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Table des matières | Table of Contents

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Avant-propos

Julie BOUCHER Rédactrice en chef

Dans la vie, rien n'est à craindre, tout est à comprendre.
L'heure est venue de comprendre plus pour craindre moins.

Marie Curie

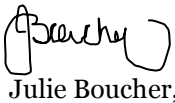
Plus de 80 ans après sa mort, les paroles de Marie-Curie, scientifique et lauréate de prix Nobel, résonnent encore aujourd'hui. Peut-être même plus dans le climat politique actuel, alors que la censure est pratique courante, que la désinformation est transmise à l'aveuglette dans les médias populaires, et que l'intégration de données probantes dans la pratique se fait lentement, confirmant que les obstacles qui nuisent au réel changement des soins de santé sont non seulement politiques, mais qu'il existe aussi un problème d'application des connaissances.

En devenant rédactrice en chef de la Revue interdisciplinaire des sciences de la santé (RISS), je souhaitais célébrer la recherche en matière de santé, mais surtout encourager la curiosité et la pensée critique des auteurs et des lecteurs. Je suis d'avis que cela favorise la diffusion des travaux de recherche d'étudiants qui aideront un jour à réduire l'écart entre la recherche appliquée et les politiques en matière de recherche en dehors du milieu universitaire. En choisissant soigneusement ses articles, la RISS favorise la pensée novatrice et fait progresser les connaissances scientifiques du domaine de la santé. Cette publication se distingue en outre grâce à sa capacité de mettre en valeur les travaux exceptionnels de jeunes chercheurs et universitaires.

Le présent numéro contient une compilation d'articles qui explorent l'éducation en matière de santé, la recherche, les politiques et la pratique partout dans le monde. Même s'ils couvrent un large éventail de sujets, tous les articles abordent d'une manière ou d'une autre les obstacles auxquels sont confrontés les soins de santé, et font appel à davantage de recherche et à l'élaboration de politiques pour orienter des changements systémiques. Plus important encore, ils préconisent l'application des déterminants de la santé pour nous faire progresser vers des solutions efficaces et réalisables aux problèmes.

Je me dois de remercier notre conseiller, professeur Raywat Deonandan, ainsi que nos éditeurs seniors et associés pour leur appui continu au cours de la dernière année. Je vous suis profondément reconnaissante de donner votre temps et de partager vos connaissances et vos compétences afin que la RISS puisse continuer de prendre de l'ampleur. Au nom de l'équipe éditoriale, je remercie notre talentueux graphiste Carlos, qui a créé la page couverture de ce numéro, et notre traductrice minutieuse Jessica, qui a traduit les résumés des articles. Je remercie également les réviseurs exceptionnels chargés de l'évaluation par les pairs, sur qui repose la qualité de la revue, pour leurs critiques éclairées et rigoureuses, et leur engagement indéfectible à l'égard de l'intégrité scientifique.

Enfin, je remercie tout particulièrement les auteurs d'avoir prêté leur voix à la conversation. En tant que futurs chercheurs en santé, professionnels de la santé et décideurs, vous avez la capacité de relever les défis du secteur de la santé et d'invoquer des changements réels et durables. Marie Curie a défié les conventions pour les femmes de son époque, et grâce à ses travaux novateurs, elle a su renverser les notions existantes sur la physique et la chimie du dix-neuvième siècle, prouvant ainsi que les idées ne sont bonnes que si elles sont bien mises en œuvre. Il suffit d'avoir un esprit curieux, de faire preuve d'ingéniosité, et de persister avec ténacité.



Julie Boucher, MSc

Foreword

Julie BOUCHER Editor-in-Chief

Nothing in life is to be feared, it is only to be understood.
Now is the time to understand more, so that we may fear less.

Marie Curie

Even 80-plus years after her death, Nobel Prize-winning scientist Marie Curie's words endure. Perhaps more so on account of today's political climate, when censorship is commonplace, misinformation is shared haphazardly by popular media, and the uptake of evidence into practice is slow to take hold, attesting that meaningful change to health care is not only a political challenge but also a problem of knowledge translation.

My goal in becoming Editor of this journal has been not only to celebrate health research, but even more, to encourage curiosity and critical thinking from authors and readers alike. It is my belief that in doing so, we are promoting the dissemination of research findings by students who will move on to close the research-practice and research-policy gaps outside of academia. Through carefully selected manuscripts, the Interdisciplinary Journal of Health Sciences (IJHS) is able to foster innovative thinking and advance scientific knowledge in the field of health. What's more, this publication sets itself apart through its ability to highlight outstanding work produced by budding researchers and academics.

The present volume contains a compilation of articles that explore health education, research, policy, and practice, worldwide. Although they span a broad gamut of topics, they all address barriers facing health services in some form or another and support further research and policy development to inform systemic change. More importantly, they advocate for the application of the determinants of health to propel us toward more effective solutions to these dilemmas and suggest that these solutions are within reach.

I must thank our Faculty Advisor, Dr. Raywat Deonandan, as well as our dedicated group of Senior and Associate Editors, for their continued support of the journal throughout the past year. I cannot be more appreciative of your willingness to volunteer your time, knowledge, and skills to ensure that the IJHS continue to grow. On behalf of the current editorial team, I would also like to thank Carlos, our talented graphic designer who created the cover page for this issue, and Jessica, our fastidious translator who translated the articles' abstracts. A journal cannot be a good one without having an outstanding group of Peer Reviewers so special thanks must also be extended to them, for their thoughtful and rigorous critiques and their unwavering commitment to scientific integrity.

Above all, thank you authors for lending your voices to the conversation. As the next generation of health researchers, practitioners, and policymakers, you have the ability to tackle the challenges facing the health sector and invoke real and lasting change. Marie Curie defied the status quo for women in her time and through her pioneering work, overturned established ideas on nineteenth-century physics and chemistry — proving that your ideas are only as good as what you do with them. All it takes is an inquiring mind, ingenuity, and a heavy dose of tenacity.

Julie Boucher, MSc

The Global Burden of Surgical Disease: An Analysis of Inaccessible Surgical Care in Low and Middle Income Countries

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Résumé :

(traduction)

À l'échelle mondiale, 4,8 milliards de personnes n'ont pas accès à des soins chirurgicaux ni à une gestion de l'anesthésie sécuritaires ou adéquats. Les soins chirurgicaux sont considérés comme « le parent pauvre de la santé mondiale »; un rappel frappant des disparités en matière de soins de santé. Les interventions chirurgicales peuvent prévenir 11 pour cent de la charge mondiale de morbidité et 1,5 million de morts annuellement. Cependant, de nombreux obstacles empêchent les pays à revenu faible et intermédiaire (PRFI) d'accéder à des soins chirurgicaux. Le premier défi consiste à offrir des soins chirurgicaux efficients malgré les restrictions financières et les bouleversements politiques. De l'aide étrangère a été mise en place pour alléger le fardeau financier et ses contributions ont été essentielles. Mais dans certains pays, en raison du climat politique, les fonds destinés au domaine de la santé sont détournés vers d'autres secteurs du gouvernement. De plus, le manque d'infrastructure, d'équipement et de personnel dans les PRFI aggrave la situation. Le second défi consiste à déterminer si une intervention chirurgicale est possible et aussi efficace qu'une intervention non chirurgicale. Les soins chirurgicaux sont essentiels et cet article vise à évaluer quels sont les obstacles qui limitent l'importance qu'on leur accorde dans les discussions portant sur la santé mondiale. Cet article abordera l'impact du financement, de l'infrastructure, de la main-d'œuvre, de la prestation de service et de la gestion de l'information sur les soins chirurgicaux, ainsi que les solutions actuelles telles que les missions d'aide humanitaire.

Mots-clés : Services de santé, pays à revenu faible et intermédiaire, chirurgie

Abstract:

Worldwide, 4.8 billion people do not have access to safe, adequate surgical care and anaesthetic management. Surgical care has been deemed “the neglected child of global health,” a startling reminder of the disparities in health services. The provision of surgical interventions can avert 11% of the global burden of disease and 1.5 million deaths each year. Many obstacles exist for low- and middle-income countries (LMIC) to progress towards accessible surgical care. The first challenge is delivering cost-effective surgical care despite financial constraints and political turmoil. Foreign aid was established to alleviate the financial burden and its contributions have been pivotal. However, based on the political climate in certain countries, funds are siphoned to government sectors other than health care. Moreover, the lack of infrastructure, equipment, and personnel in LMIC compound the issue. The other challenge is determining if surgery is as feasible and effective as non-surgical health interventions. Surgical care is crucial and this paper aims to assess the challenges that limit its stature in global health discussions. The paper will address the influence of financing, infrastructure, workforce, service delivery, and information management on surgical care, and the current resolutions, such as humanitarian aid missions.

Keywords:

Health services, low– and middle-income countries, surgery

Introduction

Worldwide, 4.8 billion people do not have access to safe, adequate surgical care and anaesthetic management (Myles & Haller, 2010; Meara et al., 2015). Of the 248 million surgeries performed each year, 75% are performed in the wealthiest nations while the poorest countries only receive 4% of operations (Myles & Haller, 2010). Low- and middle-income countries (LMIC) are facing a double burden of communicable and non-communicable diseases (Bygbjerg, 2012). Among the array of communicable and non-communicable diseases, surgical interventions can treat acute etiologies such as infections, abscesses, and osteomyelitis or chronic diseases such as cataracts, malignancies, and congenital anomalies (WHO, 2011; Ologunde, Maruthappu, Shanmugarajah, & Shalhoub, 2014). As these incidences continue to increase, the need for surgical care will be unprecedented.

The provision of surgery has been essential in advancing medical achievements and human health. In 2010, approximately 32.9% (16.9 million) of deaths worldwide were from conditions needing surgical care, surpassing the combined total of deaths from HIV/AIDS, tuberculosis, and malaria (Meara et al., 2015). As such, the global burden of disease (GBD) was established to assess risk factors, disease, and mortality using disability-adjusted life years (DALY) (WHO, 2011). Conditions requiring surgical interventions account for 11% of the treatable GBD (WHO, 2011; Fuller, 2017).

According to the third edition of the Disease Control Priorities (Debas et al., 2015), 1.5 million deaths and 77 million DALYs could be prevented each year if the 44 essential surgical procedures were provided. These surgeries can be identified in seven broad categories: dental, obstetric and gynecological, general surgery, injury, congenital, visual impairment, and non-trauma orthopaedic (Mock et al., 2015). This is a startling reminder of the disparities that continue to exist in health care in LMIC, yet surgical and anaesthetic care continue to be discounted from public discussion. Surgery is considered "the neglected stepchild of global health" (Farmer & Kim, 2008) yet it remains one of the most crucial health services to an independent health care system.

First, this paper aims to address the financial and political challenges for surgical and anaesthetic care in LMIC. The specific contexts to these challenges are the impact of financial constraints, fiscal policies, and political turmoil on population health. Second, the paper will discuss the concerns regarding the cost-effectiveness of global surgical care. The remainder of the paper will discuss the benefits and limitations of current resolutions, such as humanitarian aid missions and micro-level projects.

Discussion

The delivery of cost-effective care is one of the many barriers to accessible surgical care for individuals living in LMIC. According to the World Bank Classification (2016), LMIC are defined as countries with a gross national income of less than $3,955 per capita. Standard equipment, facility management, and training are necessary inputs to facilitate basic, accessible surgical care. However, the financial and political climate is not feasible to deliver accessible and affordable surgical care. This is not to argue that the government does not allow for accessible surgical care, but rather that surgical care is not recognized as a primary choice of intervention. During the "Millennium Development Goals" era, most of the significant political attention accosted to global health challenges led to the awareness and improvement of international donations. To build on the Millennium Development Goals, the Sustainable Development Goals (SDGs) for the 2030 Agenda were established and adopted by world leaders (UN, 2015). However, surgical and anaesthetic care was not incorporated as part of the 17 goals to alleviate poverty and achieve global health.

Financing

McIntyre et al. (2017) estimate that LMIC should allocate 5% of their total gross domestic product (GDP) for health-related spending to overcome resource deficiencies. This has been quantified in reference to the worldwide 5.5% average expenditure of GDP on health resources. However, the absolute monetary value of GDP varies greatly between countries. For instance, the GDP of the United States stands at $18.5 trillion, whereas Burundi's is at $3 billion (World Bank, 2016; BEA, 2015). Even if all LMIC reached the target goal of investing 5% of their GDP towards health care, no low-income countries and only 60% of middle-income countries would be able to provide basic universal health care coverage for essential medical services. It is rather difficult to define how much a country should invest into health expenditure as it depends on a number of factors, including per capita GDP, demographic trends in population, disease prevalence, and type of health system financing structure (Ke, Saksena, & Holly, 2011). Most countries use out-of-pocket (OOP) payments as a form of financing for health services. In LMIC, 32.8 million individuals out of 150 million face catastrophic effects from OOP payments for surgical services per year (Chao et al., 2014). Catastrophic payments are the OOP spending that exceeds the household's income, leading individuals to suffer the burden of disease (WHO, 2012). If there is a 1% increase in health expenditure by OOP payments, a proportion of households will face a 2.2% increase in catastrophic payments (McIntyre, Meheus, & Røttingen, 2017; Xu et al., 2003).

Therefore, OOP is one of the factors that can significantly impact health care expenditure. Quantifying a recommended figure for all countries for health care expenditure is unreasonable, as it does not account for each country's unique needs.

It is clear that finances still remain a large barrier to LMIC. One innovative method of funding has been the financial assistance from foreign countries to LMIC nations for the purpose of improving health-related sectors, coined "Development Assistance for Health" (DAH). Since its introduction in 1990, DAH has been a major source of foreign funding for developing nations. In 2012, approximately $28 billion was contributed by DAH, with the majority of finances directed towards communicable diseases such as HIV/AIDS, malaria, tuberculosis, maternal and newborn health, and health research (Lu et al., 2010). It has allowed developing countries to make great strides in their health care development.

