An Evaluation of a Dietary Sodium Reduction Research Consortium of Five Low- and Middle-Income Countries in Latin America

by

Janice Padilla-Moseley

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Thesis Examination Information

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An oral defense of this thesis took place on March 21, 2023 in front of the following examining committee:

Examining Committee:

Chair of Examining Committee	Dr. Nick Wattie
Research Supervisor	Dr. JoAnne Arcand
Examining Committee Member	Dr. Brenda Gamble
Examining Committee Member	Dr. Wally Bartfay
Thesis Examiner	Dr. Adam Cole

The above committee determined that the thesis is acceptable in form and content and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate during an oral examination. A signed copy of the Certificate of Approval is available from the School of Graduate and Postdoctoral Studies.

Overall Thesis Abstract

Background: Excess sodium consumption is a risk factor to cardiovascular disease (CVD). In Latin American countries (LAC), CVD rates are high. In LAC, policy development is complex and factors impacting research uptake into policies are largely unknown. The study objective is to determine if the short-term (e.g., research, capacity building), intermediary outcomes (e.g., policies) from a funded research consortium, involving Argentina, Costa Rica, Brazil, Peru and Paraguay, was achieved and to describe factors related to research uptake into policies. **Methods:** A summative evaluation using a logic model and a qualitative case study was conducted with a document review, survey and semi-structured interviews. **Results**: The research consortium achieved all short-term and select intermediary outcomes. Partnerships with actors functioned as barriers and facilitators: while, human and financial resources supported evidence gathering and policy making. **Conclusion:** The consortium activities resulted in novel data which facilitated with research adoption into dietary sodium reduction policies.
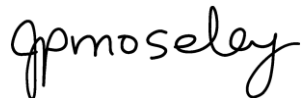

Keywords: program evaluation; sodium, policy, public health, research consortium

Author's Declaration

I hereby declare that this thesis consists of original work of which I have authored. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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The research work in this thesis that was performed in compliance with the regulations of Research Ethics Board under **REB Certificate number 14970 and 17292**.

gpmoseley

Janice Padilla-Moseley

Statement of Contributions

Chapter 5

     I co-developed the evaluation concept and design, as well as led data collection and analysis in conjunction with my thesis supervisor, Dr. Arcand. I was the lead scribe for the manuscript and technical reports. The research data described in Chapter 5 has been published as:

Peer-Reviewed Publication:

Padilla-Moseley, J., Blanco-Metzler, A., Mary R L'Abbé, & Arcand, J. (2022). *A Program Evaluation of a Dietary Sodium Reduction Research Consortium of Five Low- and Middle-Income Countries in Latin America. Nutrients*, 14(20), 4311–. https://doi.org/10.3390/nu14204311. A copy of this publication is included in Chapter 5.

Technical Report:

Padilla J and Arcand J. *Evaluation of a multi-country dietary sodium research program.* International Development Research Centre. 2020. (44 pages). Final Report: http://hdl.handle.net/10625/58972

Policy Brief:

Madriz K., Ramos E., Blanco-Metzler A, Saavedra L., Nilson Eduardo, Tiscornia V., Canete F., Vega J., Montero MA., Benavides K., Sequera G., Benítez G., Turnes C., Samman N., Ponce V., Meza M., Bistriche E., Tavares A., Allemandi L, Castronuovo L.,

Guarnieri L., Ríos B., L'Abbe M., Arcand J., Khaliq M., Grajeda R. , Franco B., **Padilla J**. Policy Brief: *The Challenge of Reducing Dietary Salt / Sodium Intake in Latin American Countries. Project - IDRC 108167 Scaling Up and Evaluating Salt Reduction Policies and Programs in Latin American Countries.* 2016-2019. Tres Ríos, Costa Rica: Costa Rican Institute of Research and Teaching in Health and Nutrition (INCIENSA), 2020.

Chapter 6

I led the study conception and design in collaboration with Dr. JoAnne Arcand, Dr. Ruben Grajeda, Nadia Flexner and Dr. Brenda Gamble. I conducted the majority of the qualitative one-on-one interviews, led the coding and data analysis in collaboration with Dr. Arcand. I was the lead scribe for the manuscript and technical report. The research described in Chapter 6 has been published and presented in/at:

Peer-Reviewed Publication (Submitted and Under Review):

Padilla-Moseley J, Sivakumar B, Flexner N, Grajeda R, Gamble B, Blanco Metzler A, Arcand J. (December 2021). *Factors impacting the uptake of dietary sodium research into sodium reduction policies in five Latin American countries: A Qualitative Study.* Manuscript submitted the journal Current Developments in Nutrition on November 9, 2022.

Published Conference Abstract:

Padilla-Moseley J, Sivakumar B, Flexner N, Grajeda R, Gamble B, Blanco Metzler A, Arcand J. *An exploration of the factors impacting uptake of dietary sodium research into dietary sodium policies in five Latin American countries.* 2021 Canadian Nutrition Society Meeting. May 2021. Published in Applied Physiology, Nutrition, and Metabolism.

With this abstract, I was a poster competition finalist in the 2021 Canadian Nutrition Society Nutrition Graduate Student and Trainee Award Competition.

Technical Report:

Padilla J, Sivakumar B, Flexner N, Grajeda R, Arcand J. *Facilitators and Barriers of Research Adoption to Policy Action in Five Latin American Countries.* International Development Research Centre. 2020. (12 pages). http://hdl.handle.net/10625/58965

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I dedicate this achievement to my parents, Fernando and Leocadia Padilla. My parents have a strong work ethic and engrained the value of education in their children. My parents worked hard to provide their children with opportunities they dreamed of achieving in the Philippines. At a young age, I remember attending my mom's graduation ceremony when she completed her nursing re-certification in Canada. Also, I recall how hard my dad worked to provide for his family, where he rarely missed a day of work. Thank you mom and dad for your sacrifices and lessons you taught us. Dad, I pray you are resting in peace with the Lord's perpetual light shining upon you knowing that I completed my degree.

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CHAPTER 5

List of Abbreviations and Symbols

CVD   Cardiovascular Disease

DOI   Diffusion of Innovation

IDRC   International Development Research Centre

INCIENSA   Costa Rican Institute of Research and Teaching in Nutrition and Health

KT   Knowledge Translation

LAC   Latin American Countries

LMIC   Low- and Middle-Income Countries

MOH   Ministry of Health

NCD   Non-communicable diseases

PAHO   Pan American Health Organization

TAG   Technical Advisory Group

USD   United States Dollar

UK   United Kingdom

WHO   World Health Organization

Glossary of Terms

Funding agency/agencies:

Consist of both private or public organizations, where they play an integral role in the creation and implementation of research into policy

Logic model:

A logic model is a graphic tool that outlines a program's activities, process indicators, short term research and consortium outcomes, intermediate outcomes and long-term outcomes according to the International Development Research Centre's program objectives.

Poor quality diet:

A poor quality diet is typically defined by one that contains little fruits, vegetables and whole grain foods, as well as high intakes of highly processed, energy dense foods, and foods that contain excess sodium, sugar and saturated fat.

Purposive criterion sampling

A sampling strategy used in qualitative research where the researcher selects individuals and sites because they meet the study eligibility and can inform an understanding of the research problem.

Snowball sampling:

A sampling technique used in qualitative research where people identify individuals of interest who are eligible to participate in the study and meet the study eligibility criteria.

Summative evaluation:

A summative evaluation is carried out for programs that are well underway or have been completed. Summative evaluations assess short, medium or long term outcomes which are both intended and unintended. Summative evaluations answer questions about the impact/difference a program made and/or if a program met all the intended goals.

Technical capacity:

Refers to the knowledge and scientific skills of an individual.

Thesis Structure

This thesis is organized as a manuscript-based theses, which includes the following chapters succeeding the introduction (Chapter 1). Chapter 2 presents a review of the literature. Chapter 3 outlines the research questions and objectives. Chapter 4 is a methods chapter, where Chapter 5 and 6 are written as independent but complete research papers. Chapter 5 has been published and Chapter 6 was submitted and is currently under peer review. Chapter 7 presents a general discussion summarizing the main findings and novelty from research papers, highlights sodium reduction policy implications, limitations and provides future directions.

Chapter 1: Introduction

Excess dietary sodium is the leading risk factor for premature mortality from non-communicable diseases (NCD), particularly cardiovascular diseases (Afshin et al., 2019). At a global level, in 2017, diets high in sodium were attributed to 3 million deaths annually (Afshin et al., 2019). Packaged foods are main sources of dietary sodium worldwide (Monteiro et al., 2013); however in some low- and middle-income countries (LMIC) and Latin American countries, discretionary salt added at the table or during cooking is the primary source. Sodium in salt is a major food preservative in fish and meat, are naturally occurring in foods such as milk, meat and shellfish, also enhances the taste of food (Aburto et al., 2013; He & Macgregor, 2008; Keast & Breslin, 2003). A 2008-2009 household survey budget in Brazil found that 74.4% of table salt or salt-based condiments were sodium sources available for intake in the country based on population buying patterns (Sarno et al., 2013). The discretionary salt added to food products, combined with food products high in sodium, could lead to over consumption of global mean sodium recommended values set by the World Health Organization (WHO) (Webster et al., 2021). Evidence demonstrates a strong relationship between excess sodium consumption and hypertension, stroke, kidney disease and cardiovascular disease (CVD) (Tommaso Filippini et al., 2021; Huang et al., 2020).

