, Baffin Island, Labrador, Nunatsiavut, and NunatuKavut.

This thorough search strategy and protocol were designed, approved, and executed with a librarian from the Department of Family Medicine at McGill University. The same search terms were entered into PubMed, Web of Science, and Scopus using Boolean operators 'AND' and 'OR', along with right truncation from the date of inception up to September 23, 2021. Circumpolar Health Bibliographic Database was also explored, but a simple concept search was deployed due to the database's limited advanced search capabilities, only allowing up to 512 characters. Following further consultation with the librarian, umbrella concepts of 'contaminants,' 'food,' 'communication,' and 'Aboriginal' were pragmatically entered together in the 'Any of these words in the Title or Abstracts' field. The 'People' field was set to 'Native peoples,' and the 'Geographic Region' was set to 'G081 – Canadian Arctic in General' to

retrieve as many relevant records as possible. The target population was combined with 'AND' and searched in all fields. Supplementary searches were conducted to widen the search scope, including hand and electronic searches of reference sections of relevant articles and searches through Google and McGill University's library catalogue. Once studies meeting the *a priori* inclusion criteria were identified, a thorough review of their references was conducted to search for any additional studies that might have been missed in the first-level searches.

3.3 Inclusion criteria

3.3.1 Types of studies

Primary peer-reviewed, full-length studies of any study design (qualitative studies, quantitative studies, cohort studies, cross-sectional studies, case-control studies, and control trials) were included except for comments, books, book reviews, conference abstracts, proceedings, as to ensure that only articles that have gone through the rigorous peer review and editorial process. Reviews and reviews with meta-analyses were also excluded as they do not provide primary data. No date restriction was applied for the searches, rather the date restriction rested upon the inception date of each database up until September 23, 2021. Articles were limited to those reported in the English language.

3.3.2 Types of outcomes

Included studies had a primary or secondary focus on the risk communication of contaminants in traditional food in communities in the geographical areas in the North, such as Yukon, Northwest

Territories, Inuvialuit Settlement Region, Nunavut, Nunavik, Baffin Island, Labrador, Nunatsiavut, and NunatuKavut.

3.4 Data collection and analysis

3.4.1 Selection of sources of evidence

Using the Rayyan online platform (rayyan.ai) (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016), RF and KZ independently screened the titles and abstracts of all studies retrieved from each database. This platform allowed blinding the two reviewers to select studies after agreeing to include or exclude a study. The reason for excluding studies was recorded by each reviewer separately and kept for later review. Both reviewers were blinded from one another's appraisal process and decision making. They resolved discrepancies on the inclusion or exclusion of individual studies through a conversation until agreement was met. Rayyan was also chosen because it allowed the reviewers to identify duplicate articles. Potentially eligible studies had their full texts retrieved and assessed against the predefined inclusion criteria.

3.4.2 Quality appraisal

The reviewers (RF and KZ) assessed and evaluated each of the included articles independently using the Quality Assessment for Diverse Studies (QuADS) (Harrison, Jones, Gardner, & Lawton, 2021). The QuADS was applied for two reasons. The first was that it was useful to address heterogeneity amongst the studies meeting this systematic review's inclusion criteria. The second was QuADS' specific design and suitability to appraise the study quality of multi- and/or mixed-method study designs within systematic reviews (Harrison et al., 2021).

The 13 items of the QuADS are: 1) theoretical or conceptual underpinning to the research; 2) a statement of research aim/s; 3) a clear description of the research setting and target population; 4) a study design appropriate to address the stated research aim/s; 5) appropriate sampling to address the research aim/s; 6) a rationale for choosing the data collection tool/s; 7) a data collection tool appropriate in format and content to address the stated research aim/s; 8) a description of data collection procedure; 9) recruitment of data provided; 10) a justification for analytic methods selected; 11) a method of analysis appropriate to answer the research aim/s; 12) evidence that the research stakeholders have been considered in the design or conduct of the research; 13) and strengths and limitations critically discussed. Each item was scored on a four-point Likert-scale (0-3). The maximum total score was 39, with higher scores indicating better study quality. Consensus was reached by discussing any item where there was a discrepancy between the reviewers' evaluations.

3.4.3 Data charting process, data items, and reporting

The reviewers created a data charting form in Microsoft Excel, and data items were determined. RF independently extracted, and KZ checked all pertinent data from the eligible studies into an *a priori* standardized table piloted ahead of time. When differences in the extracted data emerged, reviewers talked about them, and when necessary, JG, who was not involved in data extraction, served as a mediator. The following data items were included in the data charting:

- First Author, year of publication;
- Study design, region, community, contaminant type, sample size;
- Participant information, community role, sex/gender;

- Description of the risk communication method and how/if they were measured, the language of communication (i.e., English, Inuktitut, or French); and
- Study main objectives and key findings

RF and KZ independently read each article applying qualitative, exploratory, inductive analysis to organize and summarize the findings thematically (Braun & Clarke, 2006) on risk communication delivery practices and factors potentially contributing to the value of risk communication messages. Articles were uploaded into qualitative analysis software NVivo (Version 12). Using this package, RF and KZ thoroughly read each article several times to code text relevant to the research aim. They grouped the codes based on commonalities and patterns among factors enabling risk communication. As much of the research in this field is qualitative, it is common to conduct a qualitative narrative synthesis (Boyd & Furgal, 2019; Lebel et al., 2022).

4 RESULTS

4.1 Selection of sources of evidence

As summarized in Figure 4, databases and hand searching yielded 680 records; 57 duplicates were removed, leaving 623 records for screening. Based on inclusion criteria and titles and abstracts, a further 608 records were excluded, leaving 15 documents for full-text retrieval. Following assessment of their full-text, the two reviewers excluded another 10 records, concluding that five were relevant for data extraction (Boyd, Fredrickson, & Furgal, 2019; Couture et al., 2012; Friendship & Furgal, 2012; Kafarowski, 2006; Myers & Furgal, 2006).

Table 1 summarizes the reasons for excluding the 10 articles (Bocking, 2001; Calder, Bromage, & Sunderland, 2019; Drysdale et al., 2021; Duhaime, Chabot, Fréchette, Robichaud, & Proulx, 2004; Friendship & Furgal, 2010; Laird et al., 2013; Larter & Kandola, 2010; O'Neil et al., 1997; Pufall et al., 2011; Ratelle et al., 2018). Two articles contained ineligible study designs (Bocking, 2001; Ratelle et al., 2018), and eight articles did not specify the delivery, content, or evaluation of the risk communication. Rather these 10 articles mentioned only the concept in a theoretical or general manner (Calder et al., 2019; Drysdale et al., 2021; Duhaime et al., 2004; Friendship & Furgal, 2010; Laird et al., 2013; Larter & Kandola, 2010; O'Neil et al., 1997; Pufall et al., 2011).

The Kappa statistic was used to calculate the weight of agreement between the two reviewers. The value ranges between 0 and 1. Values: less than 0.2 describe poor agreement, between 0.21 and 0.4 indicate fair agreement, from 0.41 to 0.6 show moderate agreement, 0.61-0.8 denote substantial agreement, and 0.81-1 signify almost perfect to perfect agreement (Altman, 1990). The kappa of this study indicated substantial agreement with a weighted coefficient of $\kappa = 0.622$

(95% CI, 0.4617-0.7823). Statistical analysis was performed with SAS version 9.3 (SAS Institute Inc).