However, a criticism of DAH is the siphoning of government health service funds towards other domestic sources. Lu et al. (2010) examined the relationship between the allocation of government resources and DAH funding for health care resources. It was noted that in some countries instead of the DAH being used to supplement government funding, it was used to mitigate costs. In fact, it was found that on average, for every dollar received from DAH, the government reduced "expenditures allocated to the Ministry of Health and other government agencies that engage in health spending by $0.43 to $1.14" (Lu et al., 2010). This stems from the conflicting objectives and hierarchy of the government. The Ministry of Finance controls the DAH budget that the Ministry of Health receives. In turn, the Ministry of Health has the primary directive of focusing resources to health care while the Ministry of Finance's purpose is to re-direct funding in the best interests of the country. Although health care is essential for the welfare of a country, other matters may take priority such as the economy or education. Furthermore, the Ministry of Finance has ultimate control over DAH funds and can re-direct the funds at their discretion. Therefore, a major criticism is that although there is a large organization supplementing developing countries' health care system, the money may not be accessible for this purpose due to barriers in the government structure.

Infrastructure

Given the financial state of developing countries, most hospital infrastructure is not equipped to deliver surgical care and can therefore have a negative impact on population health. In order to ensure safe surgical care, standardized equipment in operating rooms must be sterile and effective. Most surgical equipment designed for hospitals is equipped with pressurized water, a boiler system, electricity, and pneumatic systems – conditions that are nonexistent in low-income countries (O'Hara, 2015; Grimes, Bowman, Dodgion, & Lavy, 2011). Nearly 95% of LMIC hospitals receive equipment through donations, which are often missing necessary components, are difficult to repair, or are out of service (O'Hara, 2015). Furthermore, the average LMIC spends $6 to $12 per capita on medical equipment. This aligns with 90% of the world spending only $6 per capita on medical equipment. In stark contrast, developed nations spend upwards of $290 per capita on medical equipment (Nimunkar, Baran, Van Sickle, & Webster, 2009). The cost of medical technology therefore serves as a consistent barrier.

Furthermore, essential medications and personal protective equipment are out-of-stock due to the lack of funds or management leading to disposable materials being reused. Most of the infrastructure in LMIC hospitals is unequipped to perform safe, surgical care. For example, out of 14 hospitals in Uganda, only four have a proper waste disposal incinerator, eight have access to oxygen (i.e., tanks, banks, infusers), and only one hospital has a working autoclave sterilization machine (Linden et al., 2012). Similarly in Afghanistan, one third of hospitals has no access to blood banks (Contini et al., 2010). Without the appropriate sanitary conditions and proper equipment, patients have a greater chance of acquiring surgical-site infections, pneumonia, urinary tract infections, blood-stream infections, or other health care-associated infections (Revelas, 2012). As a result of the financial climate, there are considerable disparities in hospital infrastructure and equipment that can put patients at an increased risk of mortality and morbidities.

Work force, service delivery, and management

Trained health care providers and health systems management are essential to the delivery of safe, accessible surgical care. In LMIC, there is a lack of health care managerial systems due to economic and political circumstances. Reducing financial gain can affect the incentives for surgical providers and medical personnel to improve quality of service and respond to patient demand in health care discussions (Chao et al., 2014). A stemming issue is the availability of trained physicians and anaesthesiologists. For instance, Rwanda has 50 surgeons for 11 million individuals and Burundi has only 15 surgeons for ten million individuals (Henry et al., 2015).

Another common issue is the lack of medical expertise in LMIC. A study reported that patients are often referred to untrained medical attendants (Mullan & Frehywot, 2007). The deficits in the workforce are based on a number of factors relating to the underfunding of health facilities, poor

remuneration, poor retirement provision, lack of postgraduate training, and civil unrest (Pang, Lansang, & Haines, 2002; Cometto, Tulenko, Muula, & Krech, 2013). In some district hospitals in Mozambique, Tanzania, and Uganda, surgical and anaesthetic care is provided by medical attendants rather than trained physicians who do not have adequate knowledge and training to handle medical crises (Grimes et al., 2011; Henry et al., 2015). Another major burden on the health care system and educational system is the "brain drain" phenomenon, whereby medical professionals from developing countries migrate to developed nations. In Africa, almost 23,000 qualified academic professionals emigrate every year for better remuneration and working conditions (Pang et al., 2002). The global shortage of physicians and insufficient training for medical attendants poses a significant risk for potential patients in the deliverance of health services. Even more, for patients living in rural areas, surgical care becomes more difficult to access due to costs of transportation, rehabilitation fees, limited facilities, and medical professionals (Grimes et al., 2011). Overall, patient satisfaction, management, and accessible health services are dependent on the physician to population ratio, service providers with appropriate training and resources, and fair employment conditions.

Cost-effectiveness

The ultimate concern for policymakers in LMIC and abroad is whether surgical care is cost-effective. Several studies agree that implementing surgical care with other interventions is expensive and complex, but suggest that it is attainable. The DALY approach has been used to analyze the cost-effectiveness of surgical care by comparing the monetary cost to avoid the loss of one year of healthy life (Chao et al., 2014; Ozgediz & Riviello, 2008). In the assessment report of 112 surgical interventions, all surgical interventions costed less than $1000 to avert a DALY. Some of these surgeries included cleft-lip repair, inguinal hernia repair, cataract surgery, and emergency caesarean section, all of which ranged from $10-300 per DALY averted. By comparison, these are similar in cost to vitamin A supplementation, bed nets for malaria, HIV/AIDS antiretroviral therapy, and oral rehydration therapy (Meara et al., 2015; Alkire et al., 2011). Even more, Chao et al. (2014) posit that while medical missions might only focus on one type of surgical intervention, such as cleft palate repairs, it has the added benefit of increasing the capacity for all surgical services. This is due to the positive outcomes of such establishments and how these missions have led to widespread adoption in other countries (Marseille & Morshed, 2014). The return-on-investments in surgical care can be greater than what is calculated at the individual level as these investments can lead to a global surgical spillover (Marseille & Morshed, 2014). Hence, the cost of these surgical interventions is as favourable as or greater of an investment than other health-related interventions.

Resolutions

Apart from the DAH, the existing strategy for global surgical care is humanitarian relief missions providing support to areas with a high burden of disease. Organizations such as Operation Rainbow and Mercy Ships have been effective in providing surgical care. The success of their medical missions can be attributed to overcoming the scarcity of resources and budget costs and overcoming cultural and language barriers (Magee, Burg, & Hatcher, 2010). The surgical outcomes of Operation Rainbow and Mercy Ships are comparable to high-income centers. Being equipped with their own laboratories, equipment, and resources allows the organizations to provide various procedures in eye care, reconstruction, general, orthopaedic, oral, and mental health, and palliative care (Magee, Burg, & Hatcher, 2010).

For other organizations, medical missions can be hindered by financial and equipment constraints, language barriers, and the complexity of procedures (Shrime, Sleemi, & Ravilla, 2014). For example, in several organizations, simple surgeries such as tonsillectomies have very low complication rates whereas other surgeries, such as hernias and cleft lip repair, have much higher complication rates. Hernia operations in Sub-Saharan Africa from medical missions have a mortality rate of 1%, which is 20 times greater than in higher income countries.

Despite the number of surgical organizations, evaluating the effectiveness of global surgical care still remains an issue due to the lack of patient follow-up care and failure to implement a focused short-term approach (Shrime et al., 2014). In addition, while humanitarian outreach has provided medical advantages, it focuses on specialty care for injuries and warfare, leaving a large gap in care for congenital and acquired deformities (Malay, 2017). In the broader scheme, challenges to humanitarian action are the loss to follow-up, high volume of patients, resource shortages, limited support services from local authorities, and paucity of preventative care (Chiu, Weng, Chen, Yank, & Lee, 2014). Given the global humanitarian efforts to overcome the global burden of disease, there remain obstacles in providing adequate and effective surgical care.

Recommendations

From a holistic perspective, inaccessible surgical care is a multifaceted social, economic, and political issue, but global surgical care can be achieved. Compiling several studies, the current literature suggests focusing on five key factors: in-

frastructure, workforce, service delivery, financing, and information management (Meara et al., 2015; O'Hara, 2015; Henry et al., 2015). Tackling the challenges associated with inaccessible surgical care is imperative to move forward. The broad recommendations for LMIC include: enhancing managerial systems, providing training and education, incorporating rural support, providing telemedicine, identifying and allocating research priorities, and creating a national budget for health care. While these are major recommendations which cannot be implemented in a short time span, they are a starting point for local and foreign policymakers. From a community perspective, certain projects aspire to resolve the "minor" issues for citizens and health care providers. For example, the REMEDY (Recovered Medical Equipment for the Developing World) project works to promote the recovery of unused medical supplies and its cost-effectiveness. In contrast to unsalvageable donations, these donations are unused and can range from gloves and syringes, to operable ambulances and x-ray machines. To address the current issues, REMEDY works to alleviate the limitations in resources, transportation, rehabilitation, and other expenses.

Conclusion

Surgical care is an essential service that is required to achieve a comprehensive health care system. Despite its importance in achieving equitable health, considerable disparities in access to surgical services remain. The Sustainable Development Goals for 2030 are an example of how, despite their documented health benefits, surgical services are not prioritized. Although there is an urgent need to address the implementation of surgical services, there are financial and political obstacles that have made it difficult to actualize. The impacts of these challenges have cumulated into the current state of affairs regarding medical equipment, infrastructure, and trained service providers. As a consequence, populations in LMIC have a greater risk for injuries, morbidities, and mortalities. Regardless, the successes and shortcomings of humanitarian aid missions and DAH were explored and both have contributed towards progressing universal surgical care. With strategic recommendations and awareness of the issues, the provision of essential surgical care can make great strides in overcoming the global burden of surgical disease.

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An Overview of Scientific-Based Knowledge on Sedentary Behaviour Among the Pediatric Population — A Conceptual Model Development

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Résumé :

(traduction)

La sédentarité a été établie comme un comportement nuisible qui affecte de multiples aspects de la santé des personnes de tous âges, y compris des enfants et des jeunes de 0 à 18 ans. Le présent rapport vise à (i) résumer la documentation qui porte sur la définition, les caractéristiques, le contexte, les déterminants et les conséquences de la sédentarité chez les enfants et les jeunes; (ii) proposer un modèle conceptuel qui résume les résultats; (iii) souligner les lacunes de la recherche présentée dans la documentation. La sédentarité est un comportement commun et complexe qui risque d'affecter la santé des enfants et des jeunes sur les plans physiologique et psychologique. Ses effets néfastes sur la santé varient selon la manière dont ils s'accumulent au cours d'une journée, par exemple, selon le nombre d'interruptions ou le contexte. La sédentarité infantile étant trop élevée dans la plupart des pays où elle a été évaluée, le développement de la recherche et l'élaboration de politiques qui ciblent la réduction de la sédentarité chez les enfants et les jeunes doivent figurer au sommet des priorités pour les organismes de santé publique partout dans le monde. Même s'il faut poursuivre la recherche sur l'identification des conséquences et des déterminants particuliers des différents types et modèles de sédentarité dans divers contextes, le modèle conceptuel de l'étude et l'interprétation de la sédentarité chez les enfants et les jeunes, donnent un aperçu du sujet et appuient l'élaboration de politiques et le développement de la recherche.

Mots-clés : Comportement sédentaire, enfants, jeunes, santé de la population

Abstract:

Sedentary behaviour has been identified as a specifically deleterious personal practice on multiple levels of health of individuals at all ages, including the pediatric population (i.e., 0 to 18 years of age). The aims of this paper are to (i) summarize the literature concerning the definition, the characteristics, the context, the determinants, and the consequences of sedentary behaviour among children and youth; (ii) propose a conceptual model that summarizes these findings; and (iii) highlight research gaps in the literature. Sedentary behaviours are common and complex behaviours that can potentially affect the health of children and youth on the physiological and psychological levels. Those deleterious effects on health can vary depending on how they are accumulated throughout the day, for example with or without interruption, or in which context. While childhood engagement in sedentary behaviours is too high in the majority of countries where it has been assessed, developing research and policies that target the reduction of sedentary behaviours among children and youth must be ranked as a top priority for all public health organizations worldwide. Although further research is needed concerning the identification of the specific determinants and consequences of different types and patterns of sedentary behaviours in various contexts, the Conceptual Model for the Study and Understanding of Children and Youth's Sedentary Behaviour, gives an overview of the topic and supports the development of policy and further research.

Keywords:

Sedentary behaviour, children, youth, population health

Introduction

The Public Health Agency of Canada (2013) defines population health as the health of a population as measured by health status indicators and influenced by social, economic and physical environments, personal health practices, individual capacity and coping skills, human biology, early childhood development, and health services. Sedentary behaviour has been identified as a specifically deleterious personal practice on multiple levels of health of individuals at all ages, including the pediatric population (Owen, Healy, Matthews, & Dunstan, 2010; Tremblay, Colley, Saunders, Healy, & Owen, 2010; Tremblay et al., 2011). The general objective of this paper is to present a pedagogic overview of the scientific knowledge concerning sedentary behaviour among children and youth to inform broad, evidence-based environmental and policy initiatives and to support the development of further research. To reach this goal, this paper will (i) review the literature to identify definitions, characteristics, contexts, determinants, and consequences of sedentary behaviour among children and youth; (ii) propose a conceptual model that summarizes these findings; and (iii) highlight research gaps in sedentary behaviour.