From 1990 to 2019, global trends found that hypertension has doubled in prevalence in people aged 30-79 years with most of the increase occurring in LMIC and middle-income regions (Paciorek et al., 2021). Specifically, LMIC are disproportionately impacted by health and economic burdens from NCD that contribute to two-thirds of

deaths and high direct healthcare costs for developing countries (Beaglehole et al., 2011). Policies on dietary sodium reduction are considered "Best Buy" policy interventions by the WHO, as they are feasible and cost-effective approaches to address CVD burden attributed to excess sodium consumption (World Health Organization, 2017).

Policies and programs designed to address NCD must be context specific, require not only robust data and resources to broker and transfer the information, but also to influence policy outcomes. Also, multiple strategic policy and program approaches are required to have a synergistic effect to support population-wide sodium reduction (Barberio et al., 2017). Multi-component strategies include food reformulation that is guided by sodium reduction targets, consumer education, social marketing to elicit behavior change, healthy foods in public settings, and front-of-pack labelling have supported changes in mean sodium reduction in other countries. This is a similar approach to Canada's healthy eating strategy which incorporates the elimination of industrially produced trans fat from the food supply (Vandenbrink et al., 2020). In the United Kingdom (UK), population sodium intake levels were successfully reduced from 3800 mg to 2400 mg per day through joint voluntary collaborations with the food industry to reformulate food products, implement awareness campaigns and enhancements to front-of-pack nutrition labelling (Appel et al., 2012; World Health Organization, 2010). Finland reduced CVD mortality rates by 80% through a community-based intervention program and the use of epidemiological data to monitor risk factor contribution on mortality change since 1972 (Vartiainen et al., 2010). Finland's example demonstrates the importance of surveillance data being used for CVD prevention programs and policies (Vartiainen et al., 2010).

Evidence-informed public health policies are essential to addressing NCD burden (Appel et al., 2012). Policy making related to dietary risk factors, such as sodium reduction, is complex and requires research evidence to support its development (Appel et al., 2012). Countries are generating research on population-wide dietary sodium policies and its health impacts, but the adoption of this evidence into policies is often slow or inconsistent in Latin American countries (LAC) (Rabadan-Diehl, 2017). The factors influencing research uptake into dietary sodium policies and programs is not widely understood in LAC. Often, the quality and content of research data with respect to clarity, relevance and reliability of the findings are important factors for the uptake of research evidence to guide policymaking in LAC, which is often limited or absent (Carden, 2009; Oliver et al., 2014; Webster et al., 2021). Overall, limited funding to support research were widely cited in the literature as barriers to research uptake into general policies (Ellen et al., 2018; Hyder et al., 2011; Mwendera et al., 2016). Likewise, improved dissemination strategies using knowledge translation principles (Oliver et al., 2014) and access to financial resources to support knowledge translation were cited as general facilitators to research uptake into general policies (Ellen et al., 2018).

Dietary sodium reduction policy and programs are complex, especially in LMIC. In LAC, dietary sodium reduction policies are particularly challenging as there are many barriers to policy development. A funded research consortium has been suggested as one effective way to address policy development and implementation in LAC, although that has yet to be determined (Smits & Denis, 2014). In 2016, the International Development Research Centre (IDRC) supported a research consortium to monitor the sodium content in packaged foods, fast foods, and artisanal and street foods; develop a regional social

marketing strategy to reduce salt/sodium consumption; and estimate the health and economic benefits of reducing population salt/ sodium intake. The IDRC research program was formed as a potential facilitator to address barriers to research uptake into policy. Investigating these factors is paramount as LAC would benefit from dietary sodium reduction policy implementation to address NCD burden, which has disproportionately high economical and health costs compared to high income countries.

The research in this thesis is comprised of two studies. The first study evaluates the short and intermdiate outcomes of a 3.5-year funded multi-country dietary sodium research consortium that assessed main sources of sodium in the food supply, conducted formative research that led to social marketing strategies to initiate behavior change, and health-economic analyses. The research objectives of the first study were achieved through capacity building, partnership formation, considering equity, diversity and inclusion. The second study explores the factors (barriers and facilitators) that led to uptake of the funded-research consortium into sodium reduction policies in the five countries that participated in a 3.5-year funded research consortium, as reported by researchers and policymakers.

Chapter 2: A Review of the Literature

2.1 **Literature Review Method**

   A narrative literature review of peer reviewed manuscripts, books, government

documents, policy briefs and grey literature were conducted to investigate how a funded

research consortium can bring evidence informed knowledge to influence dietary sodium

reduction policies in the interest of addressing hypertension in five LAC over a 3.5-year

grant period. In LAC, research data and publications on sodium reduction research is

limited. A narrative review was completed to identify and summarize the research topic

and highlight research gaps from previous publications and various sources.   From

January 2019 to January 2023, electronic database searches were completed using

PubMed, Medline via Ovid, Healthstar and Scielo. Articles were included if they were

less than 20 years old, or if they contributed valuable contextual data. A key word

search was conducted using the following key words: cardiovascular disease(s),

consortium, fund(ed), hypertension, implementation, knowledge translation, Latin

America, Latin American countries, low and-middle income countries, non-

communicable disease(s), policy(ies), policy making, program evaluation, salt and

sodium. Various combinations of these keywords were used to locate viable articles for

review. Inclusion criteria for the internet-based searches included: available abstract and

full-length peer review articles; government documents, technical reports, publications in

English and Spanish only if an English version was available; grey literature and various

study types such as trials, randomized control trials, case-controlled studies, observational

and reviews with a focus of dietary sodium reduction and/or non-communicable CVD. A

search for grey literature were found on the websites of government and specialized

health agencies and organizations involved in NCD policies and programs, such as the

Pan American Health Organization (PAHO) and the WHO. Sections on the website

named Documents, Reports and Library were accessed for grey literature. Editorials,

guidelines, letters testimonies and non-English literature were excluded from the search.

The reference lists of the literature were reviewed to retrieve potential additional

secondary sources if they met the inclusion criteria.

2.2 **Cardiovascular disease burden in LAC**

2.1.1 Global burden of non-communicable diseases (NCD)

Globally, non-communicable diseases (NCD) are responsible for a substantive

number of premature deaths (Bennett et al., 2018). On an annual basis, NCD-related

mortality account for an estimated 71% (40.5 out of 56.9 million) deaths annually

worldwide, where in 2016, approximately 57% (17 out of 30 million) deaths annually

were among people under 70 years of age (Beaglehole et al., 2011; Bennett et al., 2018).

In 2017, a global burden disease study found that hypertension was the leading risk factor

accountable for 10.4 million deaths annually and 218 million DALYs followed by

smoking which accounted for 7.10 million deaths annually and 182 million DALYs

(Abdulkader et al., 2018).

Many LMIC are undergoing epidemiological transition shifting as the primary

causes of mortality from communicable diseases (infectious diseases) to NCD (Omran,

2005; Santosa et al., 2014). Low-and middle-income countries are disproportionately

impacted by NCD where 82% NCD-related deaths such as CVD, cancer, chronic

respiratory diseases and diabetes are premature (Mendis, 2014; Williams et al., 2018)

compared to high-income countries (Beaglehole et al., 2011; Bennett et al., 2018). Cardiovascular related diseases are associated risk factors for over three quarters of deaths in LMIC (Bennett et al., 2018; WHO, 2013a). For example, NCD caused 75% of all deaths in Brazil, with CVD being the most frequent cause (Ministério da Saúde, 2019). Most premature deaths related to NCD are preventable, which calls for further action to decrease their burden.

2.1.2   Hypertension is the key factor to non-communicable disease

Excess dietary sodium intake is related to hypertension, a primary risk factor for CVD, and its high prevalence has resulted in hypertension being identified as a public health priority by the WHO (World Health Organization, 2021). Hypertension is defined as a sustained elevation of systolic blood pressure of $\geq$ 140 mm Hg and diastolic blood pressure of $\geq$ 90 mm Hg using automated office blood pressure measurement (Nerenberg et al., 2018).   In 2017, hypertension was considered the leading risk factor globally for premature death (10.4 million annually), followed by tobacco use (7.1 million annually) and metabolic syndrome (6.53 million annually) (Stanaway et al., 2018). By 2025, this rate is predicted to increase to 1.5 billion (He et al., 2012; Kearney et al., 2005). Two-thirds of the population in LMIC are hypertensive with prevalence rates two times higher in LAC compared to other regions (Kearney et al., 2005; Lamelas et al., 2019). In LAC, the prevalence of hypertension, being a modifiable risk factor, varies where 52.5% of the population in Brazil, 49.5% in Argentina, 36.2% in Costa Rica, 22% in Paraguay and 17.7% in Peru have hypertension (Caja Costarricense del Seguro Social, 2011; Lamelas et al., 2019; WHO, 2018).   This data underscores a need for NCD policies, legislation

and regulations to address hypertension, especially in LMIC, which are profoundly affected by this burden (Beaglehole et al., 2011).