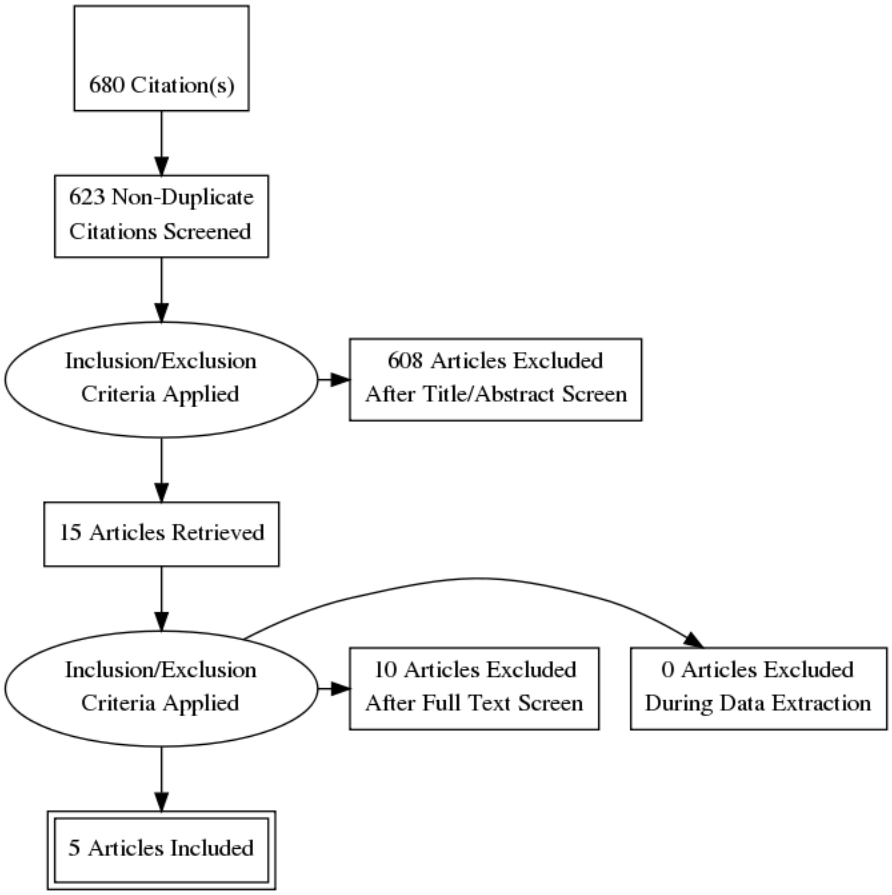

Figure 4 PRISMA flow diagram of literature search

Table 1 Characteristics of excluded studies

Study	**Reason for exclusion**
Bocking (2001)	Wrong study design (review)
Calder et al. (2019)	South of the 60th parallel, no risk communication specifics
Drysdale et al. (2021)	No risk communication specifics
Duhaime et al. (2004)	No risk communication specifics
Friendship & Furgal (2010)	No risk communication specifics
Laird et al. (2013)	No risk communication specifics
Larter and Kandola (2010)	No risk communication specifics
O'Neil et al. (1997)	No risk communication specifics
Pufall et al. (2011)	No risk communication specifics

Ratelle et al. (2018)	Wrong study design (retrospective protocol), no risk communication specifics

4.2 Characteristics of sources of evidence

Table 2 summarizes the descriptive data for each included article. These articles represent the entire Canadian North: Yukon (*n*=1) (Friendship & Furgal, 2012), Northwest Territories (*n*=1) (Boyd et al., 2019), Nunavut (*n*=2) (Boyd et al., 2019; Myers & Furgal, 2006), Nunavik (*n*=2) (Couture et al., 2012; Kafarowski, 2006), and Labrador (*n*=1) (Myers & Furgal, 2006). Two articles described research in more than one geographical location in northern Canada (Boyd et al., 2019; Myers & Furgal, 2006), so the geographical locations are not mutually exclusive.

The five articles describe a range of contaminants in traditional foods. Three articles explored specific elements: mercury (Boyd et al., 2019) and lead (Couture et al., 2012; Kafarowski, 2006). The two remaining articles evaluated environmental contaminants in general, for example, heavy metals, polychlorinated biphenyls, and/or persistent organic pollutants. However, the combination or grouping of contaminants was unspecified (Friendship & Furgal, 2012; Myers & Furgal, 2006).

Even though the search strategy allowed articles to be included from each database's inception, all articles were published in the 21st century, ranging from 2006 to 2019. Heterogenous in design, they included a case study (Kafarowski, 2006), an exploratory qualitative case study (Friendship & Furgal, 2012), and a content analysis (Boyd et al., 2019). Two articles applied cross-sectional designs (Couture et al., 2012; Myers & Furgal, 2006).

Sixty percent of the studies described that study participation were in English and Indigenous languages. Two articles provided participants with the option to complete the study in English or Inuktitut (Kafarowski, 2006; Myers & Furgal, 2006). Another article analyzed English and Indigenous communications without specifying which Indigenous languages (Boyd et al., 2019). Two articles did not state whether participation was possible in Indigenous languages or only in English (Couture et al., 2012; Friendship & Furgal, 2012).

Four of five articles received some type of funding. Two were funded by the Northern Contaminants Program (Boyd et al., 2019; Myers & Furgal, 2006), one by the Northern Scientific Training Program (Friendship & Furgal, 2012) and one from multiple awards and funders (Kafarowski, 2006). The fifth study reported receiving no funding (Couture et al., 2012).

Interestingly, Dr Chris Furgal was a co-author of three of the retained articles. This is not necessarily surprising, as he is an affiliate of the Northern Contaminants Program and contributor to its communication aspects (Government of Canada, 2016). Additionally, he holds an academic appointment at Trent University in the Department of Indigenous Studies, with interests in environmental health risk assessment, management, and communication with Indigenous populations (Trent University, 2021).

There were 2,066 participants across four of the articles included from the northern Canadian communities. One article included 139 male and female Inukjuak residents (Kafarowski, 2006) and another 1,410 adults from the 14 Nunavik communities and 308 children from Puvirnituq, Inukjuak, and Kuujjuaraapik along Nunavik's Hudson coast (Couture et al., 2012). Another

article included 28 Traditional Food Knowledge Holders that were Indigenous hunters, women, and elders from three Yukon First Nation communities: Vuntut Gwitchin First Nation (Old Crow), Tr'onde̲k Hwe̲ch'in (Dawson City), and Champagne and Aishihik First Nations (Haines Junction) (Friendship & Furgal, 2012). Along with these groups, Friendship and Furgal (2012) included 13 Territorial Health and Environment Decision-makers from Whitehorse, Yukon. They were representatives of government and wildlife agencies, public health communicators, Yukon Contaminants Committee members, and key researchers on contaminants in traditional food. Similarly, Myers and Furgal (2006) included 168 elders, hunters, and women of childbearing age from two communities in Nunavut and Labrador each. The two Nunavut communities were Clyde River and Pond Inlet. There were 25 women of childbearing age, seven elders, and 11 Hunters from Clyde River; and 21 women of childbearing age, 12 elders, and nine hunters from Pond Inlet (Myers & Furgal, 2006). The communities included from Labrador were Makkovik and Nain; with seven women of childbearing age, six elders, and 11 hunters from Makkovik; and 26 women of childbearing age, 16 elders, and 17 hunters from Nain. Women, elders, and hunters are often selected for studies involving traditional food as they generally have the most experience and knowledge (Friendship & Furgal, 2012). Hunters are targeted for communication campaigns. Elders are the longest consumers of traditional food and, like hunters, are sources of information about traditional food. At the same time, women tend to make household decisions about food and prepare traditional food (Myers & Furgal, 2006). The fifth article's (Boyd et al., 2019) methodology was a content analysis of newspaper articles describing mercury in traditional foods whose target populations were northerners and southerners of Canada. The newspaper items could be analyzed by geographical region (Boyd et al., 2019), meeting the inclusion criterion of this study. Fifty-eight newspaper articles from eight northern newspapers