1. Sedentary behaviours; definition and distinction

The study of the health impact of sedentary behaviour is an important emerging area of research. It has the potential to "suggest novel options for the prevention of non-communicable disease and to suggest environmental innovations and new policies for preserving and enhancing population health" (Tremblay et. al., 2010). But to allow optimal development of sedentary behaviour related research, such as the study of its determinants and the creation of intervention for its reduction, clarity on the use of specific terms is needed.

Indeed, sedentary behaviour and physical inactivity are two distinct concepts that have been and are still confused in the literature. According to the Sedentary Behavior Research Network (2012), sedentary behaviour is "any waking behaviour characterized by an energy expenditure ≤ 1.5 metabolic equivalents, while in a sitting or reclining posture." In contrast, the term "inactive" must be used to describe those who are performing insufficient amounts of moderate to vigorous physical activity (i.e., not meeting specified physical activity guidelines). Physical activity and sedentary behaviour can be seen as a continuum on the human movement spectrum (Gibbs, Hergenroeder, Katzmarzyk, Lee, & Jakicic, 2014). In addition, being sedentary is not necessarily associated with being inactive; an active individual can meet physical activity guidelines while spending the vast majority of the day sitting (Saunders, Chaput, & Tremblay, 2014) (Figure 1).

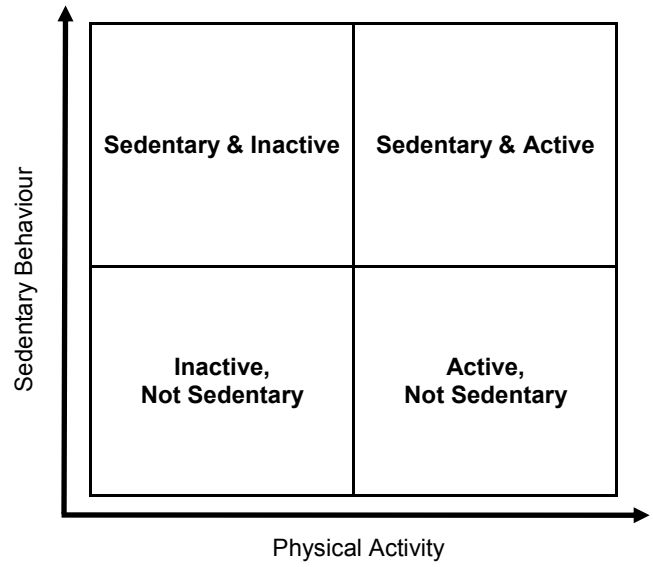

Figure 1

Sedentary behaviour and physical activity as distinct constructs. Reprinted from "Sedentary Behaviour as an Emerging Risk Factor for Cardiometabolic Diseases in Children and Youth," by T. J. Saunders, J.-P. Chaput, and M. S. Tremblay, 2014, *Canadian Journal of Diabetes*, *38*, p. 54. Copyright 2014 by Canadian Diabetes Association. Reprinted with permission.

2. Sedentary behaviours; complexity of the phenomenon

Sedentary behaviours are ubiquitous and encompass a range of activities. Sedentary behaviours, such as sitting on a sofa while watching TV or playing a board game with friends, can have very different characteristics and can occur in very different contexts, thus their determinants and consequences will not be the same. Recent evidence suggests that different types of sedentary behaviours have different impacts on health and wellbeing (Chastin, Schwarz, & Skelton, 2013). For instance, some sedentary behaviours can have potential health-enhancing effects (rest and relaxation can be an essential need). In addition, research suggests that the consequences of sedentary behaviours on health depend greatly on their pattern (i.e., how they are accumulated throughout the day). For example, the same total amount of sedentary time would be associated with fewer negative health outcomes if it is accumulated with regular interruptions than if it is continuous (Healy et al., 2008). Understanding the sedentary behaviour setting – the physical and social context where it occurs – is of particular importance to the study of its consequences on health (Owen et al., 2011).

To characterize the sedentary behaviours, an open science project called Sedentary behaviour International Taxonomy project (SIT) was setup to develop a common taxonomy of sedentary behaviours through formal consensus, taking into account the opinion of experts and the general public. The project uses the Delphi method, a technique used for "the elicitation of opinions with the object of obtaining a group response from a panel of experts. It replaces direct confrontation and debate by a carefully planned, orderly program of sequential individual interrogations usually conducted by questionnaires" (Brown, 1968). The first round of this SIT project involved international experts who were asked to make statements about the taxonomy (its purpose and use), the domains, categories or facets that should be considered and included, and the structure/architecture to arrange and link these domains and facets (Chastin et al., 2013). The project aimed to facilitate systematic and standardized investigation and analysis to enable systematic and standardized reporting, to facilitate comparison, and to develop measurement tools of sedentary behaviours.

The obtained taxonomy comprises nine complementary facets (Figure 2) characterizing the purpose (why), the environment (where), the social context (with whom), the type or modality (what), associated behaviours (what else), when the behaviour takes place (when), the mental and functional states of sedentary individual (state), posture, and measurement and quantification issues (Chastin et al., 2013). Each of these facets has more precise sub-domains and categories that can be used to describe sedentary behaviours. For example, the main facet of posture is composed of two subcategories: sitting and lying (Chastin et al., 2013).

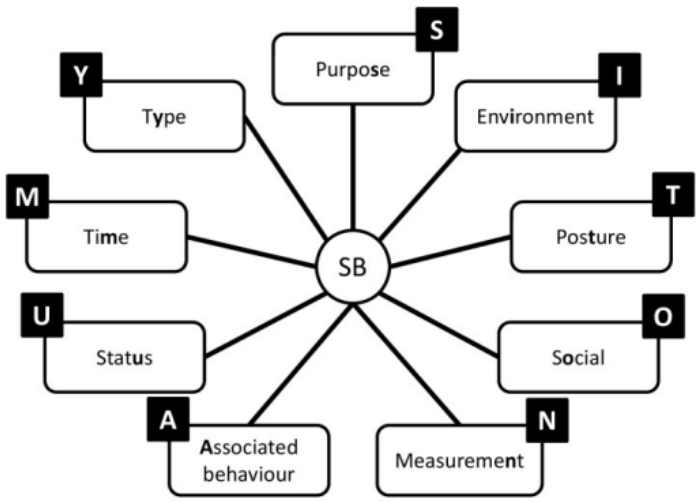

Figure 2

Taxonomy level one facets and coding labels. Reprinted from "Development of a Consensus Taxonomy of Sedentary Behaviors (SIT): Report of Delphi Round 1," by S. F. Chastin, U. Schwarz, and D. A. Skelton, 2013, *PLoS One*, *8*, p. 7. Copyright 2013 by Chastin et al. Reprinted with permission.

Quantitatively, the following are used to characterize sedentary behaviours: frequency (number of bouts of certain duration); interruptions or breaks (period spent not sedentary between two bouts of sedentary behaviour); and time (total duration of sitting/lying while awake) (Tremblay et al., 2010). A definition of "sedentary bouts" and "sedentary breaks" has been recently proposed by Altenburg and Chinapaw (2015): sedentary bout is "a minimum period of uninterrupted sedentary time" and sedentary break is "a non-sedentary period in between two sedentary bouts." Research suggests that the consequences of sedentary behaviours on health depend greatly on how they are accumulated throughout the day. For example, the same total amount of sedentary time is associated with fewer negative health outcomes if it is broken up by regular interruptions instead of being continuous (Healy et al., 2008).

This growing body of research also confuses the use of sedentary behaviour-related concepts, thus, there is a need for adopting standardized terms to describe sedentary behaviours. An international team of over 80 researchers under the supervision of Dr. Mark Tremblay and the Sedentary Behaviour Research Network recently published the Terminology Consensus Project (Tremblay et al., 2017). This project proposed final consensus definitions for stationary behaviour, sedentary behaviour, standing, screen time, non-screen-based sedentary time, sitting, reclining, lying, and sedentary behaviour pattern, including caveats and examples for all age groups and abilities, and a conceptual model integrating these terms.

3. Consequences of sedentary behaviour in children and youth, a population health issue

Increasing evidence suggests that sedentary behaviour, independent of physical activity level, is associated with negative outcomes at macroscopic and microscopic levels. Because the study of sedentary behaviour is a new area in health research, solid prospective findings among children and youth are still missing, but a review of the emergent literature is presented here.

Accumulating evidence suggests that the amount of time children and youth spend engaging in sedentary activities may be associated with increased cardiometabolic disease risk, independent of other factors such as physical activity level and abdominal obesity (Carson et al, 2016; Saunders et al., 2014). There is also an assumed association between prolonged sedentary behaviours and mental health indicators such as hyperactivity/inattention, internalizing problems, psychological well-being, and perceived quality of life

among school-aged children and adolescents, but further investigation is required to confirm this relationship (Suchert, Hanewinkel, & Isensee, 2015). A recent systematic review of sedentary behaviour and health indicators in school-aged children and youth (5 to 17 years old) found that higher durations of TV viewing and video game use were associated with unfavourable behavioural conduct, higher duration of screen time with lower fitness, and higher durations of screen time and computer use with lower self-esteem (Carson et al., 2016). Findings from numerous studies also suggest that sedentary screen-based behaviours (particularly television viewing) are likely to result in increased energy intake and positive energy balance in the pediatric population (Saunders et al., 2014). In addition, sedentary behaviours have been shown to coexist with other unhealthy behaviours such as higher energy intake from fat, sweet and salty snacks, and high-energy drinks (Biddle, Petrolini, & Pearson, 2014; Salmon, Tremblay, Marshall, & Hume, 2011), lower consumption of fruits and vegetables (Salmon et al., 2011), lower levels of physical activity (Biddle et al., 2014; Salmon et al., 2011), and inadequate sleep (Biddle et al., 2014). Other research has reported a significant positive association between media exposure (e.g., TV viewing, reading magazines) and the use of tobacco, drugs, or alcohol among youth (Salmon et al., 2011). Finally, according to a systematic review by Carson et al. (2015), increased screen time has detrimental associations with cognitive development outcomes in 38% of young children aged 0 to 5 years, while 6% report beneficial associations with cognitive developmental outcomes.

On a biological level, prolonged and uninterrupted sedentary behaviour has rapid and deleterious effects on insulin sensitivity, glucose tolerance, and triglyceride levels in adults, whereas interruptions in sedentary time benefit triglyceride and glucose metabolism (Saunders et al., 2014). To date, these findings still need to be replicated in the pediatric population. As for the pediatric population, a systematic review examining the relationship between sedentary behaviour and adiposity among school-aged children reported that 94 of 119 cross-sectional studies observed a positive association between sedentary behaviour and markers of adiposity, including higher serum cholesterol level, high systolic and diastolic blood pressure, and insulin resistance (Tremblay et al., 2011).

It is important to highlight that many studies on this topic have used “screen-time” (i.e., time spent in front of a TV or computer, assumed to be while sitting) as an indicator of sedentary behaviour instead of the total time spent being sedentary, in front of a screen or otherwise. It can lead to an underestimation of sedentary time and does not allow associations to be made about particular types of sedentary behaviour. For example, Carson et al.(2015) found that reading or being read to is most consistently associated with positive cognitive development while the vast majority of evidence suggests that screen time has either no effect or a detrimental effect on cognitive development during early childhood (0 to 5 years).

Finally, it is well recognized that behavioural patterns related to physiological risk factors (such as food choices, smoking, or physical activity) are fully established and resistant to change at the end of childhood and especially at the end of adolescence (Kelder, Perry, Klepp, & Lytle, 1994). Thus, youth who exhibit high levels of sedentary behaviour are more likely to continue to engage in high levels of sedentary behaviours as adults.

4. Situational analysis of children and youth’s sedentary behaviours

4.1 Sedentary behaviour guideline for children and youth

In response to the accumulation of research showing the deleterious effects of sedentary behaviour, insufficient physical activity, and/or insufficient/poor quality sleep in the pediatric population, the first Canadian 24-Hour Movement Guidelines for Children and Youth were published in 2016, integrating physical activity, sedentary behaviour, and sleep (Tremblay, Carson, & Chaput, 2016a). Recommendations on sedentary behaviour state that:

> For optimal health benefits, children and youth (aged 5–17 years) should achieve high levels of physical activity, low levels of sedentary behaviour, and sufficient sleep each day. A healthy 24 hours includes: […] no more than 2 hours per day of recreational screen time; limited sitting for extended periods. (CSEP, 2016)

The same team is developing guidelines for younger children, between 0 to 4 years of age. In the first Canadian Sedentary Behaviour Guidelines for the Early Years that were published in 2012, it was recommended that:

> For healthy growth and development, caregivers should minimize the time infants (aged <1 year), toddlers (aged 1–2 years) and preschoolers (aged 3–4 years) spend being sedentary during waking hours. This includes prolonged sitting or being restrained (e.g., stroller, high chair) for more than 1 h at a time. For those under 2 years, screen time (e.g., TV, computer, electronic games) is not recommended. For children 2–4 years, screen time should be limited to under 1 h per day; less is better. (Tremblay and al., 2012, p.375)

With these guidelines come new indicators and new opportunities for surveillance. Adherence to these guidelines should be assessed at a population level internationally to evaluate: i) the need for and the efficacy of interventions, ii) the comparisons between countries and/or specific populations, and iii) the determinants and health consequences associated with sedentary behaviour.

4.2 Prevalence of sedentary behaviour among children and youth in the world

In order to promote a healthy and active lifestyle among children and youth, the Active Healthy Kids Canada Report Card has been released every year between 2005 and 2016. This Report Card is a harmonized process which uses common indicators of physical activity and a standardized grading framework from A ("succeeding with a large majority of children and youth, ≥ 80%") to F ("succeeding with very few children and youth, < 20%") to mark each of these indicators. This process has been replicated in low, middle, high, and very high-income countries – 14 in 2014 (Tremblay et al., 2014), and 37 in 2016 (Tremblay et al. 2016b). The consolidated findings from participating countries were summarized in the form of a global matrix of grades from 15 countries in 2014 and from 38 countries in 2016.