2.1.3   Overall costs of NCD globally and in low-and middle-income countries

Non-communicable diseases, including CVD and hypertension, are major barriers to economic growth, health and living standards (Jailobaeva et al., 2021). By 2030, a projected $47 trillion United States dollars (USD), 75% of the global gross domestic product, will be attributed to NCD (Kazibwe et al., 2021). Populations are aging globally, where aging is associated with an increase in the prevalence of multiple chronic diseases and healthcare utilization and cost (Atella et al., 2019).   In particular, NCD in LMIC have a higher economic and social burden, where the direct costs of NCD are significantly greater compared to high income countries (Kazibwe et al., 2021). Here, low-income households experience substantive financial impacts when seeking healthcare, with pharmacological interventions bearing the highest cost (Kankeu et al., 2013). In LMIC, an estimated average healthcare expenditure for CVD of $6088.99 USD per patient per household is spent, which can entrench households into poverty (Kazibwe et al., 2021). More specifically, the direct healthcare costs of CVD was an average of $6230.04 USD in LMIC, compared to higher income countries with a direct cost of $720.49 (Kazibwe et al., 2021). As such, without effective interventions to address the economic burden of NCD, the latter will only continue to rise.

2.1.4   Healthy eating as one global strategy to address NCD

Globally, unhealthy diets are responsible for approximately 11 million deaths annually among adults, mainly due to CVD (Afshin et al., 2019). A poor-quality diet, one of four modifiable risk factors, is a main contributor to NCD-related morbidity and mortality followed by alcohol consumption, tobacco use and physical inactivity (L. Hyseni et al., 2017; Vos et al., 2013). Poor quality diets also predominately reflect low intake of fruits, vegetables and whole grain foods, as well as high intakes of highly processed, energy dense foods that often contain excess sodium, sugar and other unhealthy nutrients (Afshin et al., 2019; Vos et al., 2013). Consumption of this type of dietary pattern is common in high-income countries, and becoming increasingly prevalent in LMIC (Bhat et al., 2020; Buttriss, 2013). Diet modifications towards the recommended dietary sodium intake levels can reduce blood pressure which is associated with a decrease risk of stroke and fatal CVD in adults (Aburto et al., 2013).

2.3 Dietary sodium as a risk factor for cardiovascular disease

2.3.1   Sodium and CVD

Excess dietary sodium is the leading dietary risk factor for hypertension and CVD morbidity and mortality (Afshin et al., 2019). Globally, suboptimal diets consisting of high sodium is responsible for approximately 3 million diet-related deaths annually (Afshin et al., 2019). Sodium comes in many forms and are hidden in many food products. To name a few, sodium bicarbonate, sodium nitrate, Monosodium glutamate and sodium phosphate are ingredients commonly found in packaged and processed food

and meat products. In LMIC, high sodium diets are responsible for an average of 7

million deaths annually (Afshin et al., 2019). As such, dietary sodium consumption is a

modifiable risk factor which can minimize the risk of CVD.

High sodium intake is associated with microvascular endothelial inflammation and an

increase in extracellular volume resulting in an increased cardiac output (Blaustein et al.,

2012; Farquhar et al., 2015). Prolonged cardiac output has been linked to arterial

stiffness, leading to hypertension and CVD (Todd et al., 2010). As such, dietary sodium

reduction decreases systolic and diastolic blood pressure and CVD events (He &

MacGregor, 2003; National Academies of Sciences, 2019; Newberry SJ, 2018). Several

meta-analyses demonstrate the greatest clinical benefits of sodium reduction are observed

among those with hypertension, and among those with the highest levels of sodium intake

(Aburto et al., 2013; Tommaso Filippini et al., 2021; National Academies of Sciences,

2019). A meta-analysis of experimental studies found that modest reductions in sodium

intake of 1760 mg/day (equivalent to 4.4 g/day of salt), resulted in decreases in blood

pressure of in individuals with and without hypertension (He et al., 2013). Another meta-

analysis demonstrated, that on average, the observed blood pressure decreases were 5/3

mm Hg (systolic/diastolic) in people with hypertension and 2/1 mm Hg in normotensive

people (He et al., 2013). Another study found that systolic blood pressure was reduced by

3.47 mm Hg and diastolic blood pressure by 1.81 mm Hg when sodium consumption was

reduced to less than 2000 mg per day, WHO's recommended sodium intake value

(Aburto et al., 2013). Furthermore, randomized controlled trials involving sodium

reduction (e.g., Trials of Hypertension Prevention) found a 25% reduction in

cardiovascular disease for adults who were randomized to the "sodium reduction"

treatment arm, which can reduce the risk of long-term cardiovascular disease (Aburto et al., 2013; Cook et al., 2007; National Academies of Sciences, 2019). These findings suggest that even modest reductions of sodium would have substantive impact on reducing hypertension and CVD burden (He et al., 2013).

2.3.2   Dietary sodium recommendations

   The WHO set sodium intake recommendations considering the adverse impact of excess dietary sodium on blood pressure and CVD (WHO, 2012a, 2012b; World Health Organization, 2012a). Sodium is an essential nutrient required to maintain a number of cell and physiological functions (Aburto et al., 2013). As such, the WHO recommends that adults consume less than 2000 mg of sodium (i.e. equivalent to less than 5 g of salt) per person per day in order to reduce the burden of hypertension and cardiovascular disease (WHO, 2013a; World Health Organization, 2021). The global mean sodium intake is estimated to be 4000 mg of sodium/day, which is double the recommended levels (Webster et al., 2021). A majority of Eastern European and Asian countries are consuming more than 4800 mg/day of sodium (Powles et al., 2013). Dietary sodium reduction sources are highlighted in section 2.3.3 below. Regional efforts have been made to quantify sodium consumption in the last decade, but current research on sodium consumption trends is limited in LAC countries (Carrillo-Larco & Bernabe-Ortiz, 2020). Regardless of the lack of research, the few population sodium intake measurements that exist in LAC show overall sodium intake exceeds the WHO recommendations. For example, the estimated daily sodium intake is 4480 mg in Argentina (Ferrante et al., 2011), 3736 mg/day of sodium in Brazil (Nilson, da Silva, et al., 2020), 4600 mg in Costa

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Rica (Blanco-Metzler et al., 2017), 5480 mg/day in Paraguay (Sequera et al., 2017) and

4400 mg/day in Peru (Carrillo-Larco et al., 2018). In other countries in the Pan-

American Region, males have a daily sodium intake of 3133 mg/d and females have 2325

mg/day in Canada (Ahmed et al., 2021), and 3480 mg/day of sodium in the United

States of America (Claro et al., 2012).

2.3.3   Sources of dietary sodium

Dietary sodium is derived from diverse sources in LAC, which include sodium

added by food manufacturers to packaged and prepared (restaurants, street/artisanal)

foods, salt as a method of food preservation for meats and fish, as well as sodium from

discretionary salt added at the table or during cooking (Menyanu et al., 2019; PAHO,

2015). Overall, in LMIC, major sources of sodium include bread, meats, meat products,

baked products, instant noodles, salt preserved foods, milk, dairy products and

condiments (Menyanu et al., 2019). In high-income countries, dietary sodium intakes are

hypothesized to be consumed from packaged foods and meals eaten outside of the home

(Bhat et al., 2020).   There has been a shift in the sources of dietary sodium in LAC

towards an increased consumption of packaged foods that are often highly processed

(e.g., energy dense, high in sodium and sugar) (Dunford et al., 2012; Heredia-Blonval et

al., 2014). For instance, in Argentina approximately 65 to 70% of sodium is derived from

processed foods (Ferrante et al., 2011). The primary packaged and prepared food sources

of sodium in LAC include sauces, spreads, seasoning, meat, and meat products (Afshin et

al., 2019; Allemandi et al., 2015; Bojorquez et al., 2015; Kirkpatrick et al., 2019;

McLaren et al., 2016; Menyanu et al., 2019). In contrast, in Brazil national household

budget surveys identified that discretionary salt (74.4%) and condiments (18.9%) were the primary sources of sodium (Sarno et al., 2013). Similarly, Costa Rica identified discretionary salt added to household meals contributes to 60% of dietary sodium, whereas 28% of dietary sodium is from processed foods (Blanco-Metzler et al., 2017). In Peru, accurate data on the sources of sodium do not exist, rather sources were extrapolated from pilot studies that found sodium added to cooking was the main source (Bernabe-Ortiz et al., 2014). To appropriately address excess sodium intakes in Latin America, public health strategies should include policies not only targeting the reformulation of packaged and prepared foods to be lower in sodium, but also interventions to decrease consumer discretionary salt use by promoting population-level behavioural change (e.g., social marketing).

2.3.4   Social and cultural practices in LAC on sodium use

Social and cultural practices in LAC influence population sodium consumption levels. In Peru, households viewed themselves as low-salt consumers (Cateriano-Arévalo et al., 2021). However, Peruvian households add sodium to the cooking process driven by taste, culture and family influence (Cateriano-Arévalo et al., 2021). This study also found that Peruvian household cooking involved the addition of sodium at the onset for cooking and preparation, where approximately two tablespoons of table salt were used during cooking/preparation, a half a teaspoon was used for seasoning, and a quarter teaspoon at the conclusion of cooking (Cateriano-Arévalo et al., 2021). Likewise, China, India, Japan, Mozambique and Romania's daily sodium intake was derived from discretionary sources such as salt added to cooking or at the table (Bhat et al., 2020). In Costa Rica,

one study documented the historical, geographical, generational, social and cultural

factors influenced behavior toward sodium consumption (Blanco-Metzler, Núñez-Rivas,

et al., 2021). The addition of salt to food was a standing practice for people of

Indigenous origin and some could not consume foods without the addition of salt as it is a

basic ingredient to enhance flavor (Blanco-Metzler, Núñez-Rivas, et al., 2021). This

study also found that knowledge gaps existed, where individuals were not aware that

processed foods contained sodium. Also, public awareness was focused more on "salt"

and health, instead of "sodium" and health, where the relationship between salt and

sodium was unknown or misunderstood (Blanco-Metzler, Núñez-Rivas, et al., 2021). In

addition, demands for fast foods high in sodium have increased in Costa Rica due to

tourism and the younger generation (Blanco-Metzler, Núñez-Rivas, et al., 2021).