(Nunatsiaq News, Northern News Services, NWT News/North, Yellowknifer, Nunavut News/North, Kivalliq News, Deh Cho Drum, and Inuvik News) were analyzed in the paper, published in Inuvik, NT, Fort Simpson, NT, Iqaluit, NU, and Rankin Inlet, NU (Boyd et al., 2019). Table 3 presents article summaries.

Table 2 Characteristics of included studies

Author and date	Study Design	Region	Community	Contaminant Type	Participant and sample size (n)	Funder
Boyd et al., 2019	Content analysis of newspapers	Northwest Territories, Nunavut	Fort Simpson, Inuvik, Yellowknife, Iqaluit, Rankin Inlet	Mercury	N/A – Northern Newspaper articles (58)	Northern Contaminants Program
Couture et al., 2012	Cross-sectional case study of blood lead levels	Nunavik	All 14 communities in Nunavik	Lead	Adults (1,410) and Children (308)	Nil
Friendship & Furgal, 2012	Exploratory qualitative case study	Yukon	Vuntut Gwitchin First Nation, Tr'ondëk Hwëch'in, and Champagne and Aishihik First Nations	General environmental contaminants	Traditional Food Knowledge Holders (28), Health and Environment Decision-Makers (13)	Northern Scientific Training Program
Kafarowski, 2006	Case-study	Nunavik	Inukjuak	Lead	Male and Female residents (139)	Social Science Humanities Research Council, Canadian Federation of University Women Alice E. Wilson Award, the Arctic Institute of North America Grant-in-Aid Program, and the Northern Scientific Training Program
Myers & Furgal, 2006	Cross-sectional survey	Nunavut; Labrador	Clyde River, Pond Inlet; Makkovik, Nain	General environmental contaminants	Elders (41), Hunters (48), Women of childbearing age (79)	Northern Contaminants Program

Table 3 Article summaries

Author and date	Study Objectives	Findings
Boyd et al., 2019	• Assess how northern newspaper articles describe mercury; • Examine tone of articles (optimistic, pessimistic, neutral); and • Identify if articles provide self-efficacy	• Few articles described mercury; • Tone of articles was equally optimistic or pessimistic; • Few Indigenous people were sources of information; and • Few articles provided self-efficacy
Couture et al., 2012	• Describe the banning of lead shots of 1999 in Nunavik; and • Evaluate the joint impact of the regulation of the ban and risk communication of blood lead levels	• Blood sample analyses show that lead levels in the blood decreased significantly from the ban and the risk communication; and • Lead exposure is still higher in Nunavik compared to elsewhere in North America
Friendship & Furgal, 2012	• Understand risk perceptions of Indigenous people about food contaminants; and • Learn how Indigenous knowledge contributes to environmental health risk-benefit management and communication	• Indigenous have established community risk issues, local contexts, and communication strategies in the past; and • Participants emphasized the need for collaborations, partnerships, spending time in the community, and having open dialogue to involve Indigenous knowledge in risk-benefit management and communication
Kafarowski, 2006	• Explore how Indigenous men and women participate in hunting, identify contaminants, and how they identify the lead bullet contaminant subject differently; and • Consider how these two outlooks are significant to developing environmental health policies and programs with regards to contaminants	• Male hunters consider lead bullet contamination to be a hunting issue and regard themselves as best at answering questions about lead bullets; and • Women consider lead bullet contamination an environmental health problem and are interested in solving it

Myers & Furgal, 2006	• To assess how well past communication strategies about contaminants have worked and resident awareness of contaminants	• Information on contaminants has not been widely received; and • Women of childbearing age are the least likely to have understood the messages

4.3 Quality appraisal

The quality appraisal using QuADS of the included articles total ratings ranged between 17 and 34 points. The lowest scores were related to items concerning: critical discussion of strengths and limitations (Couture et al., 2012; Friendship & Furgal, 2012; Kafarowski, 2006; Myers & Furgal, 2006), recruitment data (Couture et al., 2012; Friendship & Furgal, 2012; Kafarowski, 2006), stakeholder involvement (Boyd, Fredrickson, & Furgal, 2019; Couture et al., 2012; Friendship & Furgal, 2012; Kafarowski, 2006), analytical method selection justification (Couture et al., 2012; Kafarowski, 2006), and rationale for choosing data collection tools (Couture et al., 2012; Kafarowski, 2006). This appraisal reflects limitations in the reporting of articles rather than judgement of the article's quality. Article quality was not an inclusion or exclusion criterion for inclusion in this systematic review but is presented in the summary table (Appendix 8.2).

4.4 Risk communication delivery

Risk communication messages were delivered by various means from article to article (Table 4). Two articles described message delivery through a single method (Boyd et al., 2019; Kafarowski, 2006), while the other three articles described various ways (Couture et al., 2012; Friendship & Furgal, 2012; Myers & Furgal, 2006). The most common methods were over the radio (n=2) (Couture et al., 2012; Myers & Furgal, 2006), in newspapers (n=3) (Boyd et al., 2019; Couture et al., 2012; Myers & Furgal, 2006), on posters (n=3) (Couture et al., 2012;

Kafarowski, 2006; Myers & Furgal, 2006), and through workshops (*n*=2) (Friendship & Furgal, 2012; Myers & Furgal, 2006). One article described disseminating information in multiple languages (Myers & Furgal, 2006). One-way communication predominated in this review comprising media including newspapers (*n*=3) (Boyd et al., 2019; Couture et al., 2012; Myers & Furgal, 2006) and posters (*n*=3) (Couture et al., 2012; Kafarowski, 2006; Myers & Furgal, 2006). The most common means of two-way communication were workshops (*n*=2) (Friendship & Furgal, 2012; Myers & Furgal, 2006).

Table 4 Delivery of risk communication messages in northern Canada

Author and Date	**Risk Communication Delivery**	**One- or two-way communication**
Boyd et al., 2019	• Newspaper articles	• One-way
Couture et al., 2012	• Pre-recorded radio public service announcements • Open line radio program with the director of Nunavik Public Health Department and his team broadcasted during prime time to all Nunavik communities • Posters and brochures distributed in public spaces • Articles in periodicals • Information was disseminated in the Makkovik Magazine distributed for free to households in Nunavik, in Le Fil des évènements from Université Laval, in the Bulletin d'Information Sante Environnementale of the Institute National de Sante Publique du Québec, as well as scientific articles and papers • All written information was disseminated in all three official languages of English, French, and Inuktitut	• One-way • Two-way • One-way • One-way • One-way

Friendship & Furgal, 2012	• Open dialogue workshops that allowed for questions and answers • Key people within the community, including hunters, elders, and women	• Two-way • Two-way
Kafarowski, 2006	• Posters	• One-way
Myers & Furgal, 2006	• Radio, television, newspaper stories • Pamphlets and newspaper inserts • Posters and videos • Community meetings with research, government, and health personnel • Workshops for hunters and health officials • Community representatives who will pass on messages	• One-way • One-way • One-way • Two-way • Two-way • Two-way

4.5 Synthesis of results

All five retained articles evaluated risk communication strategies. Most studies' data encapsulated several themes, however, one article's (Couture et al., 2012) data only produced a single theme. The recurrence of themes does not indicate value, neither is recurrence required for themes to be worthwhile (Buetow, 2010). The themes emerging for the factors to consider when developing risk communication messages were: 1) self-efficacy informed by risk perception, 2) trustworthiness, and 3) awareness. Each theme is discussed below.