Results from the Global Matrix 1.0 (Tremblay et al., 2014) showed a significant global variation in children's sedentary behaviours, although sedentary behaviour through screen time was found to be too high in the majority of countries where it was assessed (average of D). Similar results were obtained in the second edition of the Global Matrix (Tremblay et al., 2016b).

In addition, Roman-Vilas et al.(2016) evaluated adherence to new 24-hour movement guidelines (CSEP, 2016) among 6,128 children aged 9 to 11 years, across 12 countries participating in the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE). They found that only 39.3% of children from all study sites met the screen time duration recommendations (no more than 2 hours per day).

These results show that childhood engagement in sedentary behaviours is too high in the majority of countries where it has been assessed, highlighting the need for interventions that reduce sedentary time among the pediatric population.

5. Determinants of sedentary behaviours among children and youth

According to Sallis et al. (2008), multiple determinants across multiple levels and sectors (individual, social, physical environments, and policies) must be addressed to achieve population change in sedentary behaviour. Because this is a newer area of health research, it still lacks a conceptual framework incorporating the potential determinants of children's sedentary behaviours at different levels (e.g., policy environment, behaviour settings, individual factors). Such a framework could further help illustrate the complexity of the sedentary behaviour phenomenon among children and youth, guide research, and support the development of interventions and policies.

Research on determinants of sedentary behaviours is still at an early stage, and much of the available evidence is in relation to TV viewing time. However, an overview of the available findings follows.

5.1 The Ecologic Model of Sedentary Behaviours

To aid research on factors that influence sedentary behaviours, an ecologic model of four domains of sedentary behaviour (Figure 3) was developed by Owen et al. in 2011. The main objective of this model is to focus attention on the domains within which the relevant contextual factors such as environmental, social, or organizational, influence sedentary behaviours and interact with individual-level attributes (e.g., preferences, enjoyment or barriers) and social factors (e.g., family demands or workplace relationships).

According to Owen et al. (2011), this model covers factors relevant to most age groups; many influences are likely to operate similarly for children, youth, adults, and older adults, but other influences will be distinct for these different age groups. For example, school-based initiatives such as reducing sitting in physical education time will particularly affect children. This ecological model has the strength to propose an adequately complex summary of potential sedentary behaviour factors of influence and is a useful tool for the development of strategies to reduce sedentary behaviours. However, further development of the model is warranted to incorporate the characteristics and consequences on health of the sedentary behaviour phenomenon.

5.2 Mapping the environmental and social contexts of sedentary behaviour and health

A narrative review mapping the environmental and social contexts of sedentary behaviour and health was published by Owen et al. in 2014. The authors proposed a conceptual model showing relationships that needed to be identified in the study of sitting behaviours (Figure 4). The authors aimed to provide a basis for new research perspectives on

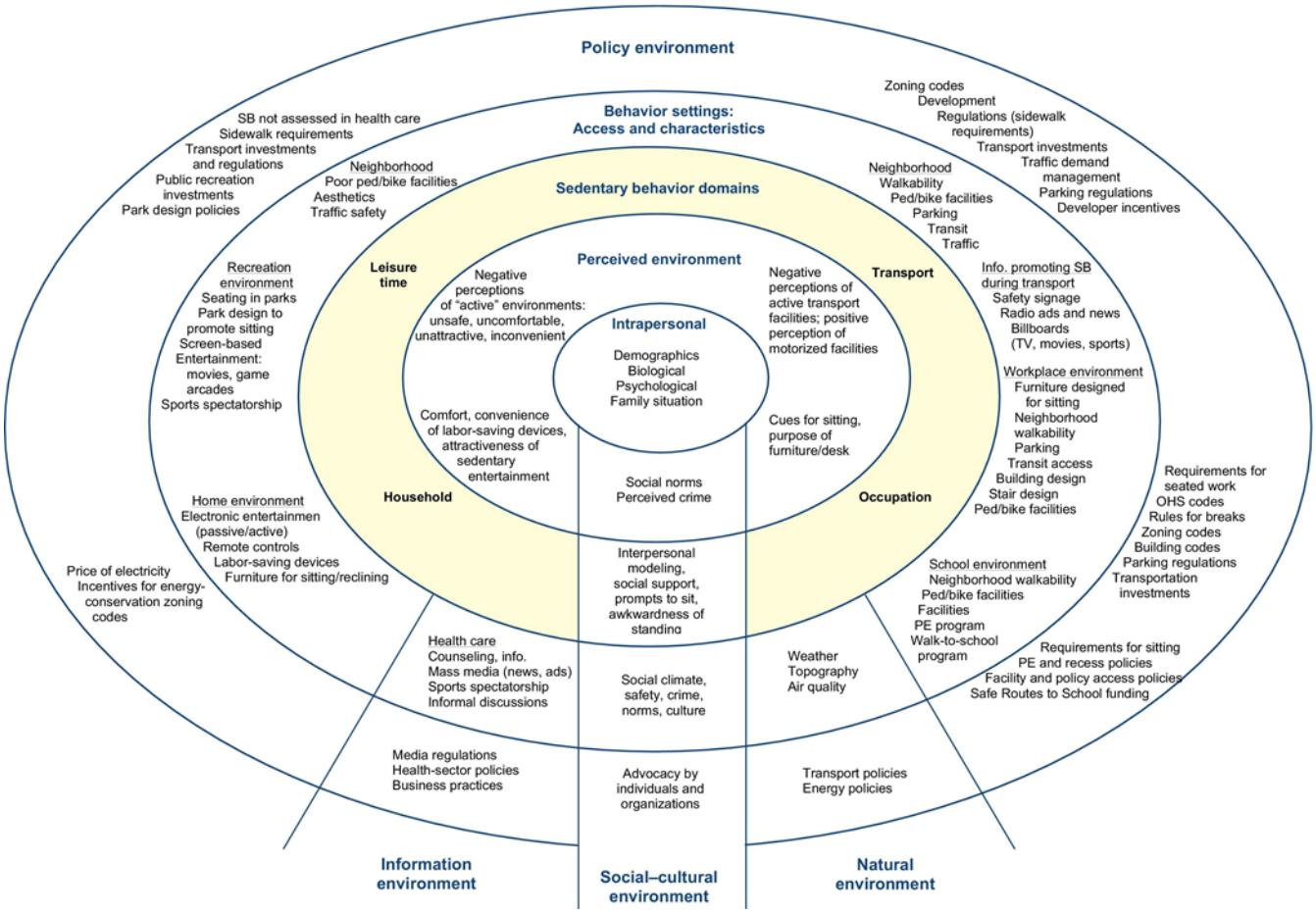

Figure 3 Ecologic model of four domains of sedentary behaviour: OHS, occupational health and safety; PE, physical education; Ped, pedestrian; SB, sedentary behaviour. Reprinted from "Adults' Sedentary Behaviour: Determinants and Interventions," by N. Owen, T. Sugiyama, E. E. Eakin, P. A. Gardiner, M. S. Tremblay, and J. F. Sallis, 2011, *American Journal of Preventive Medicine*, *41*, 191. Copyright 2011 by American Journal of Preventive Medicine. Reprinted with permission.

the adverse health outcomes of sitting time, within a broader understanding of environmental influences on health behaviours, taking an ecological and socioeconomic inequalities perspective across life stages.

This recent model has the advantage of being well organized and gives an interesting approach to the environmental settings of influences, the mediation and moderation factors, the intermediate risk factors, and the major health outcome associated with sitting time. However, this model is not specific to children. In addition, the complexity of sedentary behaviour is not well presented and it is reduced to the most recurrent "sitting time" behaviour settings. Finally, the policy environment level (such as media regulation or public recreation investment) present in the previous ecological model is missing in the "environmental settings influences".

6. Proposition of a conceptual model of sedentary behaviour among children and youth

The strengths of both previously presented models and other elements described herein, have been combined to develop a conceptual model of sedentary behaviour among children and youth (Figure 5). This new model retains the organization of the second model (Owen et al., 2014) but replaces the environmental setting influences by a summary of the determinants from the ecologic model of Owen et al. (2011). In addition, a summary of the determinants to children is presented and updated with a recent systematic review of determinants of sedentary behaviour in youth (Stierlin et al., 2015). Quantitative and qualitative characteristics of sedentary behaviour presented previously in this paper (see section entitled "Sedentary behaviours, complexity of the phenomenon") have been chosen to replace the

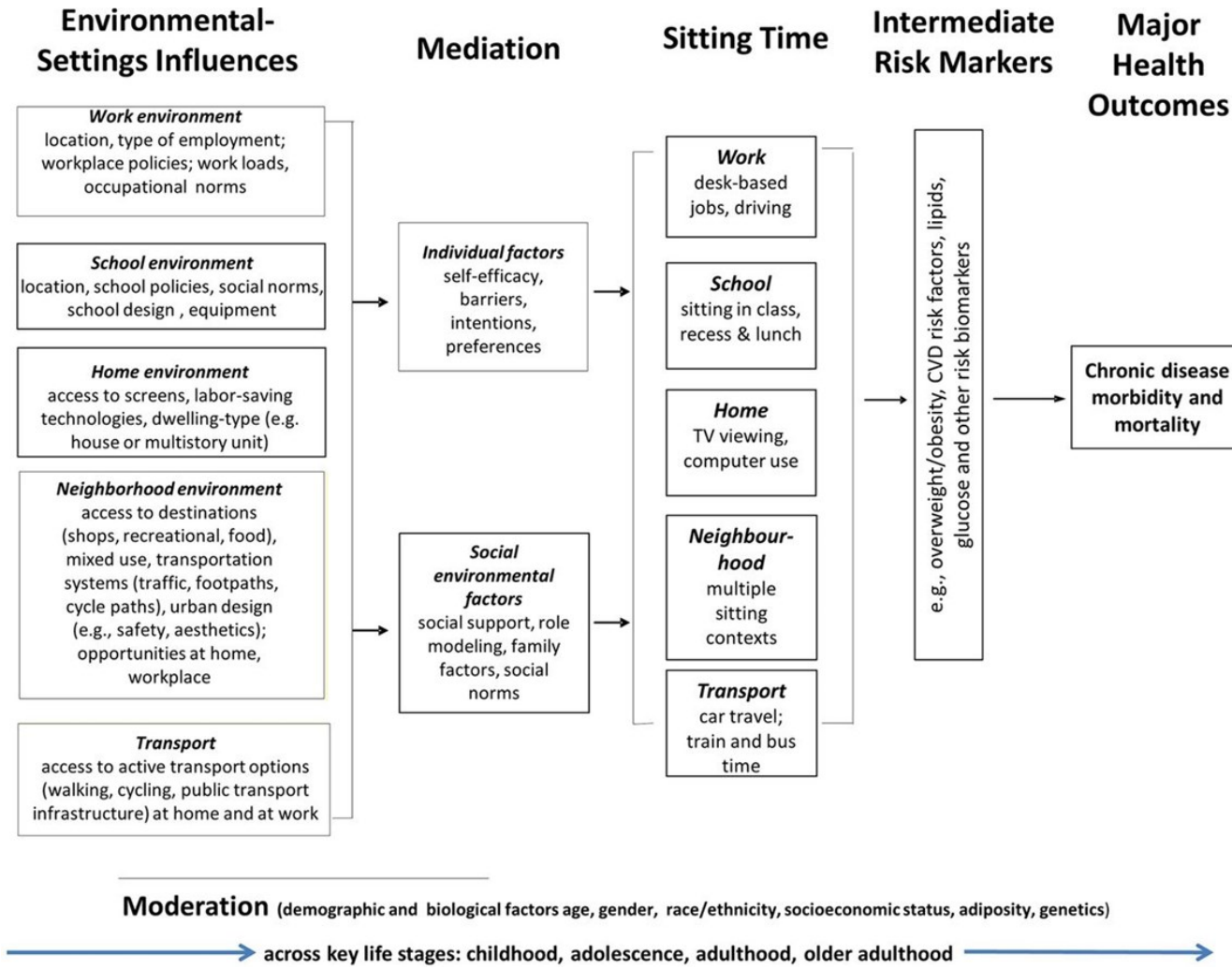

Figure 4

Overview of relationships that need to be identified — between the built, policy and social environments, prolonged sitting in particular. Reprinted from "Sedentary Behaviour and Health: Mapping Environmental and Social Contexts to Underpin Chronic Disease Prevention," by N. Owen, J. Salmon, M. J Koohsari, G. Turrell, and B. Giles-Corti, 2014, *British Journal of Sports Medicine*, *48*, p. 175. Copyright 2014 by BMJ Publishing Group Limited. Reprinted with permission.

sitting time settings. The "intermediate risk markers" and the "major health outcomes" sections from Owen et al. (2014) model have also been completed with the findings presented previously in the part reviewing the consequences of childhood sedentary behaviours. The individual factors have been presented as determinants, moderators or mediators in this model because it is assumed that their effects will vary in different countries or contexts, where environmental, social, and cultural attributes influencing sedentary behaviour may differ. This "Conceptual model for the study and understanding of children and youth's sedentary behaviour" is not meant to be exhaustive in its different categories but tries to give an overview of the available evidence and potential inferences in the literature.

The proposed model aims to inform broad, evidence-based environmental and policy initiatives. Moreover, it encourages further research on sources of influence on specific sedentary behaviours in different contexts and their direct and indirect consequences on health. The links between each of the elements in this model need to be studied in various countries, where environmental, social, and cultural attributes influencing sedentary behaviours may differ (Owen et al., 2011). For example, it would be interesting to assess if a high socio-economic status is associated with decreased sedentary time among children in high or very high-income countries and increased sedentary time among children in low-income countries.