2.4   **Population-wide policies for sodium reduction**

2.5   **Global action on sodium**

Sodium reduction policies and programs are cost effective approaches to address

the burden of CVD in LMIC. However, policies, legislation and regulations to address

NCD may be inadequate or absent in LMIC (Beaglehole et al., 2011). The

implementation of population-based interventions to promote sodium reduction are cost

effective and estimated to avert 13.8 million deaths annually in LMIC, which would cost

approximately $0.40 USD per person to implement (Perviz et al., 2007). Modelling data

from Argentina demonstrated that sodium reduction policies over a 10-year period would

avert 55,000 total deaths, 27,000 stroke related deaths, 16,000 coronary heart disease

cases, 5,000 stroke cases, and 38,000 myocardial infarction cases (World Health Organization, 2012b). In Brazil, reducing population sodium intakes to 2000 mg/day in adults would lead to a projected $102 million USD annual cost savings from reduced CVD hospitalization (Nilson, da Silva, et al., 2020). Also, in Costa Rica, reducing population intakes to 2000 mg sodium per person per day would prevent 13% of deaths from CVD if the country's National Plan for the Reduction of Salt and Sodium was met by 2021 (Vega-Solano et al., 2021). As such, these findings underscore the need for cost effective global strategies to address the global burden of NCD.

In 2011, the United Nations held a meeting to declare a movement on the prevention and control of NCD, specifically CVD (Beaglehole et al., 2011). Since then, global efforts focused on NCD have increased. In May 2013, the World Health Assembly endorsed the WHO's Global Action Plan, which provides a roadmap of policy options for all Member States and stakeholders to achieve a 25% relative reduction in premature mortality from NCD. One of the nine voluntary global targets was for all Member of States to achieve a 30% relative reduction in salt/sodium intake in populations by 2025 (WHO, 2013a). The WHO also recognized that several policies for reducing dietary sodium could be considered as "Best Buys" since they are highly cost-effective and relatively feasible to implement (World Health Organization, 2017). Each country could select "Best Buys" according to its national context, with consideration of interventions that have the highest returns on investment; engagement and commitments with key sectors such as health, trade, commerce, and finance (World Health Organization, 2017). The "Best Buys" related to sodium included food reformulation, creating supportive environments (e.g., schools, healthcare facilities and other public

settings), mass media campaigns to illicit behavior changes, and front-of-pack labelling

on packaged food products. The WHO estimates a $13 USD return of investment for

every $1 USD invested in these "Best Buy" interventions (World Health Organization,

2018). Using policy approaches to sodium reduction can lead to successful population

level outcomes in NCD. The UK successfully reduced sodium intake levels from 3800

mg to 2400 mg per day through joint voluntary collaborations with the food industry to

reformulate food products, implement awareness campaigns and enhancements to front-

of-pack nutrition labelling (Appel et al., 2012; World Health Organization, 2010).   In

2021, the United States Food and Drug Administration released voluntary sodium targets

for more than 160 categories of processed packaged food to reduce hypertension and

CVD. Finland for instance, reduced coronary mortality rates by 80% through a

community-based intervention program and the use of epidemiological data to monitor

risk factor trends since 1972. Finland's example demonstrates the importance of

surveillance data being used for CVD prevention programs and policies (Jousilahti et al.,

2016; Vartiainen et al., 2010).

2.5.1   Adoption of national sodium reduction strategies

Globally, sodium reduction strategies are in place across all WHO regions. In

2019, 96 national sodium reduction initiatives were identified, with 16 countries in the

planning phases and 18 out of 49 countries (37%) were identified in the Americas (Santos

et al., 2021). Among these countries, 18 initiatives were identified in the Americas,

which has increased by 6 initiatives since 2014 (Santos et al., 2021). As of 2019, a total

of 16 countries developed national sodium reduction strategies, with Argentina, Brazil, Costa Rica, Paraguay and Peru among the countries.

National strategies are usually multi-component, using multiple types of interventions concurrently to facilitate dietary sodium reduction (Santos et al., 2021). Mandatory front-of-pack labelling is used most frequently in the Americas, with approximately 60% of these initiatives involved regulatory approaches (Santos et al., 2021). Globally, South Africa and Argentina are the only countries that have taken a regulatory approach that set maximum sodium levels for locally derived high sodium processed and packaged foods (i.e., 18 products in 3 categories in Argentina and 13 categories in South Africa) (Ide et al., 2020); with most countries taking voluntary approaches to reformulation. The UK's national approach involved voluntary sodium targets in processed foods with timelines, monitoring and surveillance; public awareness campaigns; nutrition labelling and reductions in restaurants. In fact, UK's voluntary sodium targets for 85 processed food categories set in 2005 is the most compelling case of dietary sodium reduction, as population wide sodium intakes were decreased by 15% (560 mg of sodium/day) between 2003 and 2011 (Feng J. He et al., 2014). South Korea has also developed a multi-component approach consisting of consumer awareness campaigns, increased availability of low sodium food options and recipes and voluntary reformulation effort, resulting in a 24% population sodium reduction intake (1346 mg of sodium/day) adults aged 30-49 years in the country (Park et al., 2020). Also, Japan and Finland experienced a high degree of success with their education campaigns to substantially reduce dietary salt consumption, and reduce its associated high stroke and cardiovascular disease mortality rates (Hyseni et al., 2017) . Sodium reduction policies

and programs have progressed over time and at different rates; however, only a few
countries have reported reduce average population-wide dietary sodium intake and no
LAC has reported reduced average sodium in-take levels in the population (Arcand et al.,
2019; Santos et al., 2021). A lack of reduced mean sodium levels in LAC can partially be
explained by slow progress in policy development and implementation in the region.

2.6   **Factors impacting policy development and implementation**

Evidence informed policy making and implementation is complex, and especially
challenging in LMIC (Carden, 2009). The WHO recognizes these complexities and
advises Member States to consider policy options for NCD that are relevant, equitable,
effective, cost-effective, affordable and feasible to implement according to national
circumstances (World Health Organization, 2017). A major assumption is that research
data directly influences policy; however, this is not always the case (Carden, 2009).
Researchers also commonly expect their findings to be quickly adopted into policy when
this process takes time to implement with observed effects (Carden, 2009). Identifying
the role of evidence and factors influencing policy has challenges as limited empirical
studies about policy processes or the implementation exist (Oliver et al., 2014).
Specifically, there is a lack of research evidence on the factors related to the uptake of
dietary sodium reduction policies in LAC in order to address the high CVD burden in the
country. Policy making related to dietary factors, such as sodium reduction is considered
highly complex and requires high quality research, among other factors, to support its
development and implementation (Appel et al., 2012). Some LAC are generating research
to inform population-wide dietary sodium policies, but evidence suggests adoption of this

research policies is often slow or inconsistent. Factors involved in adopting dietary

sodium policies and programs in LAC is poorly understood. Not to mention, it is not

known if a funded research consortium is an effective way to address policy

developments and/or changes in dietary sodium reduction policies in LAC as it was

intended to do (Smits & Denis, 2014). Investigating these factors (i.e., barriers and

facilitators) is paramount as LAC would benefit dietary sodium reduction policy

implementation to address NCD burden, which has disproportionately high economical

and health costs compared to high income countries. By identifying and understanding

barriers and facilitators to policy development and implementation can provide insights to

researchers and policy makers on what works and what does not work to bring timely,

relevant and reliable evidence to bear on policy decisions in dietary sodium reduction in

LAC to meet WHO's target by 2025. Although minimal literature exists specifically

related to factors that impact dietary sodium research into policy, insights into public

health policy areas are described below.

2.6.1   Barriers to policy development and implementation

   Research funding. The access to research and quality of research are frequently

reported barriers to policy development in LMIC (Carden, 2009; Oliver et al., 2014;

Webster et al., 2021). Shifts in political leaderships, declining currency value and gross

domestic product have negatively affected research coordination and funding in LAC and

Caribbean countries (Becerra-Posada et al., 2021). For instance, in Brazil, funding for the

science and technology sector experienced an estimated 70% reduction as a result of

government changeover in 2016 (Becerra-Posada et al., 2021). Meanwhile, in Mexico, in

2018 the government abolished funding for health research with no plan for future

investments (Becerra-Posada et al., 2021). Related to dietary sodium, a lack of funding

and technical capacity (e.g. knowledge and scientific skills) has led to limited reliable

local data to inform and monitor policy implementation (Webster et al., 2021). A

multiple-methods study conducted in Argentina, Mongolia, South Africa and Vietnam

was one of the first published studies to examine barriers and facilitators to sodium policy

implementation (Webster et al., 2021). The Walt and Gibson's Health Policy Triangle

framework was used to guide the data collection and deductive data analysis on factors

involving context, content, process and actors that influenced policy implementation

(Walt & Gilson, 1994). The Walt and Gibson's Health Policy dimensions are similar

dimensions used from Trostle's (1999) study which investigated the factors related to

communication exchanges between researchers and policy makers in Mexico. Trostle's

(1999) dimensions were used to inform the data collection and analysis for this thesis

research; however, these dimensions were applied to research implementation rather than

policy implementation. The Webster et al., (2021) study found that limited funds

impacted the generation of regional-specific data in Argentina and Vietnam. In Argentina

and South Africa, a lack of funds for monitoring and evaluation further impeded effective

policy implementation. In contrast, Mongolia's robust local data collection, which

informed their national salt reduction strategy, was possible through a substantial

injection of foreign funds (Webster et al., 2021). As such, funding to drive the generation

of research data is an important step in policy development.