4.5.1 Self-efficacy informed by risk perception

Within the title of this theme, is the term self-efficacy, which refers to a person's belief in their capacity to carry out behaviors required to produce specific performance attainments (Bandura, 1977; Bandura, Freeman, & Lightsey, 1999). In terms of risk communication, an example of self-efficacy is providing information that describes how people can mitigate their exposure to

contaminants in traditional food through their own actions. People who perceive their self-efficacy to be high, believe in their capacity to attain a goal through their own behaviours (Bandura, 1993).

In four of the five retained articles, the theme self-efficacy emerged (Boyd et al., 2019; Friendship & Furgal, 2012; Kafarowski, 2006). Boyd et al. (2019) reported whether newspaper articles provided direction for self-efficacy and noted that one-third of northern newspaper articles did. The authors highlighted that an example of self-efficacy for contaminants risk mitigation would be to inform people about the risks of eating certain traditional foods, while highlighting the benefits of other traditional foods (Boyd et al., 2019). This approach may include recommending the consumption of smaller parts of animals or specific parts or not to eat certain fish or marine animals (Boyd et al., 2019). The use of Indigenous knowledge is integral to self-efficacy. Friendship and Furgal (2012) described participants using observations, teachings, experiences, and culture to add to their knowledge when determining whether or not something was safe to eat. For example, people referred to the seasons, location, behaviour of the animal at the time of harvest, and the quality of prepared meats, which may or may not align with advisories. This demonstrates people exercising their self-efficacy and applying their own risk perception, informing their judgement to determine if the harvested food is safe to eat. Kafarowski (2006) described how:

> a poster released by the Nunavik Nutrition and Health Committee in 1999, at the time of the ban on using lead shot, demonstrated what lead shot in meat looked like and provided instructions for removing the lead shot and cutting away the meat around it (p. 40).

However, less than 20% of participants in Inukjuak knew about the ban of lead shots and their possible health effects and continued using them because they did not believe the message or were not interested (Kafarowski, 2006). Several factors affect self-efficacy, such as: how communication was framed, the method of dissemination, who disseminated the message, and what resources, language, and jargon were used (Myers & Furgal, 2006). Self-efficacy and risk perception, which are informed by knowledge, are significant aspects that appear to be related.

4.5.2 Trustworthiness

This theme encapsulates trustworthiness, where conceptually trust encompasses a nuanced term that includes the essence of a community's experience of the world that provides good reasons to trust or distrust (Möllering, 2001). Four of the five retained articles reported on trustworthiness (Boyd et al., 2019; Friendship & Furgal, 2012; Kafarowski, 2006; Myers & Furgal, 2006). Who communicates the message was important to the recipient (Myers & Furgal, 2006). Trusted sources of information were described as people with whom the community members had already developed trusting relationships (Friendship & Furgal, 2012). Elders were the most trusted sources of information for Indigenous People in the Yukon (Friendship & Furgal, 2012). Friendship and Furgal (2012) described how, when making food choices, most people listened to elders. Communicators built respectful partnerships with people and communities to be considered trustworthy (Friendship & Furgal, 2012). One participant explained:

> I would begin with a relationship with people and communities and build those relationships. You open those pathways of trust and understanding, and then knowledge will flow back and forth. That seems awfully short and simplistic, but I really think that that is the key (Friendship & Furgal, 2012, p.10).

Trusted sources of information need to be aware of their impact on community behaviour and provide their society with proper information. Furthermore, including Indigenous people in the development and process of messaging was significant for trustworthiness (Friendship & Furgal, 2012). Boyd et al. (2019) described how Indigenous people were rarely quoted in newspaper articles. Through their inclusion, Indigenous voices would provide rich context about contaminants in traditional food for the everyday person. This displays the likely importance of having persons one can relate to, disseminating information about contaminants in traditional foods. Additionally, hunters and trapper organizations should be involved in the dialogue on contaminants (Kafarowski, 2006), as they have the closest connection with the land and its wildlife sources for traditional food. Boyd et al. (2019) advised that newspaper journalists covering contaminants talk to trusted sources about contaminants, such as health professionals, contaminant researchers and scientists, who were quoted in 43 of 58 northern articles. Conversely, Myers and Furgal (2006) described how northern Indigenous people did not trust southern government agents, scientists, and outsiders. This demonstrates the potential variability regarding who Indigenous People of Canada's north consider as 'expert' sources for traditional food information.

4.5.3 Awareness

This theme centers around Indigenous Peoples of Canada's knowledge and understanding of what contaminants are, where they come from, and how they affect people. Four of the five retained articles described awareness regarding contaminants in traditional foods (Boyd et al., 2019; Couture et al., 2012; Kafarowski, 2006; Myers & Furgal, 2006). Of these articles, Myers and Furgal (2006) whose participants were from two different northern regions (two

communities in Nunavut and two communities in Labrador) provide the most extensive description of awareness of contaminants in traditional food. The authors (Myers & Furgal, 2006) reported that most participants in both regions had heard about contaminants in traditional food. Still, based on the Northern Contaminants Program's definition, less than half could define what a contaminant was. Many participants identified visible objects such as garbage, old seal skins on the beach, or rusted metal as contaminants. Furthermore, "sources of contaminants were commonly identified [by participants] as development, the DEW Line, modern technology, air pollution, garbage, consumer goods, and motor vehicles. Noise, tourists, and scientists were also identified, though by fewer respondents (Myers & Furgal, 2006, p. 52)." It seems that the participants demonstrate awareness of contaminants, however, the awareness is limited to items that can be visibly seen. Unfortunately, this excludes contaminants found in traditional food sources.

Few Nunavummiut believed people to have or acquire contaminants, while more Labrador participants thought contaminants might be in people (Myers & Furgal, 2006). Interestingly, most hunters from Nunavut and Labrador responded that there were contaminants in traditional food, whereas many elders and women from the same regions said there were not or did not know if there were contaminants in traditional foods (Myers & Furgal, 2006). Labrador participants were recorded as responding with more certainty about contaminants possibly being in traditional food than did Nunavut respondents (Myers & Furgal, 2006). This demonstrates a difference in awareness of contaminants between regions.

There was almost no recognition that some demographic groups, such as women of childbearing age, should be most aware of contaminants due to the effects on fetal development (Myers & Furgal, 2006). Women of childbearing age showed the least awareness of this issue (Myers & Furgal, 2006). All participants said they ate traditional food, and most said they had not been exposed to contaminants (Myers & Furgal, 2006). Avoidance of certain traditional foods was not because of contaminants but rather taste preferences (Myers & Furgal, 2006). Most Nunavut respondents reported they would not change their diet or the foods they ate because of contaminants (Myers & Furgal, 2006). In contrast, most Labrador participants reported that they would change their diets or behaviours because of contaminants (Myers & Furgal, 2006).