7. Gaps in the literature

Because sedentary behaviour related health research is a burgeoning area of study, there are still many gaps in the literature. However, some initiatives are seeking to address these needs. To standardize the methodology used in stud-

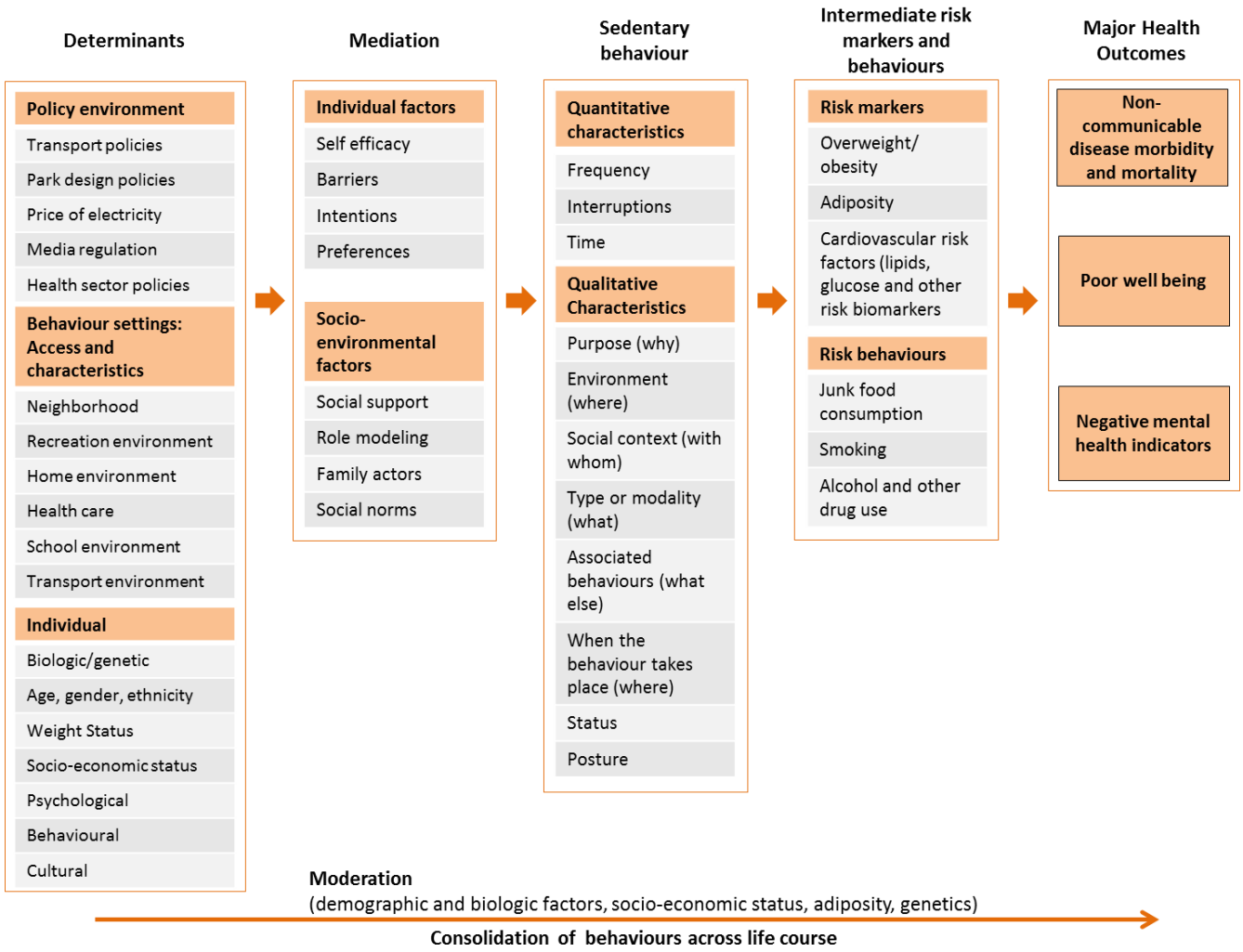

Figure 5 Conceptual model for the study and understanding of children and youth's sedentary behaviour.

ies in terms of sedentary behaviour (and physical activity) measurements, the International Society for the Measurement of Physical Behavior was created. It is now organizing an annual congress and sharing resources on its website. In addition, the SIT project, referred to above, is still ongoing.

Evidence on the potential moderating role of socioeconomic inequality on sedentary behaviours and their adverse health outcomes are needed from a multilevel, longitudinal, and life-course perspective (Owen et al., 2014). Future research also needs to examine the common and distinct influences of environmental, social, and other relevant determinants of sitting time in relevant settings (Owen et al., 2014).

It is also necessary to take into consideration the complexity of sedentary behaviours for the development of policies that target sedentary time among children and youth. All types of sedentary behaviours may not be equally deleterious for health. It is of utmost importance to identify the sedentary behaviours associated with the most negative impacts on health, their specific determinants, their mediators and moderators in different countries, while also considering different environmental, social, and cultural contexts.

Further research is also needed to identify the modifiable environmental and social determinants of sedentary behaviour to better understand how to reduce them and work towards population-wide strategies targeting prolonged sitting time (Owen et al., 2014).

Finally, identifying the important correlates at multiple levels for sitting time in different settings is also required. For instance, time spent sitting in cars is associated with urban design and transportation factors while sitting at work or in the domestic environment may be associated with arrangements of furniture, communication technology, and proximal–social factors (Owen et al., 2011).

Conclusion

Sedentary behaviours are common and complex behaviours that can potentially affect the health of children and youth on both a physiological and a psychological level, depending on how they are accumulated throughout the day. While childhood engagement in sedentary behaviours has been found to be too high in the majority of countries where it has been assessed, developing research and policies that target the reduction of sedentary behaviours among children and youth must be ranked as a top priority for all public health organizations worldwide. Although further research is needed to identify specific determinants and consequences of different types and patterns of sedentary behaviours in various contexts, the Conceptual Model for the Study and Understanding of Children and Youth's Sedentary Behaviour proposed in this paper, gives an overview of the topic and supports the development of specific actions.

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Reducing Interprofessional Conflicts in Order to Facilitate Better Rural Care: A Report From a 2016 Rural Surgical Network Invitational Meeting

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Résumé :

(traduction)

Le Centre sur la recherche en santé rurale a tenu une réunion sur invitation pour faciliter les discussions avec les chirurgiens généraux en Colombie-Britannique; l'objectif était de bien comprendre leurs préoccupations et traiter des questions portant sur les médecins de famille qui possèdent des compétences chirurgicales avancées (FPESS). En particulier, la réunion a porté sur les défis interprofessionnels qui nuisent à l'adoption d'un modèle de réseau entre les chirurgiens généraux et les FPESS. Ce rapport résume les conclusions (n = 5) et les recommandations (n = 8) qui ont été formulées lors de la réunion. La réunion a démontré le besoin d'avoir davantage de discussions réfléchies afin d'établir un climat de confiance et d'assurer le support interprofessionnel entre les chirurgiens généraux et les FPESS au moyen d'un système de soins de santé intégré et de réseaux adéquats.

Mots-clés : Rural, services de santé en milieu rural, FPESS, chirurgien général, Colombie-Britannique, réseau

Abstract:

An invitational meeting organized by the Centre for Rural Health Research convened to facilitate respectful dialogue with general surgeons in British Columbia; the objective was to clearly understand concerns and address questions around rural family physicians with enhanced surgical skills (FPESS). In particular, the meeting focused on interprofessional challenges that hinder the adoption of a network model between general surgeons and FPESS. This report summarizes the findings (n = 5) and recommendations (n = 8) made during the meeting. The meeting underscored the need for more thoughtful discussions to develop interprofessional trust and support between general surgeons and FPESS through an integrated health care system and proper networks.

Keywords: Rural, rural health services, FPESS, general surgeon, British Columbia, network

Introduction

In response to decreased provision of surgical and maternal health services in rural areas, family physicians with enhanced surgical skills (FPESS) are filling the gap by providing appropriate and effective care to rural residents (Kornelsen & Friesen, 2016; Kornelsen, Iglesias, & Woollard, 2016a; Kornelsen, Iglesias, & Woollard, 2016b). For family physicians to be certified as having enhanced surgical skills (ESS), they must first receive training at the University of Alberta, AB, Canada. The program titled "Enhanced Skills" is the only program in Canada that provides students with procedural skills training in areas such as caesarean section, endoscopy, and carpel tunnel repair. Although the ESS program is an innovative solution to the lack of surgeons practicing in rural areas, graduates of the ESS program have reported interprofessional difficulties regarding "turf wars" with general surgery colleagues that act as a barrier to the provision of necessary and appropriate care (Kornelsen et al., 2016a; Iglesias et al., 2015; Kornelsen et al., 2016b). In order to improve interprofessional relationships and reduce rural health care inequities, this invitational meeting aimed to provide a platform for general surgeons to express their concerns regarding ESS practice. Concerns identified during the event were noted and analyzed in an effort to develop a solution that is satisfying to both FPESS and general surgeons.

Background

A specialized professional culture characterized by expertise, controlled resources, and clearly set boundaries has been shown to lead to increased isolation of general practitioners (GPs) and specialists (Manca, Breault, & Wishart, 2011). Comparatively, a comprehensive professional culture characterized by the negotiation of boundaries to achieve relationship-building and effective collaboration, has been shown to contribute positively to the work culture amongst GPs and specialists. In addition, a comprehensive professional culture puts emphasis on mutual empowerment of generalists and specialists, fostering a greater level of collaboration (Kornelsen et al., 2016a; Kornelsen et al., 2016b)

Although these "turf war" conflicts seem to occur naturally in a clinical environment, studies have shown that through increased dialogue and interaction, it is possible to significantly improve interprofessional relationships. This should be encouraged as it is believed to foster mutual understanding and respect (Marshall & Philips, 1999).

Baxter and Brumfit (2008) recommend that in order to change what has traditionally been deemed "professionalism," a whole-systems approach must be adopted. This approach involves redefining what society views as a profession and the roles attributed to the given "profession." The authors identified an important distinction between team identity and professional identity; the difference being that teams have important factors such a size and regular contact, that aid in creating a sense of belonging.

Within the academic literature, networks of care have been proposed as another potential solution to traditional hierarchical models (Addicott, McGivern, & Ferlie, 2010). A network of care refers to the collaboration of low-resource levels of care, secondary care, and tertiary care in the provision of health services. In essence, a referral hospital — usually secondary or tertiary care in a mid-sized city — will act as an outreach extension for rural health services that would otherwise not be sustainable (Addicott et al., 2010; Kornelsen & Friesen, 2016). The case for networks of care is rooted in the belief that with this model, knowledge can transcend boundaries. Networks have therefore been viewed as an opportunity for two-way knowledge sharing.

Using NHS Cancer Network as a case study, Addicott et al. (2010) highlighted the importance of creating a network of care. They reported that emphasis must be placed on naturally occurring relationships and an increase in support and initiatives for these relationships. Organic relationships were found to be the most successful because they are rooted in socialization and trust, which are vital to the formation of genuine communities of practice. Managed networks, which placed a higher importance on performance, were unsuccessful. It is suspected that this is because there was a significant focus on competition and following protocols which outweighed the need for knowledge exchange and the overall growth of the network to provide better care (Addicott et al., 2010). Another significant barrier to implementing a network of care is the attitudes of clinicians. In this study, clinicians frequently reported feeling that they had nothing to gain or learn from others and therefore would not participate in a network.

The objective of this Rural Surgical Network Meeting was to facilitate respectful dialogue with General Surgeons in British Columbia to clearly understand concerns and address questions around rural FPESS.

Meeting structure and purpose

An invitational meeting hosted by the Centre for Rural Health Research and in part by the Rural Coordination Centre of BC titled "Rural Surgical Networks," took place on November 28th, 2016 in Vernon, British Columbia. The initiative consisted of subject matter experts from the Canadi-

an Association of General Surgeons (CAGS) membership and practicing rural general surgeons. The event began with a review of the meeting goals and the agenda and was followed by invited presentations and discussions.

Invitees consisted of subject matter experts and key policy stakeholders, together representing a wide range of interests. The core goal of the meeting was to clearly understand the general surgeons' concerns about FPESS and address questions surrounding rural FPESS, in order to identify barriers that hinder the development of a rural surgical network between the two professional groups.

Two keynote presentations provided context on the history of rural health services and FPESS, as well as insight into future innovations. Following the presentations were question and discussion periods, lasting approximately 60 minutes in length. Notes taken by a scribe throughout the meeting were then summarized and synthesized by the author to develop policy-relevant findings and recommendations.

Findings and recommendations

Networks of health service delivery involving key "coaches" have been developing throughout rural Canada as a potential solution to rural health disparities, which result in part from the attrition of rural surgical and maternity services. When this model was presented to the invited surgeons, four main barriers were identified. Key findings and recommendations from the meeting participants are summarized herein and in Table 1.

Barrier 1 — The Role of Semi or Fully Retired Surgeons

Participants discussed the role of partly or fully retired surgeons taking part in the network model as potential coaches because of their increased availability compared to full-time surgeons. Key players expressed that although retired or semi-retired surgeons may have more time to commit to the network model of care, full-time non-retired surgeons are preferred and are better suited. The role of a coach is in part to connect the general surgeons to a larger network of surgeons and to be a reliable point of contact between regional referral centres. Naturally, this requires that the coach be a key player at the regional referral centre, something that would not effectively be possible with semi-retired or retired surgeons.