Capacity. Lack of confidence and capacity in translating research into policy is an

underlying factor that may impede research adoption into policy (Uzochukwu et al.,

2016). In Fiji, policy leaders reported a lack of confidence and competency using research in food policy development (Latu et al., 2018). Here, policy leaders did not have the opportunity to build capacity on using research in policy development as external consultants were commissioned for this work. The lack of domestic capacity to use and understand the research methods commonly results in an over reliance on international external technical experts for support (Oliver et al., 2014). There are advantages and disadvantages of relying on international external technical experts to fill a knowledge and skillset gap. First, reliance on international external technical experts do not support domestic capacity development of researchers when skills and knowledge are acquired and utilized outside of the country (Carden, 2009). However, training international champions in the field could be utilized to enhance policy makers' understanding of the fundamentals for interpreting scientific evidence and how research is applied in this area (Appel et al., 2012). In South Africa, key stakeholders consisting of government, non-governmental organizations to name a few, lacked capacity for implementation and evaluation of policies (Webster et al., 2021). In Argentina, a lack of technical capacity (e.g. knowledge and scientific skills) and guidance were barriers to effective implementation of research on sodium reduction communication education campaigns (Webster et al., 2021).

Communication gaps. Poor communication and dissemination of evidence between health researchers and policy makers in LMIC is a widely cited barrier to the uptake of research into policy (Hyder et al., 2011). Researchers need to convey data into clear and succinct messages for policy makers, who may not have the technical background and are limited on time to conduct in-depth reviews of research (Appel et al.,

2012; Hyder et al., 2011). A qualitative study that included interviews with 83 policy makers in 6 LMIC found that public health research was being generated, but no formal channels were in place to allow research to flow through information to policy makers (Hyder et al., 2011). Resource constraints can influence communication as small teams have limited time to synthesize the research due to time and technical skills (Hyder et al., 2011). A lack of managerial support and high turnovers of personnel at the governmental level are other reported barriers that inhibited communication, which can create further disruptions and challenges to the review and use of research. These constraints may be more greatly exacerbated in LMIC, compared to high-resource countries. To date, limited studies exist investigating communication breakdowns between researchers and policy makers related to dietary sodium.

Food Industry opposition. There is a substantive amount of evidence suggesting the food industry has posed a major barrier on the development and implementation on dietary sodium reduction policy, dating back to as early as 1990 in the UK. Here, the UK food industry lobbied against the government adoption of a sodium recommendation of less than 2000 mg/day and threatened to withdraw political funding (He et al., 2014) . Likewise, a Canadian study on Health Canada's Healthy Eating Strategy observed a high number of the documented exchanges where the food industry utilized a wide variety of tactics to influence Canada's nutrition policy (Vandenbrink et al., 2020). The food industry's opposition is rooted by concerns that consumers would have reduced acceptability and thus purchase intentions of food products reformulated to be lower in sodium, due to an altered taste profile, which was perceived to potentially negatively impact sales revenue (Michael et al., 2021; Webster et al., 2021). Although mandatory

sodium limits for packaged foods benefits the food industry by creating a "level playing field" among companies, the food industry has lobbied against this approach. The influence of the food industry highlights the importance of researchers and policy makers to collaboratively utilize their persuasive power over the government to sway decision-making on public health policy in their favor.

2.6.2   Facilitators to policy development and implementation

Knowledge translation activities and utilization. Improving the strategies and tactics to translate and utilize knowledge is a reported enabler to use of research into policy (Oliver et al., 2014), especially since research takes an average of 17 years for evidence-based practices to be incorporated into practice. Simple packaging of information as a communication tactic is shown to be a key strategy to support research uptake (Ellen et al., 2018). Access to data that is relevant to drive policy is critical to policy development (Oliver et al., 2014). This includes data that is specific to a national or regional context, so that policies can be culturally relevant and impactful (Webster et al., 2021). Also, the format of the research findings, use of plain language and avoidance of technical jargon were important considerations to generate relevant research for policy makers (Dobbins et al., 2007; Oliver et al., 2014). Decision makers reported a preference to receiving information as executive summaries (53.2%) that are 2 pages in length and summarize the local context, available evidence, practice and policy implications for each evidence point, as well as in the form of abstracts (29.3%) and original articles (17.4%) (Dobbins et al., 2007). This highlights the need for relevant research evidence to the target audience members and engage in meaningful dialogue

with policy makers (Dobbins et al., 2007). Likewise, knowledge producers (i.e., researchers) need to evaluate the barriers and facilitators to research uptake to inform the knowledge translation strategy (Grimshaw et al., 2012). Most importantly, dedicated personnel focused on compiling and synthesizing research evidence to advise the government and ministry, as well as increased collaborations with researchers to discuss the findings, were viewed as an enabler in LMIC (Hyder et al., 2011).

Multi-sectoral relationships. Collaborations between policy makers and researchers are also cited as common facilitators to supporting the uptake of research into policy (Oliver et al., 2014; Weiss et al., 2016). In general, researchers rarely work in silos as there are benefits of collaborations in supporting communication and translation of research to policy makers and ensure that research aligns with policy maker priorities (Ion et al., 2019; Langlois et al., 2019). This has been documented related to sodium reduction, where one qualitative study found that strong political collaboration and support were facilitators at the onset of voluntary approaches to sodium reduction strategies in Argentina and South Africa (Webster et al., 2021). Partnerships with the food industry and with the media were attributed to researcher and policy maker success in achieving a 15% sodium reduction in sodium intake in the UK (Hyseni et al., 2017).

Partnerships with non-governmental organizations and international scientific experts are also a documented facilitator related to the use of research in sodium reduction policy making, including in Argentina and South Africa during the development and implementation of mandatory limits for the sodium content of packaged foods (Webster et al., 2021). In 2015, PAHO, the regional office for the Americas of the

WHO, assembled a Technical Advisory Group (TAG) on Cardiovascular Disease

Prevention expert group which had a mandate to provide technical support, supply tools

and issue recommendations for strategies and interventions to Member States in their

efforts to reduce dietary sodium consumption (e.g., the development of harmonized

regional sodium targets for packaged foods; a set of guidelines that are especially relevant

when national food supply data is unavailable for local target setting; creation of dietary

sodium surveillance protocols) (Pan American Health Organization, 2021d). The TAG

has also created dietary sodium surveillance protocols. As such, non-governmental

organizations and other institutions can mobilize resources to inform sodium reduction

policies.

 Funding for research and knowledge translation. Funding agencies, consisting of

both private or public organizations, play an integral role in the creation and

implementation of research into policy. An example of the impact of funding can be

observed in the United States. In the 1970's, the United States National Heart lung and

Blood Institute funded epidemiologic and clinical research on the health effects of

sodium intake (Appel et al., 2012). Subsequently, blood pressure education programs

were developed and the United States Dietary Guidelines for Americans made its first

recommendation about dietary sodium (Appel et al., 2012). In contrast, in 2003 the UK's

Consensus Action on Salt & Health (an NGO) developed a dietary sodium reduction

program with the food industry and led advocacy efforts for policies at the national level.

Initially, the work completed by Consensus Action on Salt & Health was driven by

research staff being paid by other grants (He et al., 2014), with financial support

eventually coming from external grants specific to the cause. Many funding agencies

incorporate knowledge translation as an agency mandate (Cordero et al., 2008; Smits & Denis, 2014). Research funding that includes funds to support knowledge exchange between researchers policy makers has been reported to be a facilitator in research adoption (Ellen et al., 2018). Many LAC have relied on international donors and sponsors to direct funds for health research agendas (Moloney, 2009). As such, funding is essential to support data acquisition and knowledge translation to facilitate with successful implementation of research into policies.

2.7   **A multi-country research consortium in Latin America**

In 2015, the International Development Research Centre (IDRC), a Crown corporation of the Canadian federal government, developed a "Food, Environment and Health" international research funding consortium to offer resources and support for research knowledge advancements in developing regions where financial resources are scarce. The funded consortium aimed to focus on public policy interventions on food systems to impact healthy and sustainable diets and to develop and/or scale up market innovations for changing local and national food systems in LMIC. Thus, in 2016, the IDRC funded a multi-country research consortium consisting of researchers and knowledge users from Argentina, Brazil, Costa Rica, Paraguay and Peru (referred to as the "IDRC countries"). The grant objectives focused on the generation of research data and knowledge translation to policy makers to drive the development of sodium reduction policies (IDRC Grant 108167, 09/2016 to 03/2020). To achieve the research objectives, the funding supported the development of research capacity, the formation of

partnerships, strategies for equity, diversity and inclusion, and the development of integrated and end-of-grant knowledge translation strategies.