A barrier to awareness of contaminants is described by Boyd et al. (2019). They noted that articles in northern newpapers had a lack of description or definition of contaminants (Boyd et al., 2019). Mercury in particular was not described, which might have contributed to peoples' lack of awareness. The authors (Boyd et al., 2019) recommended that journalists explain what contaminants are, who is most at risk from them, and what traditional food alternatives are available. Providing this additional information on contaminants in local/regional newspaper articles may support facilitating awareness to members of the community, who read the newspaper.

In 1992, adult Inuit representing the 14 communities of Nunavik had blood lead levels measured with follow-up in 2004 (Couture et al., 2012). Between these years a ban on lead bullets occurred in 1999, and a decrease in blood lead levels was measured at the 2004 timepoint (Couture et al., 2012). Based on the results, it appears that Nunavik heard and were aware of the messaging of

the significant negative health effects of lead shots (Couture et al., 2012), however causality cannot be determined. When surveyed, Kafarowski (2006) found that 69% of hunters in Inukjuak, one of the 14 communities in Nunavik, were not aware of the ban on lead shots. These results appear to demonstrate that hunters in Inukjuak were not aware of the communication about the ban of lead shots.

5 DISCUSSION

5.1 Summary of evidence

This systematic review explored the literature on risk communication deliveries of environmental contaminants in Indigenous traditional foods in northern Canada. It has also described what factors to consider in designing risk communication messages. This study has revealed that while there is plenty of literature about contaminants in the North, including their accumulation in traditional food, there is a relative dearth of literature about risk communication to northern Indigenous Peoples about contaminants in their traditional food. Five studies met the inclusion criteria for this review covering 2,066 participants across northern Canada. These participants are representative of each province and territory in the North. This review described predominantly one-way communication through traditional print media, including newspapers and posters. These studies yielded the following themes: self-efficacy informed by risk perception, trustworthiness, and awareness about contaminants in traditional food.

The type of contaminant focused on in each article varied. Three articles explored communication about specific contaminants, while two focused on contaminants in general. No difference was detected in the mode of risk communication across the different contaminants. For example, Couture et al. (2012) discussed using the radio, posters, brochures, and written articles to communicate the risk of using lead bullets for hunting, while Myers and Furgal (2006) described previous communications employing the same or similar techniques.

Findings from this review found that print media (posters [*n*=3]; newspapers [*n*=3]) was the most common means of risk communication. Similarly, another review found that written

communication is the most prevalent medium for risk communication, despite the top choices of the public being the radio, television or hearing and discussing the information with a neighbour (Gamhewage, 2014a). These findings could reflect peoples' lack of trust in hearing directly from authorities and health experts (Gamhewage, 2014a). Print media of risk communication demonstrates the use of one-way communication methods, and by its design it provides unidirectional flow of information. From the studies included in this review, oral dissemination (radio [*n*=2]; workshops [*n*=2]) was the second most common approach to sharing risk communication. Oral dissemination through two-way communication enables encoding, transmission, and decoding of information (Bennett, Calman, Curtis, & Fischbacher-Smith, 2010), highlighting the importance of relationship cultivation and interactions to build trust and shared perspectives (Friendship & Furgal, 2012). Orally sharing information through two-way communication, such as workshops, aligns with Indigenous story-telling to pass on knowledge (Gadgil, Berkes, & Folke, 1993; Hausknecht, Freeman, Martin, Nash, & Skinner, 2021). This fosters engagement on the topic with the communicator and recipient, as both parties are activity engaged in the process.

Technological advances have begun to transform one- and two-way communication. Although risk communication is delivered through various means, social media is absent as a dissemination approach in this study. Included articles were published between 2006 and 2019, that is since the inception of popular social media websites and applications such as Facebook (2004), YouTube (2005), Reddit (2005), Twitter (2006), Instagram (2010), Snapchat (2011), and TikTok (2016). Also, during this period, there was significant uptake of mainstream virtual face-to-face communication platforms, such as Skype (2003), FaceTime (2010), and Zoom

(2012). In northern Canada, the Internet is available through wired, 3/4/5G, and/or satellite connections, however connectivity is poor, and the price in remote areas is costly (Intahchomphoo, 2018). Nevertheless, Indigenous communities are interested in developing their infrastructure to close this digital divide and establish a platform for digital self-determination (McMahon, 2014). Accordingly, the Indigenous Peoples of Canada are on the Internet. Social media and virtual face-to-face platforms can disseminate up-to-date one- and two-way communication.

Other than the one article analyzing newspaper article contents (Boyd et al., 2019), the remaining articles (Couture et al., 2012; Friendship & Furgal, 2012; Kafarowski, 2006; Myers & Furgal, 2006) include participants varying from adults and children to elders, traditional knowledge holders, women of childbearing age, and environmental decision-makers. This diversity increases the likelihood that the review findings are transferrable to similar research settings.

5.2 Themes

The qualitative analysis suggested what and who to include in the design, development, and delivery of risk communication about environmental contaminants in traditional food to northern Indigenous Peoples of Canada.

5.2.1 Self-efficacy informed by risk perception

Risk perception and self-efficacy appear to intertwine. Indigenous hunters use traditional knowledge when judging whether an animal is safe to consume or not (Friendship & Furgal, 2012; Kafarowski, 2006). The correlation between knowledge and behaviour is typically greater

among people with high self-efficacy (Rimal, 2000). It is plausible that Indigenous People have high self-efficacy, as traditional knowledge is passed down from generation to generation (Gadgil, Berkes, & Folke, 1993) and can be utilized, especially when harvesting and hunting traditional foods. This may guide their perspective, constructs, and worldviews and influence on their risk perception. Rimal (2001) identified four types of behaviours regarding risk perception and self-efficacy. When the perceived risk is low, and self-efficacy is low, peoples' attitudes are indifferent; when perceived risk is low, and self-efficacy is high people take a proactive attitude; when risk perception is high and peoples' self-efficacy is low, people demonstrate avoidance behaviour; and when risk perception is high, and self-efficacy is high people take a responsive attitude (Rimal, 2001). Three of four behaviours – responsive, avoidance, and proactive (Rimal, 2001) – are demonstrated in this systematic review, leaving indifference as an absent behaviour. If an animal behaves strangely and the hunter is unsure of its behaviour, the hunter will not take it. This displays responsive behaviour, including owing to Indigenous Peoples worldview deeming the whole animal unsafe to eat (Friendship & Furgal, 2010; Rimal, 2001). The use of lead shots was banned in Nunavik in 1999 because of the high risk of lead exposure when consuming game meat (Kafarowski, 2006). Just under 20% of hunters said they had heard of the ban but continued to use lead shots stating they either did not believe the messages about lead contamination or did not care (Kafarowski, 2006). According to Rimal (2001), these hunters are using avoidance behaviour. The risk communication in Nunavik regarding lead shot covered what lead shot in meat looks like, how to remove the bullet, and how to cut around the entry site. It empowered peoples' self-efficacy to behave proactively and continue enjoying their traditional foods (Kafarowski, 2006; Rimal, 2001). Two-thirds of these behaviours, responsive and proactive versus avoidance, use a high level of self-efficacy. Boyd et al. (2019) recommended

that journalists include self-efficacy of mitigation strategies within their newspaper articles, such as recommending alternative species for consumption to avoid exposure of contaminants to help their readership reduce their risk (Rimal & Real, 2003). There is likely significant importance as highlighted by Boyd et al. (2019) attached to traditional food mitigation options. The mitigation options connect directly to psychological aspects, indicating that self-efficacy is a central factor, directly and indirectly influencing health behaviour (Wöhlke, Schaper, & Schicktanz, 2019).