Barrier 2 — Unclear Role of a Coach

The participants expressed a sense of confusion regarding the role of a "coach." It was evident from the discussions that took place that role clarification would be needed in order to move forward with a network model.

One expert expanded on his vision of the coaching role and the development that has already begun in British Columbia. He expressed that the responsibility of the coach is not to perform any sort of training, nor is it to teach general surgeons how to do procedures. Instead, it is a much-needed opportunity for general surgeons to feel supported by their colleagues. Coaches would therefore act as a support system for FPESS, to help them improve upon the things that they are already trained to do.

Table 1 Identified barriers and solutions to adopting a supportive network model based on the participants' perspectives.

Barrier	Solution	Target decision maker (if applicable)
The role of retired or semi-retired surgeons	Have full-time surgeons act as coaches rather than retired surgeons	N/A
Unclear role of a network "coach"	Develop a clear definition and distribute it to all general surgeons	The network development team, and supported by various health authorities
The role of health authorities	Integrate health authorities in the development of a network model of care in order to initiate a change in culture and infrastructure	Health authorities throughout British Columbia
FPESS unrealistic expectations	Provide clarity to FPESS about the field of surgery in order to reduce unrealistic expectations and gain the support of general surgeons	FPESS program and its graduates
Remuneration and man power	Engage in further discussions about how the network model of care would recruit the necessary human resources and provide the general surgeons with appropriate remuneration	CAGS and the network development team

Barrier 3 — The Role of Health Authorities

In British Columbia, health services are regulated by regional health authorities. The majority of participants feel that the main obstacle to creating and implementing a network model of care does not lay with the surgeons, but rather with the regional health authorities. Work must be done to integrate the health authorities into the conversation around networks as early on as possible in order to effectively change the current culture and infrastructure. A potential first step in this area could involve the inclusion of local administrative staff and nurses in the coaching program.

Barrier 4 — FPESS Unrealistic Expectations

Participants noted a concern towards unrealistic goals of general surgeons. Of the few general surgeons that the participants had dealt with, they found that more FPESS hold the belief that once they have completed their training, they will be as competent as a surgeon. The event participants noted a deep concern for this type of mentality and expressed that they would require clear objectives from the network model program in order to get on board.

Barrier 5 — Remuneration and "Man Power"

As a natural follow-up to the discussions regarding the role of general surgeons in adopting the network model, subsequent discussions were held regarding what this would require in terms of remuneration and human resources. The participants were far from uniform in their opinions on the two discussion points. Some participants overtly stated the need to be compensated in monetary format for the time committed to the new model of care, while others disagreed, stating that the financial repayment would work itself out and that a larger focus should be placed on the human resources available to take-on coaching roles. It is evident that the discussion around remuneration and available human resources will require input from a larger sample of surgeons in order to draw an appropriate conclusion.

Moving forward

Rural surgical networks are an emerging potential solution to the various challenges of providing sustainable, local care in rural British Columbia. The actualization of the model is fraught with challenges inherent in low resource environments, including lack of timely access to specialist and maternal care, and difficulty maintaining competence and confidence due to low procedure volume. Findings from the invitational meeting suggest focusing on the following steps in order to enable the reduction of rural health inequities through the introduction of a rural surgical network.

1. Discuss scope of practice at the CAGS level.
2. Develop trust that is natural and instinctive by facilitating and encouraging surgeons to visit rural sites. It is anticipated that this will allow for a better understanding of the situation and resources.
3. Involve CAGS and health authorities as early on as possible in order to scale ideas and provide support.

Conclusion

The possibility of British Columbia adopting a network model of care has shed light on issues regarding privileging of FPESS and general surgeons to the forefront of healthcare research as well as health policy. The 2016 Invitational Rural Surgical Network meeting focused on topics related to the concerns of general surgeons in adopting the network model and engaging as "coaches." Realizing the potential of networks in improving rural health inequities and moving it from an idea to routine practice will involve addressing a number of important barriers. The recommendations emerging from the meeting underscore the need for more thoughtful discussions to develop the interprofessional trust and support between general surgeons and FPESS through an integrated health care system and proper networks of care.

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An Interdisciplinary Population Health Approach to the Radon Health Risk Management in Canada

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Résumé :

(traduction)

Le radon est un cancérigène qui se retrouve dans l'air intérieur et qui existe en quantités supérieures au niveau de référence du gouvernement fédéral (200 Bq/m3) dans environ dix pour cent des foyers canadiens. Le cancer du poumon provoqué par le radon tue plus de 3 000 personnes chaque année, ce qui représente 16 pour cent des décès annuels causés par le cancer du poumon au Canada. Le radon est la cause principale des décès attribués au cancer du poumon chez les non-fumeurs et la deuxième chez les fumeurs. Les enfants, les femmes et les fumeurs issus de groupes à faible revenu sont touchés de façon disproportionnée. Bien que le gouvernement fédéral ait réajusté le niveau de référence de 600 Bq/m^3 à 200 Bq/m^3 et que les gouvernements provinciaux aient révisé les codes de construction pour limiter l'exposition, les dernières avancées scientifiques pour adopter des stratégies de gestion du radon au Canada demeurent controversées.

Cette analyse se sert d'une approche intégrée axée sur la santé de la population pour examiner les relations et les interactions entre les déterminants de la santé de la population, tels que la biologie, la génétique, l'environnement, la profession, et les facteurs socioéconomiques qui influencent le risque du radon pour la santé. Les données recueillies et les politiques analysées en appliquant les principes éthiques et les principes de la gestion des risques ont mené à l'identification de stratégies de prévention efficaces, abordables à grande échelle et au niveau de la population. Les conclusions servent à améliorer la santé de la population en proposant des modalités d'intervention cruciales pour le Programme national sur le radon de Santé Canada.

Mots-clés :

Radon, risque pour la santé publique, déterminants de la santé, principes de la santé de la population, approche interdisciplinaire

Abstract:

Radon is a known carcinogen found in indoor air that exists at higher than the federal reference level (200 Bq/m3) in about 10% of Canadian homes. Every year, over 3,000 people die from radon-induced lung cancer, which accounts for 16% of annual lung cancer deaths in Canada. Radon is the leading cause of lung cancer deaths among non-smokers and is second among smokers. Children, women, and smokers from lower income groups are disproportionately affected. Although the Federal Government has reset the guideline (from the previous 600 Bq/m^3 down to 200 Bq/m^3) and provincial governments revised the building codes to limit exposure, there remain controversies with the latest scientific development in adopting strategies of radon management in Canada.

This review applies an Integrated Population Health Framework to look at the relationships and interactions between population health determinants such as biology and genetics, environment and occupation, and social and economic factors, that influence the health risk of radon. The evidence gathered supports policy analysis with the application of ethical and risk management principles that lead to the identification of efficient and affordable broad-based and population-level preventive strategies. The final inferences enhance the framework by adding critical intervention modalities to Health Canada's National Radon Program.

Keywords:

Radon, public health risk, determinants of health, population health principles, interdisciplinary approach

Introduction

Indoor air quality is one of the key determinants of health for Canadians as they spend over 90% of their time indoors (Setton et al., 2013). Having the world's largest deposits of high-grade uranium, Canadian land emits soil gas radon that can seep into homes (Natural Resources Canada, 2014). This route of entry is enhanced by a growing negative pressure inside heated homes when the temperature falls outdoors (Henderson, Kosatski, & Barn, 2012). Radon degrades to emit radioactive alpha particles that attach to indoor aerosols, smoke, and particulate matters (CNSC, 2011). Upon inhalation, these alpha particles can induce DNA mutations in lung tissue, which can lead to cancer (Noh et al., 2016).

About 10% of Canadian homes have been identified as containing radon gas exceeding the federal reference level (200 Bq/m^3; Henderson et al., 2012). Over 3,000 people die annually from radon-induced lung cancer, which accounts for 16% of all lung cancer deaths (Canadian Cancer Society, 2016). Radon gas is, therefore, the leading cause of lung cancer deaths among non-smokers and the second among smokers (Health Canada, 2014). Children, women, and smokers from lower socioeconomic status (SES) are disproportionately affected (Hill, Butterfield, & Larsson, 2006). While it is understandable that children have faster breathing thus inhale more air, and smokers have irritated lungs, it is still not clear why women are more susceptible to the effects of radon. A rough estimate determined the annual economic burden of radon-induced lung cancer to be about $18 million in Canada alone (Health Canada, 2014).

In 2007, the Federal Government revised the original 1988 guideline for acceptable levels of radon (lowering it from 600 Bq/m^3 to 200 Bq/m^3), when studies established a link between exposure to high levels of radon and increased risk of developing lung cancer. The National Building Codes were also revised in 2010 to limit exposure. However, there remain notable controversies within the scientific community regarding radon risk management strategies in Canada. In particular, the reference level (a cut-off point to minimize risk) is still twice that of the 100 Bq/m^3 recommended by the World Health Organization (2009). Moreover, research has indicated that there is no safe threshold level for radon and any amount of exposure may contribute to the development of lung cancer (Darby, 2005; Turner et al., 2011). As per Rose's population strategy of prevention, shifting the distribution of a risk factor in a whole population will lower everybody's risk and reduce the number of cases (Schwartz & Diez-Roux, 2001). Thus, spreading the radon management plan to address the population distribution of risk can lower the incidence of lung cancer cases at the population level rather than only targeting low SES individuals. Based on the "optimization principle" of risk management, the International Commission on Radiological Protection (ICRP) recommends reducing radon levels as much as possible (2009). Therefore, not enforcing the federal guideline and only applying the building codes where radon level is high, are not the best solutions for radon risk management.

In order to address these shortcomings, this review applies an Integrated Population Health Framework (Figure 1, only "framework" hereafter) to the assessment and management of indoor radon to identify affordable, broad-based population-level measures aimed at preventing radon-induced lung cancer in Canada.

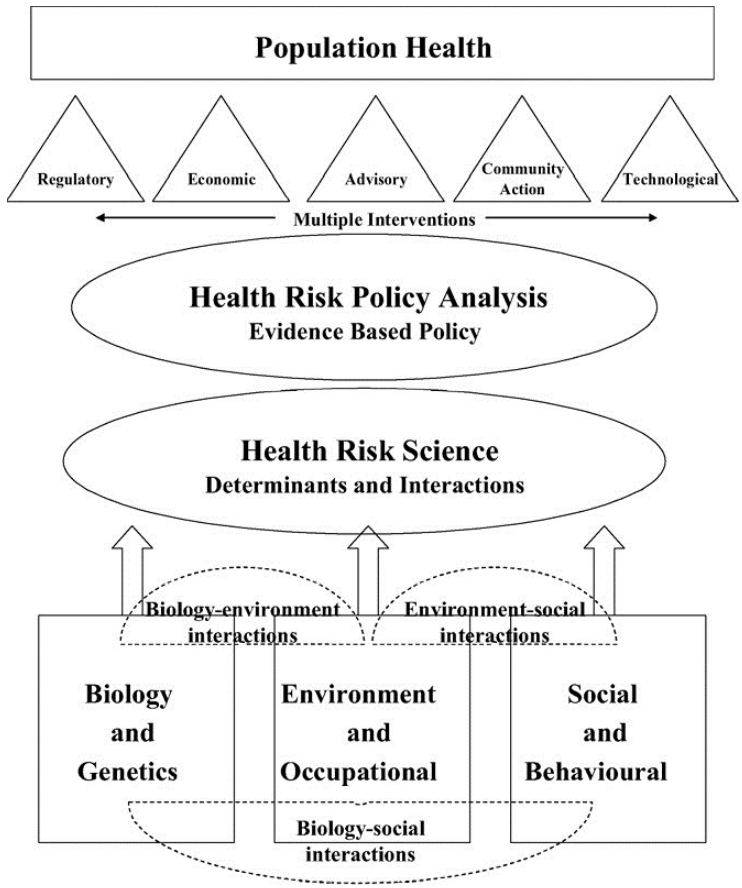

Figure 1

The integrated population health framework. Reprinted from "An Integrated Framework for Risk Management and Population Health," by D. Krewski, V. Hogan, M. C. Turner, P. L. Zeman, I. McDowell, N. Edwards, and J. Losos, 2007, *Human and Ecological Risk Assessment, 13*, p. 1300. Copyright 2007 by Taylor & Francis Group, LLC. Reprinted with permission.

Integrated Population Health Risk Assessment and Management Framework

The framework is based on three basic sets of population health determinants: i) biology and genetic endowment, ii) environment and occupation, and iii) social and behavioral factors. This review will synthesize evidence on the interactions among these determinants to identify preventive strategies and to inform effective policy-making. The integrated nature of the framework also considers public health values, health economics, and ethics, as well as risk management principles (Krewski et al., 2007). These all are relevant to designing population health interventions and will be discussed in light of the evidence gathered.

Methods

A framework synthesis examined the relationships and interactions among the determinants that shape radon public health risk. The following electronic databases were searched for literature published between January 1990 and June 2016: EMBASE, MEDLINE, CINAHL, Environmental Sciences and Pollution Management, Sociological Abstracts, and Cochrane (Wiley). Search terms used were: "radon," "public health risk," "housing and indoor air pollution," "population health," "interdisciplinary approach," "public health," "heath disparity," and "health equity." Reference lists of identified articles were also searched for additional and relevant citations. Other material retrieved included official reports, guidelines, and statutes from the governmental, non- and inter-governmental websites such as Health Canada, Canadian Nuclear Safety Commission, Canadian Cancer Society, US National Institutes of Health, International Commission on Radiological Protection, United Nations Scientific Committee on the Atomic Radiation, and World Health Organization.