Under the funded IDRC research consortium, several strategic research program objectives were implemented to drive sodium policy. The first research program objective assessed the sodium content of packaged foods and the proportion that meet sodium reduction targets. Also, this project objective determined the sodium content of key artisanal, street & fast foods by direct chemical analysis. This objective addressed a lack of high-quality data on the sodium content of foods in LAC, providing data to policy makers and the food industry that can drive the development of sodium reduction targets and food reformulation. The second objective consisted of social marketing research which identified consumer-related barriers and facilitators to behavioural changes to discretionary salt reduction. In addition, this objective developed a regional social marketing and communication strategy to broadly implement behavioural change social marketing campaigns to reduce dietary sodium consumption and bring awareness of the health impacts. The third program objective determined the health and economic benefits of population-wide sodium initiatives to inform sodium reduction policies. This objective provided relevant research data to policy decision makers on the benefits of sodium reduction policies through mathematical modeling on estimates of CVD deaths and cases prevented or postponed and its effect of disease treatment costs. In countries with financial restraints, the health and economic data provided strong arguments to persuade policy decision makers for change. The fourth program objective disseminated research findings through a systematic knowledge translation strategy that was customized to consider contextual factors in each country, designed to enhance

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communication between researchers and policy decision makers. To achieve the research objectives, several partnerships were developed between the research teams, NGOs, international experts and government policymakers. Planned periodic training took place to build capacity, and efforts were made to support equity diversity and inclusion, including the incorporation of undergraduate and graduate students. Finally, the consortium was coordinated by a central site at INCIENSA in Costa Rica, who was responsible for financial management, but also for ensuring communication and strategies for team building and collaboration.

Overall, it was anticipated that the IDRC's funding and activities that took place under the research consortium would lead to success in achieving the consortium's short term (e.g. research generation and capacity building) and intermediate outcomes (research adoption into dietary sodium reduction policies). In part, these benefits would be achieved since a consortium was utilized to address several barriers and facilitators associated with research and policy development and implementation, as reviewed in Sections 2.6.1 (e.g., research funding, capacity, communication gaps, food industry opposition) and 2.6.2 (e.g. knowledge translation, partnerships, funding). However, there are no data to suggest that such consortium-based funding investments positively impact health policy implementation. This research gap is addressed in this thesis.

Chapter 3: Research Question and Objectives

Population-wide dietary sodium reduction policies and programs are key strategies to reduce health and economic burden from CVD and hypertention. However, policy development and implementation of dietary sodium reduction policy are complex and challenging, especially in LMIC. A funded research consortium has been suggested as one effective way to address policy development and implementation challenges in LAC (Smits & Denis, 2014), where the IDRC research program was formed as a potential facilitator to address barriers to research uptake into policy. This thesis addresses the following research questions based on the literature and known knowledge gaps in policy implementation.

Study 1 (Program Evaluation):

Research Question: To what extent does a funded research consortium consisting of five LAC meet its short-term outcomes (e.g., research capacity building) and intermediate outcomes (e.g., changes to policies and programs) during a 3.5-year period?

Objective: The objective of this study was to describe the impacts of a 3.5-year IDRC-funded research consortium on dietary sodium reduction policies in five Latin American countries (LAC) from Argentina, Brazil, Costa Rica, Paraguay and Peru. In a summative evaluation, this research measured the degree of success achieved in meeting the consortium-level outcomes and intermediate outcomes. Specifically, this program

evaluation assessed if the following consortium-level outcomes (i.e., short-term outcomes) were achieved:

1. The creation of scientific evidence and innovations across multiple research program objectives that can be scaled-up to produce policy changes across multiple LAC;

2. The formation of multi-sectoral and multi-disciplinary partnerships;

3. The formation of equitable, diverse and inclusive partnerships;

4. The enhancement of consortium researchers' confidence, capacity, and scientific abilities in conducting research to address public health nutrition issues in LACs.

The evaluation also assessed intermediate program outcomes which were defined as sodium reduction policy and program changes (e.g., a policy commitment from the food industry and addition of sodium reduction to a political agenda); however, it was unexpected that would occur over the relatively short 3.5-year funding period.

Study 2 (Qualitative Case Study):

Research Question: What are the factors impacting the uptake of dietary sodium research into policies and programs in LMICs in Latin America?

Objective: The objective of this case study was to describe the barriers and facilitators to the uptake of research into dietary sodium reduction policies in five LAC. A constructivist approach informed a single qualitative case study.

Chapter 4: Design and Methods

The methods for both thesis studies are described in their respective Chapters. However, it is recognized that published papers do not have space for extensive methodological details. Therefore, this chapter outlines in detail the methodological steps taken to provide the reader with an understanding of the methodological rigor taken when conducting this thesis research.

4.1 Study 1 (Program Evaluation)

Rationale for approach

A reductionist linear evaluation model and system theory approach informed the program evaluation. Under a reductionist theory approach, individual program components are isolated by investigating and understanding the contribution of this component to determine the association with outcomes (Frye & Hemmer, 2012). This model has an underlying assumption that program components have a linear logical flow from the beginning to the end and from input to output (Frye & Hemmer, 2012). For instance, a small programmatic change results in predictable outcomes as they flow through orderly pathways like a logic model, which was used as the basis for this evaluation.

In parallel, a system theory approach informed the program logic model development and program evaluation. A system theory approach consists of iterative feedback loops, where evaluators focus careful attention on the programmatic components and its relationship to the program context (Frye & Hemmer, 2012). The

research consortium and regional context (e.g., social cultural and political features) were carefully considered in the development of the logic model and in the evaluation of the consortium's performance. Using a logic model is common in other public health policy interventions, as seen in tobacco control policy implementation (Langley et al., 2021).

Study Design

There are a variety of evaluation types based on when the evaluations are being conducted and the type of information that is being collected (Bartfay & Bartfay, 2018). Formative evaluation is one type of evaluation that focuses on programs that are in the planning and/or development stage. Under a formative evaluation, needs assessments, pilot tests, and/or preliminary analysis are completed to ensure that the stakeholder's needs are being addressed at the onset of the program (Bartfay & Bartfay, 2018). Process evaluation is another type of evaluation that focusses on programs that have already been implemented and are well underway with a focus on the implementation of tasks and procedures (Bartfay & Bartfay, 2018). A summative evaluation is another type of evaluation which is carried out when a program is well underway or has concluded. A summative program evaluation is used to evaluate the short, medium and/or long term outcomes of a program and to assess if the program made a difference, made an impact and/or met all intended goals (Bartfay & Bartfay, 2018). A summative program evaluation was selected to carry out this research at the conclusion of the 3.5 year grant period as medium and long term outcomes take a longer time frame to observe changes.

A summative program evaluation was completed at the end of a 3.5-year funded research consortium. This evaluation was guided by a logic model, which was

established at the onset of the grant and formed the foundation of the evaluation plan.

Funding agencies in North America commonly require the use of a logic model (Frye &

Hemmer, 2012). Consortium researchers co-constructed a logic model that outlined

process indicators, short term research and consortium outcomes, intermediate outcomes

and long-term outcomes according to the program objectives (Figure 5.1). Existing

literature has criticized the logic model for its failure in capturing external contextual

factors such as political, environmental and economical factors, that are not under the

program's control but can influence the implementation and outcome (Ebenso et al.,

2019; Hill & Thies, 2010). As such, consortium researchers provided iterative feedback

on drafts of the logic model, identified contextual factors which was discussed with the

research team who identified solutions and adjusted the indicators and outcomes until a

final version of the logic model was established. The logic model allowed evaluators to

streamline and focus on intended or unintended short-term and intermediate outcomes of

dietary sodium reduction policies at the national level.

Participants and Sampling

    Participants of the program evaluation included:

1.   The assigned consortium leads (n=5) from Argentina, Brazil, Costa Rica,

    Paraguay and Peru (one per country). Consortium leads oversaw the

    development and direction of the program activities in their country, and

    often led activities themselves to drive policy and program changes. The

    lead consortium Principal Investigator is from the Costa Rican Institute for

Research and Teaching in Nutrition and Health (INCIENSA) in Costa Rica, as the lead coordinating site.

2. Consortium research team members who supported the consortium leads to actionize the objectives of the research consortium.

Individuals who were not involved in the research consortium activities, either as a lead or a research team member, were not included in the program evaluation. The research consortium funder was not included as a participant in the program evaluation.

Recruitment Strategy

Study participants from each country were recruited by email invitation in January 2020 (Appendix A1). The recruitment correspondence took place in English. The recruitment email included a preamble about the nature of the survey, time commitment and confidentiality provisions. A maximum of 2 follow up emails were sent to participants.

Data Collection

Embedded document review. Several types of documents were reviewed, including the original grant application, interim progress reports, a compendium of knowledge translation activities conducted, meeting notes, memos, and country-level data on existing programs and policies from the PAHO (Pan American Health Organization, 2021c). An overview of the outcomes and sources of data examined in the program evaluation is listed in Table 4.1.

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Program Evaluation Survey.   In January 2020, a web-based survey through Google

Form (Appendix D1) was administered to the consortium researchers consisting of 5

consortium research leads and 13 researchers. The survey objective was to evaluate

consortium-level outcomes related to partnerships, capacity, and the overall experiences

as a consortium member. The ESSENCE framework   (Essence on Health Research,

2016) and Larkan's et al (2016) (Larkan et al., 2016) consolidated set of attributes

informed the survey questions related to partnerships. The survey consisted of 10

multiple choice questions based on a 5-point Likert scale and 8 open-ended questions.