5.2.2 Trustworthiness

Trust plays an important role in risk communication uptake, as described in the literature (Covello, 2003; Slovic, 1986), as well as within the results of this systematic review. The findings of this systematic review indicate that northern Indigenous Peoples have low trust in scientists and government officials who communicate about contaminants in traditional foods (Myers & Furgal, 2006). Owing to the lack of sensory (sight, smell, feel, and taste) characteristics of contaminants in traditional food, knowledge of prior personal experience with this risk is difficult to identify, which is coupled with the general lack of trustworthiness toward government authorities (Wachinger, Renn, Begg, & Kuhlicke, 2013). These are critical elements for shaping risk perception (Wachinger et al., 2013). A study in two communities in Labrador and two communities in Northwest Territories found similar findings, low trust in researchers and public servants (Jardine & Furgal, 2007). All four communities reported government officials as poor sources of health information (Jardine & Furgal, 2007). Indigenous Peoples' view health professionals, scientists, and government agencies as untrustworthy because of past negative experiences involving difficult-to-ignore discrimination, colonization, disempowerment, and assimilation (Horrill, McMillan, Schultz, & Thompson, 2018). In contrast,

elders are a highly trusted source of information, despite not being a main health communicator (Jardine & Furgal, 2007). Friendship and Furgal (2012) similarly found that most people listen to elders' knowledge. Indigenous People pay more attention to/are engaged with communication that is delivered by their own credible sources. Jardine and Furgal (2007) described the importance of relationship building for effective communication, demonstrating the importance of the content messaging and who was involved in its design and delivery. They highlighted the need to include the affected audience at every step (Boyd & Furgal, 2019). Without solid relationships, northern Indigenous communities will not trust information from southern researchers, which affects their uptake of new information (O'Neil et al., 1997; Usher et al., 1995). Conversely, Boyd et al. (2019) recommended northern newspaper journalists speak with health professionals and scientists without mentioning if Indigenous Peoples trust them. Thereby, demonstrating variability of who is best suited to sharing risk communication messaging to communities. Also, trust between the expert and the public is built through open two-way communication that goes beyond the risk communication messaging (Fischbacher-Smith, Irwin, & Fischbacher-Smith, 2010), and this would not solely be feasible through having expert opinion in northern newspapers. Health professionals, scientists, and government agencies should be aware of these obstacles, as well as recognize how these barriers limit their ability to successfully disseminate risk communication about contaminants in traditional food. A possible means to ameliorate this is by working with the communities, especially elders, to build trusting partnerships that support Indigenous perceptions and worldviews. This has the capacity to have positive impact on the sharing of information on contaminants in traditional food, as well as create social connectedness within the community. Partnerships are viewed by many as the foundation for effective risk communication (Gamhewage, 2014b). Even though contaminants in

traditional food in northern Canada are not yet a public health emergency, the findings from this theme align with the World Health Organization's guide to "Identify people that the community trusts and build relationships with them. Involve them in decision-making to ensure interventions are collaborative, contextually appropriate and that communication is community-owned (World Health Organization, 2017, p.xiii)." Trust is a significant aspect, as higher levels are associated with communication behaviours such as transparency, sharing of uncertainty, having meaningful engagement involving input from the public, timely sharing of easily understandable communication disseminated through many means, which is consistent and connects to self-efficacy (World Health Organization, 2017). This advice from the World Health Organization is significant for risk communication on contaminants in traditional food for northern Indigenous People, as this approach will foster effective risk reduction by supporting the inclusion of sociocultural aspects of risk perceptions.

Indigenous People of northern Canada view elders, friends, and family as trusted sources for risk communication messaging (Jardine & Furgal, 2007; Myers & Furgal, 2006). It is probable that this provides initial insight of the preferred means of risk communication dissemination. Common characteristics that elders, friends and family have are the ability to engage in conversations (two-way communication) and a trusting partnership is already established between the parties. Northern Indigenous People deemed friends and family as trusted sources of information suggests that they have significant influence of one's perception of risk (Slovic, 1987).

5.2.3 Awareness

While the correlation between contaminants in traditional foods and negative health effects is well studied (Van Oostdam et al., 2005), this systematic review suggests that awareness is lacking in communities of northern Indigenous Peoples of Canada. One potential reason for the lack of awareness about contaminants in traditional food is that contaminants cannot be detected using sensory methods (Friendship & Furgal, 2012). That is, contaminants are odourless, tasteless, and for the most part, invisible. This belief goes against Indigenous traditional knowledge obtained through observations and passed down from generation to generation (Gadgil et al., 1993). Therefore, it is unsurprising that participants described objects such as rusted metals and abandoned seal skins on the beach as contaminants (Myers & Furgal, 2006). These physical objects can be recognized as garbage and implicitly as contaminants when they are not. Participants of another study suggested that health professionals provide northerners with microscopes and teach them how to view hazards in the hunted game (O'Neil, Elias, & Yassi, 1996). The inability to see, taste, and smell contaminants, strengthens Boyd et al.'s (2019) recommendations that risk communication messages describe what contaminants are, who is at risk from them, and what traditional food alternatives are available. Indigenous Peoples' awareness of contaminants is likely influenced by their worldview, perceptions, and constructs. Further, sociocultural context forms the way they perceive and respond to risk (Slovic, 1987) encompassing attitudes, morals, and beliefs (Bennett et al., 2010), which are guided by generations of Indigenous traditional knowledge.

A significant aspect of risk communication is how the public perceives the messaging. Past risk communication about contaminants in traditional food has led to fear and confusion (Kinloch,

Kuhnlein, & Muir, 1992; Usher et al., 1995), which may still be an issue with Indigenous communities in northern Canada. Messages can be contradictory. For example, the communication informs people of the health risks associated with consuming contaminated meat yet reminds them their traditional foods are healthy and socially, culturally, spiritually, and economically beneficial (Furgal et al., 2005). It is no wonder that people listen to the latter rather than the former, especially when they misunderstand the problem (Kuhnlein & Chan, 2000), reinforcing the need to describe what contaminants are (Boyd et al., 2019). Furthermore, risk communicators are better at getting the message across when they facilitate a two-way communication process, which allows for a question-and-answer period to clarify issues, rather than a one-way, top-down 'information-out' approach to risk communication (Furgal et al., 2005; Guan, Bao, Liu, & Raymond, 2021).

Myers and Furgal (2006) found that Nunavut participants said they would likely not change their diet behaviours based on contaminants, but those in Labrador would. The authors noted that this might be due to Nunavut's more extended history of dealing with the issue, along with research activity on health and the environment (Myers & Furgal, 2006). It has recently been found that chronic exposure to environmental contaminants links to psychological trauma (Sullivan et al., 2021). Barraged with health messaging about how their food is poisoned yet still suitable for them, the Nunavummiut appear to be apathetic toward messages about contaminants altogether. For a woman of childbearing age, the least knowledgeable demographic on the contaminant subject in Nunavut (Myers & Furgal, 2006), this behaviour is problematic because of the known developmental effects of contaminants on the growing fetus and young children.