Search Results

A total of 1,440 documents (articles and grey literature) were identified (Figure 2); 1,132 articles were peer reviewed, including primary studies and systematic reviews. Title and abstract screening found 291 articles to be potentially relevant. The full texts of 50 articles were not retrievable. Of the remaining articles, 241 underwent in-depth relevance checking with the objectives of this review and 158 articles were excluded. Subsequently, 83 articles were reviewed for eligibility and 36 were eliminated after full-text analysis. A total of 47 articles met the inclusion criteria. Among these, 19 were reviews [14 high quality, five moderate quality (AMSTAR criteria)] and 25 were quantitative studies [12 high quality (experimental), 11 average (case-control and

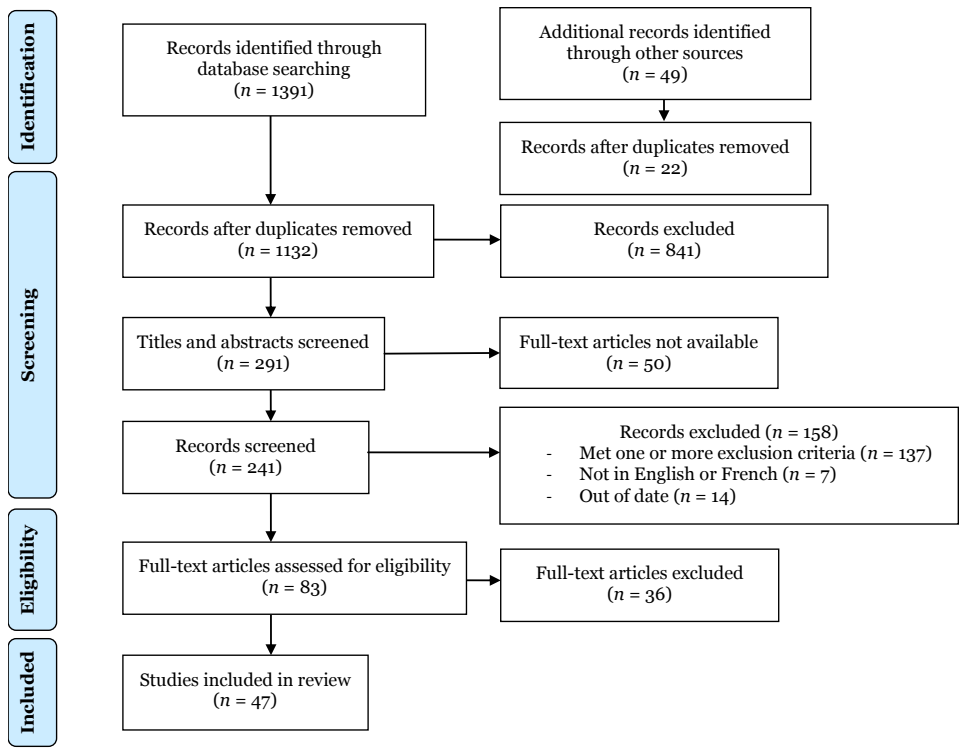

Figure 2 Prisma flow diagram.

cohort), and two weak (surveys)]. Only one qualitative study was a high-quality review. Two mixed methods studies were also included, one of which was of high quality and another of moderate quality. There were 11 reports, two statutes, one glossary, one guideline, one essay, one editorial, one commentary, one conference paper, and three books also included to minimize the likelihood of publication bias.

Review Outcomes

Evidence garnered from the review were fed into the framework to explain the relationships and interactions of radon exposure to the three sets of population health determinants as follows:

1. Biology and genetic endowment: Feeble biological construction (Chauhan et al., 2012; Robertson, Allen, Laney, & Curnow, 2013) and genetic vulnerability (Druzhinin et al., 2015; Madas & Varga, 2014) make some people more susceptible to adverse environmental outcomes than others. Likewise, individuals with robust immunity are less affected than those with weak or hypersensitive immune systems (Lin et al., 2004). Similarly, the presence of certain genetic traits can make some people more vulnerable to hazards (Kiyohara et al., 2004). Hill et al. (2006) noted that risk varied based on age and sex; children are more affected than adults due to a higher respiration rate. Men being more aware of the risks of radon exposure, will test houses more often but are less concerned and less affected compared to women (Poortinga, 2008, 2011). Temporal trends in lung cancer mortality are increasing for women while decreasing for men (Branion-Calles et al., 2015). However, it is not yet clear whether this is due to the increasing rates of smoking among women or due to their spending more time indoors.

2. Environmental and occupational: Radon degrades at different speeds in different geographical, seasonal, and meteorological conditions. Because exposure is a function of the degradation rate, the risk is determined by these conditional factors (Appleton, 2007; Chen & Marro, 2011; El-Zaher, 2011). The lunisolar gravitational tides influence the geological environment and this, in turn, affects radon release and further degradation into alpha particles (Zakhvataev, 2015). The radon infiltration rate into homes increases as outdoor temperatures decrease because the warmer indoor environment creates a pressure differential that draws soil gas into the building (Henderson et al., 2012). Therefore, increasing airtightness of dwellings in pursuit of energy efficiency will increase radon emission from the ground (Vardoulakis et al., 2015). Exposure will also depend on the type of ventilation system used (exhaust fan or heat and energy recovery ventilators; Jerrett et al., 2005). Radon exposure varies with the change in occupation as certain occupational groups such as miners are particularly affected while working in closed mines (Field et al., 2006). Likewise, the status of being a tenant or house-owner has differential impacts as tenants have limited resources and authority to take remedial actions (Beck et al., 2013; Poortinga et al., 2011).

3. Social and behavioural: In North America, over 30% of homes are rented, and about 70% of tenants are young adults with children. This group is typically of low SES and is less likely to have knowledge about the risks of radon exposure or the means and rights to have their dwellings tested and repaired (Hill et al., 2006; Larson et al., 2011). There are clear socioeconomic differences in radon-related awareness, risk perceptions, and behaviors. People from lower SES (Kendall et al., 2016) and rural areas (Hill et al., 2006) are less likely to be aware of the risks of radon exposure. Time-series studies of exposure to air pollution found a higher risk of all-cause mortality for people of lower SES (Lin et al., 2004; Villeneuve et al., 2003). Adults in Canada spend 93.75% of their time indoor, either working, studying, playing, or just maintaining a sedentary lifestyle mainly due to the long winter season (Setton et al., 2013). Whereas increased mobility experienced in the summer, decreases the extent of exposure (Pope & Dockery, 2006). Lastly, smoking has a possible synergistic effect with radon, making smokers up to seven times more vulnerable to lung cancer risk (Lubin & NIH, 1994), increasing life-years lost threefold compared to never-smokers (Noh et al., 2016).

Interactions between the determinants

1. Gene-environment interactions: Genetic factors influence specific respiratory health outcomes associated with air pollution and lung cancer (Kiyohara et al., 2004). Although certain individual genes can only be activated by specific environmental triggers (Ruano-Ravina et al., 2014), a genetic correlation with radon has yet to be established.

2. Biology and social interactions: Radon-induced lung cancer is highly prevalent among miners who are also habitual smokers compared to non-smokers (Krewski et al., 2005). Furthermore, more social interaction is associated with more resources and social capital that boost immunity; thus, people with higher SES are affected less often than their low SES counterparts (Lin et al., 2004; Villeneuve et al., 2003).

3. Biology-environment interactions: Radon exposure occurs in houses that have cracks in the basement and are exposed to the soil (Jerrett et al., 2005; Lin et al., 2004; Villeneuve et al., 2003). Oftentimes, these houses will have more dust, aerosols, combustion by-products, and tobacco

smoke, which will mix with radon decay products (RDP) to get fixed in lung mucosa that is already irritated by tobacco smoking (Schmid, Kuwert, & Drexler, 2010).

4. Environment and social interactions: People of lower SES usually live in older houses that are under-maintained. They are less likely to change an old furnace and clean ducts regularly. In contrast, people with a higher SES maintain their houses and control or even modify their environment with newer technologies (Vardoulakis et al., 2015). However, a recent study in the UK shows an inverse relation to SES, whereby affluent houses that are air-tight and drought-proof have higher levels of radon (Kendall et al., 2016).

5. Behavioural and environmental interactions: Individual behaviour to risk responses such as closing windows to avoid crime or sleeping in the basement to avoid traffic noise, modifies the living environment, thus increasing the level of exposure to radon (Briggs, Abellan, & Fecht, 2008).

Radon health risk science

This section summarizes the review results by assessing the gravity of the problem and proposing solutions that prove efficacious in mitigating radon public health risk. As noted from early quantitative studies (Darby et al., 2005), the average annual exposure to indoor radon in Canada is 1.8 mSv, which is higher than the worldwide average dose of 1.2 mSv (UNSCEAR, 2011). The Lifetime Excess Cancer Risk (LECR) is 23,655 per million people in Canada; thus, radon poses the highest risk among the most common environmental carcinogens (Henderson et al., 2012). Similarly, Chen and Marro (2011) found radon equilibrium factors to be higher in both outdoor and indoor atmospheres in Canada. Despite the gravity of the risk, only 42% of homeowners have heard about radon and 5% have tested for it (Statistics Canada, 2015). Yet, according to a Canadian survey, there has been a significant rise in lung cancer risk due to residential level exposure.

The level of awareness about the risk is critical to scaling up the preventive programs (Beck et al., 2013). Risk perception raises concern and drives individuals to make proactive decisions to mitigate the risks. Evidence shows that low-income rural citizens do not understand the harmful consequences of radon exposure due to lack of access to adequate information (Hill et al., 2006). Disagreement also exists between experts and lay people about the gravity of radon risk. Therefore, risk communication approaches should consider people's psychometrics, as well as the social and cultural contexts that shape their risk perception (Poortinga, Bronstering, & Lannon, 2011). Krewski et al. (2006) previously identified the psychometrics that covered the perception of risk gravity: immediacy and severity of the effects, newness or uncertainty about the risk, voluntary nature of exposure, and the characteristics of individuals. Moreover, personal knowledge, beliefs, and worldview also play important roles (Poortinga et al., 2008). Social contexts can either amplify or attenuate the effects depending on factors such as access to media, education, and social position (Hill et al., 2006; Larsson et al., 2011). It is easier for public health authorities to encourage testing and remediation when homeowners are convinced that their property and its inhabitants have an elevated risk (Henderson et al., 2012). Such was the case in Winnipeg, where homeowners were unmotivated to act when the radon level reached 1100 Bq/m^3, but once they were made aware of the health risks, they became willing to pay for remediation even at a level of 702 Bq/m^3 (Spiegel & Krewski, 2002).

As per above evidence, radon exposure is a serious public health problem. People adopt testing and remediation measures widely once they are aware. Nevertheless, effective population health prevention policy should employ multiple approaches that are evidence-based, negotiated and accepted by the stakeholders, economically feasible, and ethically sound (Chen, Moir, & Whyte, 2015; Hystad et al., 2014).

Discussion and health policy analysis

The traditional knowledge-driven models where new knowledge creates pressure to adopt a policy is not ideal for the issue of radon. Considering the long-term effects of radon, public health professionals need to explore and integrate problem-solving, as well as interactive and political models of policy formulation, by synthesizing evidence from a variety of sources, engaging the vulnerable population, and raising awareness to create a social climate that is favourable for the policy (Nutbeam, Harris, & Wise, 2010). Milio's (1987) framework considers the broad social, economic, and political contexts beyond the views of the public to drive a policy initiative, whereas the 3-i framework from Political Science contemplates three specific actors for policy change: interest, idea, and institution (Hall, 1997). Accordingly, identifying the vested interests, conflicting values, ideas, and perspectives of radon stakeholders as well as exploring the capacity and roles of mandated institutions and organizations are all crucial for leveraging radon health risk policy.

Economic analysis

There has been no recent economic analysis on radon in Canada. Letourneau et al. (1992) conducted a comparative economic analysis and demonstrated that a universal radon

program would impose an unjustifiable financial burden; hence, they recommended some alternative courses of action that include imposing building codes for all new constructions, and testing and mitigation of houses at the point of sale. However, the latter does not cover rented and community houses that seldom are put up for sale, thus excludes over 30% of residents from the program. To achieve the population-wide goal of radon risk reduction, we should look for suitable, pro-equity interventions that will have maximum coverage.

Analysis of ethical principles

The ethical principles of radon public health risk management primarily relate to social justice, as there is an issue of health inequity. To this end, strategies should:

i. Adopt a fair process of decision-making that is unbiased and objectively covers all vulnerable dwellings as far as possible.

ii. Use the limited risk management resources optimally to maximize benefit.

iii. Foster informed risk decision-making by providing stakeholders with full access to the necessary information.

iv. Be flexible and evolutionary to accept new scientific evidence.

v. Be aware that complete elimination of radon risk is not possible even after employing all efforts (Krewski, 2015).

Radon health risk management: Multiple interventions

Drawing on the evidence synthesized by Krewski (2015), actions are required at multiple levels to reduce radon exposure and prevent lung cancer. In addition to the five actions mentioned in the framework, the following health communication and population-level preventive measures (suitable for lower-income households) are suggested that enhance the framework:

1. Regulatory action: Many European countries have introduced regulations to protect their populations from the risk of lung cancer associated with radon exposure (Bochicchio, 2008; Colgan & Gutierrez, 1996; Synnott & Fenton, 2005). In Canada, no law requires homeowners to test radon levels, minimize exposure, or disclose test results, apart from the limited building and construction codes enforced in certain high radon areas in Ontario and Quebec (CELA, 2014). There is an urgent need to pass a comprehensive radon act, imposing mitigation measures on all house owners and making it an essential condition to legalize all real-estate transactions.

2. Economic action: As mentioned, testing of homes at the time of sale and mitigation when necessary, have found to be the most cost-effective option (Letourneau et al., 1992). In this regard, the provincial government could provide a reasonable rebate to homeowners to compensate the cost of mitigation. However, this is not the solution for community houses and buildings that are rarely up for sale.