Two external independent reviewers assessed face content validity of the survey using a

checklist with prompts for tone and clarity of questions, choice of words, and format of

the survey. To mitigate left-side selection bias (i.e. a phenomenon where respondents are

likely to select options that are presented on the left side as they are accustomed to

reading text from left to right), the survey response options were presented in ascending

order (e.g. strongly disagree, disagree, neutral, agree, strongly agree) (Chyung et al.,

2018). Evaluators often use closed ended questions in surveys to collect quantitative data

(Chyung et al., 2018). However, open-ended responses were included in the survey to

allow respondents to provide feedback on their experience in their own words which is a

limitation for surveys with only closed ended response options.

Team meetings. In February 2019, the coordinating consortium team at INCIENSA

hosted an interim in-person team meeting with all consortium researchers and partners.

Consortium researchers from each country presented preliminary study results, sought

feedback and input from consortium researchers and partners on program logistics and

methodologies. During these meetings, challenges and successes with the research were

also captured. In January 2020, a one-week face-to-face meeting in Costa Rica took

place with the consortium coordinating team at INCIENSA. The coordinating team in

Costa Rica were interviewed about the program outcomes. Meeting notes taken and

subsequently used to inform the evaluation report. Three additional follow-up interviews

were conducted with lead consortium researchers from Argentina, Brazil, Paraguay, via

Skype, to expand upon and add clarity to the outcomes assessed in this evaluation. The

additional interviews were 30 minutes in duration and typed notes where used to

document responses. No structured interview guide was used as questions were based on

information gaps found in the document analysis which required clarification from the

lead consortium researcher.

Table 4.1 Outcomes and sources of data examined in the program evaluation.

	Document Review	Survey	Interviews	Qualitative Study
Short term Research Outcomes *(Primary program evaluation outcomes)*				
Outcome 1: Research conducted, data generated and innovations scaled-up or created	X	X	X	X
Consortium Outcomes				

(Primary program evaluation outcomes)				
Outcome 2: Multi-sectoral and multi-disciplinary partnerships are newly formed and/or strengthened, engaged and activated		X	X	
Outcome 3: Partnerships and collaborations formed are equitable, diverse and inclusive		X	X	
Outcome 4: Confidence, capacity, and scientific abilities to conduct research to address public health nutrition issues in LAC is increased		X	X	X
Intermediate and Long Term Outcomes ● As per logic model. Documented if identified during the evaluation.	X	X	X	X

Data Analysis

Research consortium outcomes were systematically evaluated and analyzed using multiple methods and data sources on information related to the research consortium's

design, objectives, implementation of the objectives for the purpose of monitoring the

consortium activities and providing a report to the IDRC. Program evaluators conducted

a thematic deductive analysis of all data sources to report patterns and themes within the

data. First, evaluators familiarized themselves with the data, generated initial codes,

searched, reviewed and defined themes, followed by a write-up (Braun & Clarke, 2006).

Codes and a codebook were established a priori using the DOI and Trostle's et al (1999)

themes which are listed in Table 4.2. The graduate student lead coded these data sources

using NVivo Software (Version 12). Descriptive statistics were used to analyze results

from the program evaluation survey. Evaluation data was triangulated through multiple

data sources (e.g. document review, team meeting notes and survey) that ensured

validation, credibility and added to the breadth of findings.

Table 4.2. Parent and child codes for qualitative research

Main code (Parent)	Sub code (child)
Facilitators	**Actor** • Government political will • Formation of new partnerships
	Content • Scientific data
	Context
	Process • Capacity building • Funding • Knowledge Translation
	Relative Advantage

Barriers	Actor
	• Food industry
	Content
	Context
	• Change in leadership
	Process
	• Human resources

4.2 Study 2 (Qualitative Research)

Rationale for Approach

A constructivist approach informed a single qualitative case study that included

one-on-one interviews with the lead country researchers (i.e., consortium researchers) and

Ministry of Health (MOH) officers from five LAC. Constructivism has a focus on

understanding the historical and cultural context where people live and work, while using

multiple perspectives to illuminate the research topic. A case study approach was chosen

to explore how research outputs produced from the funded research consortium

influenced sodium reduction policy development and change, within a bounded system,

which is bounded by time and place (Creswell & Poth, 2018). Case studies of this nature

describe the real-life context of when an implemented intervention is applied (i.e. funded

research program), case may even a specific project (Yin, 2014).

Case

The case was defined as the IDRC funded research consortium that existed from

September 2016 to March 2020 (IDRC 18167). The case included a consortium of

researchers and Ministry of Health Officers from Argentina, Brazil, Costa Rica, Paraguay and Peru. The consortium was led by the Costa Rican Institute of Research and Teaching in Nutrition and Health (INCIENSA) and received technical support from the University of Toronto and Ontario Tech University. The funded countries are the unit of analysis for this case. The consortium was supported by a core advisory group, which included public health nutrition researchers, experts from INCIENSA, the University of Toronto, Ontario Tech University and PAHO, who provided scientific, knowledge translation, and program governance support.   The core advisory group made decisions by consensus and in rare instances when members had conflicting opinions, a vote would be called. Decisions with a majority vote would move forward. Program stakeholders consisted of IDRC program funders and consortium research leads, with policy decision makers as secondary stakeholders.

Study Participants and sampling

Two groups of participants were included in Study 2.

Group 1: Included in this study were the lead consortium researchers from Argentina, Brazil, Costa Rica, Paraguay and Peru (one from each country). The lead consortium researchers were public health researchers focused on NCD prevention and management in their respective countries who carried out and led the research activities under the funded program. Including a researcher from each country ensured diverse cultural (e.g., social standards, experiences, beliefs and traditions) and contextual influences (e.g., external situational) could be captured.

Group 2: Also included in this study were MOH officers from each consortium country. The MOH officer was an individual who worked for the Ministry of Health who was responsible for the development and/or implementation of NCD policies in their country.

MOH Officers who were involved in the collection or analysis of consortium research were excluded from the study.

A purposive criterion sampling was utilized for the qualitative interviews. Using a snowball sampling approach (e.g. a sampling strategy where cases of interest are identified from people who are aware of cases that are rich in information (Creswell & Poth, 2018)), the consortium researchers facilitated with the recruitment of MOH officers from each funded country. The consortium researchers had established connections with the MOH within their country which was leveraged for recommendations for a hard-to-reach population due to competing priorities and time constraints for activities outside of their role. A MOH officer was recruited from each country; however, the MOH officer from Brazil was unable to complete the interview due to scheduling conflicts. Extraordinary efforts were made to recruit a new MOH officer from Brazil; however, incumbents serving this position are limited and had competing priorities which precluded them from study participation. A total of 9 research participants consisting of 5 consortium researchers and 4 MOH officers from Argentina, Brazil, Costa Rica, Paraguay and Peru participated in the research study which is outlined in Table 4.3. Of these participants, 7 spoke English and 2 spoke Spanish.

Table 4.3 Research participants for case study

	Argentina	Brazil	Costa Rica	Paraguay	Peru
Consortium researcher (lead)	X	X	X	X	X
MOH Officer	X		X	X (Spanish)	X (Spanish)
Total number of participants	2	1	2	2	2

Recruitment Strategy

Study participants were recruited by email invitation, written in English, from November 2019 to January 2020 (Appendix A2). Study participants received a maximum of 2 follow-up emails when no response was received. Participants were provided with a consent form (Appendix B1), interview guide questions (Appendix C1 and C2) and country specific policy map for review via email prior to the scheduled interview (Flexner et al., 2020) . The policy maps listed government policies, programs, interventions and regulations on NCD and nutrition that was led by the PAHO (Pan American Health Organization, 2021c). Study participants provided verbal informed consent to the interviewer prior to commencement of the interview.

Data Collection

A 45 to 60-minute semi-structured interview took place via videoconference. Questions about the policy map for each country were embedded into the interview guide (Appendix C1 and C2 under section, *"Sodium focused policy and initiative changes from the onset of the project in 2016"*), providing a basis to explore the country-specific sodium-policy context and the changes in dietary sodium policies, programs, interventions, and regulations that occurred during the grant period. Participants received the interview guide containing the questions to be asked, which were available in Spanish and English, and a country-specific policy map prior to the interview.

A joint review and discussion of country-specific policy maps were completed during the interview (Flexner et al., 2020). The policy map was emailed to participants in advance of the interview. Participants commented on policies and initiatives that they were familiar with or had some involvement with its development. A discussion of these maps provided contextual background information about past, existing and future policies and programs in the country, as well as their progress in the region.

Separate semi-structured interview guides were created for the researchers (16 questions) and the MOH officers (20 questions). Interview guides were created for each participant pool with variations in the questions to reflect the two different types of respondents. A few examples include, additional questions were asked of the MOH officer to probe on how the research outputs of the research consortium would be used in policies development (Appendix C2, question 6). Also, MOH officers were asked how sodium reduction policies could be prioritized to the top (Appendix C2, question 7). The interview guides probed on developments and changes on dietary sodium reduction

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policies in the countries that occurred over the funding period and inquired about the barriers and facilitators to implementing dietary sodium reduction policies and programs. The Diffusion of Innovation (DOI) Theory (Rogers, 2003) informed the interview guide and prompts to questions. The DOI theory (Rogers, 2003) constructs identified how research has been adopted within organizations. The DOI and Trostle's et al (1999) dimensions of content, actors, process and context was used to inform the codes for data analysis (Trostle et al., 1999). Trostle's et al (1999) dimensions were used in similar research on policy implementation in LAC. The guides were validated by research team members to ensure clarity of questions, accurate choice of words, appropriate tone, and freedom from leading questions.