5.3 Comparison with literature

The findings of this systematic review are in line with similar reviews. Boyd and Furgal (2019) reported similar factors to consider when developing risk communication messages, such as disseminating messages through trusted spokespeople and that messages are understandable so people are aware of the risk. Their review looked at Indigenous populations across the globe (Boyd & Furgal, 2019), indicating similar Indigenous worldviews and knowledge despite geographical location. Another review reported how messages were most effective when the community was involved in the process, but messages warning about traditional food safety led to cultural loss because of the disturbance of nutritional, social, economic, and psychological lifestyles (McAuley & Knopper, 2011). Similar to this review, the authors (McAuley & Knopper, 2011) also found that northern communities have decided to ignore the messages despite hearing and understanding risk communication about contaminants in traditional foods. They keep living a traditional lifestyle and believe the benefits of traditional food consumption outweigh the risks (McAuley & Knopper, 2011). This review did not find any studies using social media to communicate risk about contaminants in traditional food. Krüemmel and Gilman (2016) discussed several considerations when using social media, but it is often in the form of one-way communication.

5.4 Limitations

There are several limitations to this systematic review. First, it only focuses on peer-reviewed primary research articles in academic journals. Future reviews might consider expanding the inclusion criteria to include books, reports, and grey literature along with peer-review primary articles to cast the most comprehensive net. When this review began, grey literature was a part of

the inclusion criteria. However, halfway through it came to light that a significant portion of the grey literature was not digitized and access to printed copies were unavailable locally in Montréal, Québec. Therefore, it was determined to exclude all grey literature to reduce bias. The inclusion criteria were amended to reflect this change. Also, grey literature relating to Indigenous research and data are often retained and kept locally or in regional Arctic archives that are not well-known or accessible to those with university affiliation (Hitomi & Loring, 2018). Thus, future researchers conducting reviews may need to consider traveling to northern locations to obtain data to complete an inclusive review. It is plausible that applying the eligibility criteria could have excluded informative studies, such as those published in the grey literature. Relevant articles may also have been inadvertently excluded when screening them based on title and abstract if a keyword was not present. Four databases were used to search the literature. The inclusion of additional databases may find newer or potentially missed articles. Three of five articles were authored by Dr. Chris Furgal. It is possible that his views could have introduced researcher bias (Buetow & Zawaly, 2021) to the findings reported in this review. However, this bias was likely mitigated as Dr. Chris Furgal's publications were authored with various co-authors. This review was only able to evaluate published studies; it is possible that others have been conducted but not yet published. Excluding non-English studies narrowed the breadth of the peer-reviewed literature captured in this systematic review. Included studies covered the entire North; but the number of studies on risk communication of contaminants in traditional food was limited. This review was not prospectively registered in PROSPERO or elsewhere, as it does not have a direct health-related outcome, although this decision introduced the risk of reporting bias. Only five studies met the inclusion criteria. Nevertheless, there is no minimum number of studies

to include in a systematic review. Indeed, even "empty reviews" that find no studies eligible to include can be significant, for example, in identifying knowledge gaps (Gray, 2021).

The data from this systematic review are specific to northern Indigenous Peoples of Canada, which might not apply to southern and other Indigenous Peoples throughout the world, even though some studies (e.g., Boyd & Furgal, 2019) have reported similar Indigenous worldviews in additional geographic settings. The retained articles provide a relatively represented sample of Indigenous participants from Canada's north, even so, the generalizability of the results may be limited. The results suggest that there might be potential value in tailoring risk communication for specific communities. Myers & Furgal's (2006) indepth exploration of awareness of contaminants in two regions (Nunavut and Labrador) demonstrate the differences in perception of contaminants, which may influence uptake of risk communication messages. This supports the practice of risk communication being better suited on smaller scales (Cope et al., 2010).

5.5 Implications

Findings from this systematic review of peer-reviewed research about contaminants in traditional food in northern Canada provide critical information to inform messaging practice. In mid-2022, RF presented the factors to consider when designing risk communication to northern Indigenous communities about contaminants in traditional food to Health Canada's Healthy Environments and Consumer Safety Branch, which included attendance from members of the Northern Contaminants Program. Following RF's presentation, rich discussions took place with these stakeholders. They indicated that they will consider using the findings from this study, specifically the three themes identified – self-efficacy, trustworthiness, and awareness – when

designing risk communication messages about contaminants in northern Indigenous Peoples traditional food sources.

The restricted sample of included eligible peer-reviewed publications provides an argument that further exploration is necessary and that the Northern Contaminants Program and other funders may wish to include the study of risk communication as a funding priority. Further research might also consider working with northern communities to build trust and explore the preference of dissemination of risk communication about contaminants in traditional food or if there is even the desirability for it within communities. As well, a publication of this systematic review will contribute to filling this lacuna in the peer-reviewed literature.

6 CONCLUSION

This study employed a systematic review to explore the current practices and influential factors for risk communication targeting Indigenous Peoples about environmental contaminants in traditional foods in northern Canada. Connecting people to the land and community, traditional foods are a significant resource for Indigenous Peoples' health, physical, sociocultural, spiritual, and economic well-being (Assembly of First Nations, 2007; Kuhnlein et al., 2000). Moreover, Indigenous Peoples can continue to safely enjoy their traditional foods (Calder et al., 2019), accommodating alternatives provided in risk communication messaging. The review indicates the importance of including self-efficacy in message design, to ensure that Indigenous Peoples can enjoy their food, but also have strategies to mitigate their exposure to contaminants. It also recommends that risk communication include Indigenous voices, using two-way, culturally-sensitive communication with trusted people to deliver messages through trusted sources. Lastly, messages need to ensure that people know what contaminants are and how they can affect health.

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8 APPENDICES

This appendix provides an example of the comprehensive search strategy applied in PubMed, the QuADS quality appraisal tool, and PRISMA 2020 checklist.

8.1 APPENDIX 1 – Search Strategy

The search terms combined with the following subject heading and keywords were translated according to the requirement for each database with the assistance of McGill University's Department of Family Medicine liaison librarian.

("Toxic Actions"[mesh] OR "Environmental Pollutants"[pa] OR "Environmental Pollution"[mesh] OR "Food Contamination"[mesh] OR "contamin*"[tw] OR "chemical*"[tw] OR "pollut*"[tw] OR "poison*"[tw] OR "carcinogen*"[tw] OR "toxic"[tw] OR "POPs"[tw] OR "pesticide*"[tw] OR "dichlorodiphenyltrichloroethane"[tw] OR "DDT"[tw] OR "dichlorodiphenyldichloroethylene"[tw] OR "DDE"[tw] OR "polychlorinated biphenyl*"[tw] OR "PCBs"[tw] OR "hexachlorobenzene"[tw] OR "HCB"[tw] OR "polybrominated diphenyl ether*"[tw] OR "PBDEs"[tw] OR "dioxin*"[tw] OR "furan*"[tw] OR "toxaphene"[tw] OR "heavy metal*"[tw] OR "mercury"[tw] OR "Hg"[tw] OR "lead"[tw] OR "Pb"[tw] OR "cadmium"[tw] OR "Cd"[tw] OR "arsenic"[tw] OR "methylmercury"[tw] OR "MeHg"[tw] OR "selenium"[tw] OR "Se"[tw] OR "perfluor*"[tw] OR "polyfluorinated alkyl substances"[tw] OR "PFAS"[tw] OR "PFCs") AND ("Food"[mesh] OR "Food Quality"[mesh] OR "Food Supply"[mesh] OR "Diet"[mesh] OR "Food Handling"[mesh] OR "Food Contamination"[mesh] OR "Meat Products"[mesh] OR "food*" OR "subsistence" OR "sustenance" OR "harvest*" OR "hunt*" OR "fish*" OR "gather*" OR "land animal*" OR "wild game" OR "bison" OR "buffalo" OR "moose" OR "caribou" OR "elk" OR "deer" OR "muskox" OR "bear" OR "polar