3. Advisory action: At the federal level, the guideline on radon is advisory, meaning that compliance is voluntary, and the responsibility for testing, remediation, and associated costs rests with the property owners. There are three different approaches: a) Guideline approach: Conducting research on the effects of radon exposure and evaluating the measurement techniques, thus, refining the guidelines. b) Consultative approach: Persuading homeowners to mitigate radon risks. Providing homeowners with a guide booklet can be an active approach by dedicated environmental health professionals. c) Administrative approach: Here, the local government assumes responsibility for designing and implementing formal safety standards and enforcing them through specialized agencies (Krewski, 2015). There could be an inspectorate within Health Canada to randomly inspect susceptible houses, test for radon, and advise on remediation.

4. Community action: Under planned community initiatives, a "Radon Committee" could engage members of the community in dialogue to increase awareness about the presence of indoor radon, radon health risks, cost-effectiveness of testing, and decision making for mitigation, where necessary. This committee could inform people that they are required by law to test and mitigate radon levels when buying or selling a home.

5. Technological action: The effectiveness of a radon remediation technique depends on the building architecture. As per current evidence, placement of a radon-proof slab during construction or sub-slab depressurization in existing homes is the gold standard for radon prevention and mitigation, and should be included in the guideline (WHO, 2009).

6. Risk communication: Uncertainty regarding the risk associated with radon should no longer be a challenge in persuading people. However, there remain constraints regarding costs of mitigation, lack of incentives, and inadequate access to information for residents (Ganong et al., 2008). It must involve having a clear understanding of people's knowledge and beliefs about the issue (Nutbeam, 2010). An effective risk communication campaign should

convey the message in a manner that the gravity of risk is understood up to the point where people are moved to act (European Commission, 2011). An effective strategy should engage stakeholders including government agencies, industries, unions, professional organizations, public interest groups, media, as well as individual residents (Krewski, 2015). Health Canada has been using social media, workshops, webinars, public forums, poster contests, trade shows, and conference events to communicate radon risk (Cheng, 2016). Regrettably, these communication efforts have not made a significant impact. Therefore, a better risk communication strategy should be based on sound theories to target behavioral issues that people can adopt gradually via their means and capacities. A combination of health belief theory and social marketing principles could be a good strategy to convey the gravity of the situation as well as to explain the benefits of mitigation. In this regard, Cheng (2016) stressed the identification and demystification of certain myths that are prevalent about radon. These include the reality of the mere presence of radon, the gravity of the risk, relations of its indoor concentration with human behavior, and the efficiency of mitigation. He also emphasized the need for contextual adaptation and engagement of the stakeholders to work together in sharing knowledge, expertise, and resources (Cheng, 2016).

Table 1

Preventive actions. Adapted from "Radon Testing for Low-Income Montana Families," by L. S. Larsson, P. Butterfield, W. G. Hill, G. Houck, D. C. Messecar, and S. Cudney, 2011, *Proceedings of the 2011. International AARST Symposium*. Retrieved from http:// www.aarst.org/proceedings/2011/RADON_ TEST-ING_FOR_LOW-INCOME_MONTANA_ FAMILIES.pdf. Copyright 2011 by AARST. Adapted with permission.

Know the Risk	Every home has radon. It's harmful at any level and adverse health effects are irreversible.
Talk and Exchange	Make radon a topic in the social discussion! Give radon test kits as a gift.
Move Up!	Avoid basement and ground level apartments. Move up kids' bedrooms and play areas.
Talk to the Landlord	If renting, talk to the landlord or property manager about measuring indoor radon level.
Test your Home	Ask homeowners whether a home is tested by a radon professional every two years.
See Results	Ask to see results of radon measurements for children's schools and day-care facilities.
Quit Smoking	If radon is higher than the guideline level, it's one more reason to quit!
Risks and Rewards	Consider the risks of having home-gym equipment in a high-radon basement.
Plan Saving	If you can't afford mitigation right away, make a saving plan, your lungs are worth it!
Clean Your Air	Place a surgical mask over desktop fan.
Shun Wood Furnace	Buy a portable air cleaner rather than use wood for heating.
Open Doors-Windows	Open doors and windows whenever the weather allows.
Employ your Furnace	Use high-efficiency filters to block radon particles.
Run a Fan	Run a fan with an electronic motor on a low-speed setting to clean indoor air.
Step Out	When possible, consider spending more time outdoors.
Open Vents	Increase ventilation under the house by opening foundation vents.
Seal Cracks	Control indoor radon by sealing cracks and openings in the basement.
Place a Membrane	Decrease radon by putting a plastic sheet over exposed soil in the cellar.
"Do-It-Yourself"	Testing is easy; search YouTube for "DIY home radon test."

Population-level preventive actions

Following Rose's principle, radon risk management should include broader population-level preventive actions that could be scaled-up to maximize the benefits (Milat et al., 2014). Table 1 below displays messages, activities, and strategies targeting low-income families that can increase radon program uptake.

Conclusion

This framework review makes clear the significant public health risk that radon exposure poses via its ability to induce DNA mutations even at a concentration below the current reference level. It captures the determinants shaping radon health risk and synthesizes scientific evidence to inform policy decisions and demonstrate a need for multilevel interventions. It identifies what is known so far, what works, and what is inconsistent with the latest scientific developments.

Finally, the framework suggests recommendations for action. These include cost-effective population-level measures that can be encouraged through Health Canada's National Radon Program, and suggestions that can be applied directly to the low-income households.

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Conflict and Disease: A Complex Relationship

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Societies will always be subjected to situations that test their tolerance thresholds. When a stressor exceeds a society's capacity to cope, "failure" of the system is often manifested as social unrest, falling along a spectrum of intensity ranging from civil wars and revolutions to riots, strikes, and protests (Braha, 2012). The conflict leading to social unrest is most often initiated by groups on the disadvantaged end of systemic inequalities, as a desperate effort at effecting change (Haas, 1986). Although social unrest is sometimes a necessary vehicle for cultural revolution, the resultant disruption of society invariably creates a volatile environment that is vulnerable to adverse health outcomes (Jovanović, Renn, & Schröter, 2012).

Societal health is an area that is particularly susceptible to disruption as a result of social unrest. In addition, some factors contributing to social unrest are independent determinants of health that directly promote adverse health consequences. Social unrest is a powerful warning sign for negative health outcomes due to its direct disruptive effects in addition to the simultaneous and independent influences of racial tensions, socioeconomic inequality, and economic collapse on both civil stability and societal health. Thus, healthcare providers must exercise a heightened level of vigilance in communities experiencing conflict.

Health consequences of social unrest

Disorder in society predisposes citizens to an inherently elevated risk of poor health outcomes. Aside from the burden placed on the medical system by physical injuries resulting from violent conflict (Ballantyne, 2006), various underlying consequences of social unrest indirectly impair health. Firstly, the displacement of individuals from their home regions as a result of local conflict is often associated with an increased incidence of infectious disease. Due to differences in endemic organisms between regions, displaced individuals can introduce new infectious agents into their places of refuge, while being susceptible to infection by the endemic organisms of their new locations (World Health Organization, 2000). The increased likelihood of injury and illness in turbulent situations is compounded by inhibited access to, and utilization of, health services. Amidst turmoil, physicians may feel pressured to relocate for political or safety reasons, leaving fewer healthcare providers for the remaining citizens. Depending on the extent of conflict, physical barriers, such as transportation blockades, may explicitly prevent individuals from accessing any available healthcare that remains. Even in the absence of such barriers, fear for personal safety may result in a negative correlation between healthcare seeking and the amount of conflict-related violence (Price & Bohara, 2012). In extreme cases, violent unrest can result in destruction of health posts, as well as kidnapping and torture of healthcare providers (Devkota & Teijlingen, 2010; Collins, 2006). Consequently, safety considerations may deter health aid organizations from serving these volatile regions (CLAS Berkeley, 2015). Social unrest produces various conditions that exert a direct impact on the health of those involved.

Impact of Ethnic Inequality

Cultural and ethnic inequalities create societal tensions that contribute to interpersonal conflict. When a division of power exists between ethnic groups, the relatively deprived group will inevitably perceive unfavourable biases in multiple settings. Furthermore, inequalities that arise from identity-based divisions tend to amplify negative perceptions, while simultaneously enhancing solidarity among the disadvantaged group, thereby inciting conflict and rebellion (Ostby, 2008). Even when conflict has not erupted, the pervasive tensions that exist between races can interfere with the provision of adequate healthcare. Many African American patients distrust their Caucasian physicians due in part to expectations of racism and financial discrimination. A lack of trust reduces the likelihood of healthcare-seeking and hinders patient compliance (Jacobs, 2006). However, a patient's distrust is not always unwarranted. Physicians may perpetuate perceptions of racism via alterations in their approaches to medical care based on patients' ethnicities (Wellesley Institute, 2012). Given the importance of the doctor-patient relationship in producing favourable outcomes, compromised rapport due to racial conflict presents a major barrier to healthcare.

Impact of Socioeconomic Disadvantage

The limited resource accessibility experienced by communities at socioeconomic disadvantage creates a culture of hostility towards societal institutions. The isolation experi-

enced in impoverished regions can result in distrust of mainstream society and aggression toward established institutions, contributing to social unrest (Polisen, n.d.). Medical care is among the most important resources to which individuals in disadvantaged areas have limited access. Affected individuals are less likely to have regular healthcare providers or to obtain preventative services, regardless of the availability of these resources (Kirby & Kaneda, 2005), possibly due to limited education and negative perceptions of mainstream society. Ironically, these individuals are often in the greatest need of healthcare services, given the adverse health behaviours such as poor diets, smoking, obesity, and inactivity associated with lower socioeconomic status (Darmon & Drewnowski, 2008; Pampel, Krueger, & Denney, 2010). Thus, disadvantaged communities are not only in a position of social volatility, but are simultaneously burdened with reduced baseline health status and subsequent barriers to improvement.

Impact of Economic Instability

Financial crises hinder quality of life, while promoting redistribution of funds away from areas that are most beneficial to citizens. A common feature of economic crises is a rapid increase in unemployment, which often results in instability and mass protest (International Labour Organization, 2013). The uncertainty associated with financial loss is also a significant stressor that can negatively impact mental and physical health. Throughout the economic crisis in Greece, mental illness and suicide rates have increased significantly, while HIV rates have also increased due to intravenous drug utilization (Simou & Koutsogeorgou, 2014). Furthermore, many individuals are thrust into poverty and subsequently face the barriers associated with low socioeconomic status. Despite the significant impact of economic collapse on societal health, the quality of healthcare is often paradoxically sacrificed due to reallocation of limited funds, as highlighted by the funding cuts to mental health and drug abuse prevention programs in Greece during its economic struggles (Simou & Koutsogeorgou, 2014). A society in economic crisis, therefore, faces a conflicting scenario with increased demand for, but reduced supply of, health services.

Role of Healthcare Professionals

The profound health-related impact of social unrest reflects a need for healthcare professionals to take action. The approach to alleviating the negative health consequences of social unrest includes eliminating the cause, and mitigating the damage. The powerful collective voice of physicians advocating for change can be utilized to modify factors that are strongly rooted in society. Promoting racial equality, encouraging fair distribution of resources towards the support of individuals in disadvantaged communities, and encouraging prioritization of healthcare in government fund allocation, could all reduce social unrest and its associated health consequences. However, given that systemic change cannot occur instantaneously, social unrest is inevitable and physicians must aim to minimize health consequences when conflict arises. The first and most important step is recognition of social unrest and identification of the responsible determinants. Healthcare providers should exercise heightened vigilance in communities experiencing conflict, to facilitate recognition of affected patients and initiation of preventative interventions. Social unrest in a given community should be noted as a risk factor for affected patients, prompting arrangement of interdisciplinary community resources, such as housing, vocational, and educational supports. Astute physicians should also demonstrate neutrality and professionalism in these situations, ensuring that all patients feel comfortable in the healthcare environment and that the physician-patient relationship does not suffer during times of hostility. Finally, physicians practicing in areas of persistent conflict can consider decentralizing or mobilizing their services in order to provide patients with safer means of accessing care.

While countless factors can contribute to social unrest, those with independent effects on both the stability and health of societies are of particular concern due to compounded health consequences. Given that social unrest stems from inequalities, worsening health outcomes in the disadvantaged group may contribute to further disparity, which could subsequently enhance social unrest, creating a vicious cycle of societal conflict and adverse health outcomes (Figure 1). Although physicians are traditionally most comfortable treating existing disease, primary prevention is the most effective means of eliminating adverse health outcomes. Physicians must break the cycle of unrest and disease in order to promote health stability in an inevitably unstable world.

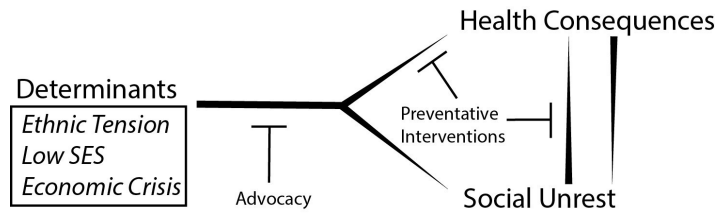

Figure 1 Cycle of social unrest and health consequences with key points of intervention.

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APPEL À CONTRIBUTIONS

Les critères de soumission se basent sur les douze déterminants de la santé, tels que définis par Santé Canada et l'Agence de santé publique du Canada. Idéalement, toute personne qui souhaite soumettre un manuscrit à la RISS devrait clairement identifier quel déterminant de la santé est associé à sa recherche, ainsi que la nature de cette relation : *de quelle façon le sujet à l'étude est-il relié à la santé humaine, à travers le déterminant de la santé choisi ?*

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