bear” OR “porcupine” OR “lynx” OR “pig” OR “rabbit” OR “squirrel” OR “beaver” OR “fox” OR “badger” OR “muskrat” OR “otter” OR “sheep” OR “bird*” OR “goose” OR “grouse” OR “ptarmigan” OR “duck” OR “mallard” OR “wigeon” OR “swan” OR “pheasant” OR “turkey” OR “oldsquaw” OR “canvasback” OR “pintail” OR “eagle” OR “falcon” OR “hawk” OR “owl” OR “loon” OR “pelican” OR “plant*” OR “fruit*” OR “vegetable*” OR “berr*” OR “blueberr*” OR “cranberr*” OR “raspberr*” OR “strawberr*” OR “knuckleberr*” OR “cloudberr*” OR “gooseberr*” OR “blackberr*” OR “currant*” OR “rosehip” OR “rat root” OR “Labrador tea” OR “peppermint” OR “mushroom” OR “onion” OR “rhubarb” OR “fiddlehead” OR “bean*” OR “corn” OR “squash” OR “carrot*” OR “spruce gum” OR “freshwater animal*” OR “pickerel” OR “walleye” OR “catfish” OR “red sucker” OR “minnow*” OR “perch” OR “pike” OR “jackfish” OR “loche” OR “burbot” OR “trout” OR “grayling” OR “bluefish” OR “whitefish” OR “inconnu” OR “herring” OR “cisco” OR “marine animal*” OR “arctic char” OR “seal” OR “narwhal” OR “whale” OR “beluga” OR “walrus” OR “fat” OR “blubber” OR “egg” OR "eggs" OR “gizzard*” OR “cooking method” OR “cooked” OR “fried” OR “roasted” OR “baked” OR “smoked” OR “raw” OR “boiled” OR “soup” OR “camp fire” OR “bottle” OR “jam” OR "jams" OR “ferment*” OR “igunaq” OR “muktuk” OR “mattak” OR “maktaq” OR “muktaaq” OR “maktaaq” OR “maktak” OR “aalu” OR “misiraq” OR “nirukkaq” OR “akutaq” OR “suaasat”) AND ("Communications Media"[mesh] OR "Mass media"[mesh] OR "Communication"[mesh] OR "Health Communication"[mesh] OR “communicat*"[tw] OR “messag*"[tw] OR "notice"[tw] OR "notices"[tw] OR “advis*"[tw] or “advertis*"[tw] OR “inform*"[tw] OR “disseminat*"[tw] OR “media"[tw] OR “tv"[tw] OR “television"[tw] OR “radio"[tw] OR “phone"[tw] OR “telephone"[tw] OR “Internet"[tw] OR “social media"[tw] OR “Facebook"[tw] OR “Instagram"[tw] OR “SnapChat"[tw] OR “Tik Tok"[tw] OR "TikTok"[tw] OR

“newspaper*"[tw] OR “news"[tw] or “poster*"[tw] OR “pamphlet*"[tw] OR “flyer*"[tw] OR “story"[tw] OR “stories"[tw] OR “teach*"[tw] OR “meet*"[tw] OR “word-of-mouth"[tw] OR “language"[tw] OR "translat*"[tw] OR interpreter*[tw] OR "health education"[tw]) AND ("Indians, North American"[mesh] OR "Indigenous Canadians"[mesh] OR “Indigenous” OR “Aboriginal*” OR “First Nation*” OR “First People*” OR “Inuk” OR “Inuit” OR “Cree” OR “Dene” OR “Indian*” OR “Eskimo*” OR “Natives” OR “elder*” OR “knowledge keeper*”) AND ((("Arctic Regions"[mesh] OR "Inuits"[mesh] OR "Circumpolar"[all] OR "Arctic"[all]) AND ("Canada"[mesh] OR Canad*[all])) OR “Northern Canada” OR “60th parallel north” OR “Inuit Nunangat” OR “Yukon” OR “North West Territories” OR "Northwest Territories" OR “Inuvialuit Settlement Region” OR “Nunavut” OR “Nunavik” OR “Baffin Island*” OR “Newfoundland” OR “Labrador” OR “Nunatsiavut” OR “NunatuKavut” AND “Inuk” OR “Inuit” OR “Cree” OR “Dene” OR "Indigenous" AND “country food” OR “traditional food”)

8.2 APPENDIX II – Quality assessment for diverse studies

Quality Assessment of Included Articles Using the Quality Assessment for Diverse Studies (QuADS)

QuADS criteria	Boyd et al., 2019	Couture et al., 2012	Friendship & Furgal, 2012	Kafarowski, 2006	Myers & Furgal, 2006	Total
1. Theoretical or conceptual underpinning to the research	3	2	2	3	3	13
2. Statement of research aim/s	3	2	3	2	3	13
3. Clear description of research setting and target population	3	2	3	3	3	14
4. The study design is appropriate to address the stated research aim/s	3	2	3	3	3	14
5. Appropriate sampling to address the research aim/s	3	1	3	2	3	12
6. Rationale for choice of data collection tool/s	2	1	3	0	3	9
7. The format and content of data collection tool is appropriate to address the stated research aim/s	3	2	3	1	3	12
8. Description of data collection procedure	3	1	3	1	3	11
9. Recruitment data provided	3	0	1	0	2	6
10. Justification for analytic method selected	3	1	2	0	2	8
11. The method of analysis was appropriate to	3	1	3	1	2	10

answer the research aim/s						
12. Evidence that the research stakeholders have been considered in research design or conduct.	1	1	1	1	2	6
13. Strengths and limitations critically discussed	2	1	0	0	0	3
Total out of 39	35	17	30	17	32	

8.3 APPENDIX III – PRISMA checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	p.i
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p.ii-iii
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p.19-21
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p.21
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p.25-26
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p.24-25
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	p.22-25, 76-78
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p.26 and 28
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p.26 and 28
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	p.25-26
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p.27-28
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p.26-27
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study	p.28

Section and Topic	Item #	Checklist item	Location where item is reported
methods		intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p.28
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	p.29-31
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	p.29-31
Study characteristics	17	Cite each included study and present its characteristics.	p.29-37
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	p.37, p.79-80
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	N/A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	N/A
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	p.46-55
	23b	Discuss any limitations of the evidence included in the review.	p.55-57
	23c	Discuss any limitations of the review processes used.	p.55-57
	23d	Discuss implications of the results for practice, policy, and future research.	p.57-58
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	p.56
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	p.24
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	p.55-56
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p.v and 57
Competing interests	26	Declare any competing interests of review authors.	N/A
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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