Interviews were conducted in English or Spanish by an English-speaking student lead or a Spanish-speaking research team member. Interview training sessions and post interview debrief sessions were conducted to support consistency with interview style. Skype interviews were audio-recorded with Audacity version 2.3.3 on a laptop with recordings stored on the university's cloud storage. Recordings were transcribed verbatim by two researchers and the transcript validation was completed through comparisons to the recorded interview. A translator from another university's translations services was contracted to transcribed the Spanish interviews and then translated the transcripts into English for analysis. The translator signed a confidentiality agreement prior to starting the work (Appendix E1). Reflective memos post interview were captured on ideas, insights, observations and a self-critique of performance in the interview (Groenewald, 2008). Also, the student lead wrote reflective memos as transcripts were coded which informed the code book described in the next section. All

direct and indirect identifiers were removed from the transcripts when participants

expressed opinions, direct quotes or identifiable information in the quote. Study

participants were identified by their professional role (e.g., consortium researcher or

MOH officer) and an assigned country code (Country A to E) to respect confidentiality.

In the written report, country names were only used when stating publicly available

information about the country.

Research Team and Reflexivity

The research team consisted of two graduate students, two Associate Professors

and two public health professionals from the PAHO and INCIENSA in Costa Rica.

Team members had mixed expertise in sodium research, policy and qualitative methods.

The graduate student lead is a North American with professional experience in

biomedical research ethics and previous experience in qualitative research in the North

American setting. A qualitative researcher from the research team provided subject

matter expertise on the study methods.

Some research team members had a pre-existing relationship with the consortium

researchers. This involvement established an authentic connection and rapport with the

researchers (Allen, 2017), who became participants in this study. This was crucial to

create a comfortable environment to disclose information in the qualitative interview and

program evaluation survey to provide insight to the researchers on the participants'

cultural and contextual perspective which informed the data analysis and interpretation of

the study findings. No previous relationship existed between the MOH participants and

the qualitative interviewers.

Data Analysis

Wolcott's (1994) approach to data analysis informed the inquiry for the qualitative research arm. Full text reviews of the transcripts were completed to become familiar with the data. In parallel, the student lead wrote memos consisting of reflective thoughts captured while reading through transcripts which informed the code book. Codes were established a priori using the DOI and Trostle's et al (1999) factors then further refined into themes with descriptions and eligibility criteria to inform the reporting. During a debriefing session, the student lead and another researcher refined the code book. All transcripts and reflective notes were uploaded into QSR NVivo Software Version 12, which was used for data organization and analysis.

The graduate student lead and another researcher independently coded all interview transcripts in a deductive fashion derived from the constructs and themes from DOI and Trostle's et al (1999) work by applying the codes to relevant segmented sentences and paragraphs consisting of specific illustrations, participant perspectives and direct quotes into the most appropriate code. The codes in Table 4.2 were expanded with sub-codes that emerged through subsequent reviews of the data. The graduate student and another researcher met for a second coding debrief to discuss emergent themes, patterned regularities and compared the coded passages. The graduate student and other researcher would decide if each coded passage was assigned the same code based on the code book. The decision would either be "yes" or "no", where the percentage of agreement would be calculated. Intercoder agreement was reached through consensus when both coders agreed on the application of a code to the selected segment. When coded texts varied, a

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discussion took place about what code would be applied for the selected passage. When disagreements occurred, a third researcher was consulted to provide input and select a code. Keeping in mind the "how" and "why" of the research question, final assertions of the findings concluded with what lessons were learned from the study promising patterns, insights and concepts from the data that were observed.

Evaluating Authenticity and Trustworthiness

The qualitative interviews underwent multiple validation strategies to support authenticity and trustworthiness of the data. Whittemore, Chase, and Mandle's (2001) primary criteria of credibility, authenticity, criticality and integrity were used to validate the data as it was most suited for an interpretivist lens with a focus on research reflexivity (Creswell & Poth, 2018). The interview transcripts were member checked by the study participants to affirm accuracy of content. The graduate student had post interview de-brief discussions and reflective memos to summarize the interview, provide preliminary interpretations and capture emergent themes to support authenticity. Also, another researcher who was familiar with the program was included to ensure authenticity of the data to provide an impartial view of the study, provide feedback on the codebook and contribute to the interpretation of the study findings through several peer review debriefing sessions. Written notes were taken during the peer review session to document the process, discussions and decisions made. Criticality and integrity were achieved through critical appraisal of all aspects of the research activities and through researcher's reflexivity at the onset of the study.

Chapter 5: A program evaluation of a dietary sodium reduction research consortium of five low-and middle-income countries in Latin America

Abstract

Excess dietary sodium is a global public health priority, particularly in low- and middle-income countries where rates of hypertension and cardiovascular disease are high. The International Development Research Centre funded a research consortium of five Latin American countries (LAC) to inform public health policy for dietary sodium reduction (2016 - 2020). The objective of this study was to determine the outcomes of this funding on short-term (e.g., research, capacity building) and intermediary outcomes (e.g., policies). A summative program evaluation was conducted, using a logic model and multiple data sources including document review, surveys and interviews. Researchers from Argentina, Costa Rica, Brazil, Peru and Paraguay produced a significant amount of scientific evidence to guide decision making on sodium policy related to its content in foods, consumer behaviors (social marketing), and the health and economic benefits of dietary reduction. Over 490 knowledge translation products were produced. The funding enabled training opportunities for researchers who developed skills that can be scaled-up to other critical nutrients and health issues. It was unexpected that intermediary policy changes would occur, however several countries demonstrated early policy improvements derived from this research. A funded research consortium of LAC is a practical approach to invoke policy innovations.

Keywords: program evaluation; diet, nutrition, sodium, policy, public health, knowledge translation, research consortium, community of practice.

5.1 **Introduction**

Low-and middle-income countries (LMIC) are disproportionately impacted by non-communicable diseases (NCD). Globally, two thirds of deaths annually are attributed to NCDs; while LMICs experience four-fifths of these deaths predominantly due to cardiovascular diseases (CVDs) (Beaglehole et al., 2011). NCDs have a high economic burden in LMICs, where direct costs are significantly higher compared to higher income countries (Kazibwe et al., 2021). Additionally, several NCD risk factors, including hypertension, are more common in LMICs (WHO, 2013a) which adds substantive social and economic burden from NCDs in these resource-constrained settings (Schutte et al., 2021)

Excess dietary sodium is a leading risk factor for NCDs, including hypertension, CVDs, stroke and kidney disease (Aburto et al., 2013; T. Filippini et al., 2021). Globally, excess sodium intake is associated with approximately 3.2 million deaths annually and 70 million disability-adjusted life-years (Afshin et al., 2019). Reducing dietary sodium lowers blood pressure and risk of hypertension, CVD and stroke-related deaths, as well as of other NCD related with excessive sodium intake (Aburto et al., 2013; Tommaso Filippini et al., 2021; Huang et al., 2020). The World Health Organization (WHO) recommends adults consume less than 2000 mg of sodium/day (equivalent to 5 g of salt/day) (WHO, 2013b); however, intakes in LAC far exceed these recommendations. For example, the average estimated sodium intake in Argentina is 4480 mg/day (Allemandi et al., 2015; Ferrante et al., 2011; Konfino et al., 2013), Brazil is 4720 mg/day (Nilson et al., 2017), Costa Rica is 4600 mg (Blanco-Metzler et al., 2017), Paraguay is 5480 mg/day (Sequera et al., 2017) and Peru is 3880 mg/day (Pesantes et al.,

2017). Dietary sodium sources vary by country. In most LAC, a large proportion of dietary sodium is derived from discretionary sodium (i.e., sodium added via salt during cooking or at the table)(Blanco-Metzler et al., 2017; Monteiro et al., 2010); whereas in some countries the primary source is from packaged and prepared foods (Allemandi et al., 2015).

The WHO set global targets to address NCD risk factors, which included a 30% relative reduction in mean population sodium intake by 2025 (WHO, 2013a). Policy interventions to support dietary sodium reduction are highly cost effective and thus have been labelled as "Best Buys" by the WHO (Webb et al., 2017). Not surprisingly, the number of countries with a national level sodium reduction program have increased by 28% since 2014 (Santos et al., 2021). These national sodium reduction programs are most often multi-component, incorporating a combination of the WHO's Best Buy interventions, including food reformulation with target sodium levels, consumer education, healthy foods in public settings, and front-of-pack labelling (Santos et al., 2021). However, despite country-level commitments to sodium reduction, progress towards the global targets is lagging. Only a few countries have reduced population sodium intakes and none having met WHO's global target for sodium reduction (Santos et al., 2021; World Health Organization, 2021).

In Latin American countries (LAC), policy development and implementation are complex and often challenging. Up-to-date national-level data that is high quality is frequently unavailable. This includes key data to drive sodium policy such as on the health and economic benefits of sodium reduction policies, the sodium content of foods consumed nationally and the factors influencing dietary sodium behaviors. A recent

qualitative study demonstrated that the limited availability of sodium research in LAC is often due to a lack of funding, and limited human resources and infrastructure available to researchers (Padilla-Moseley J, 2021). Researchers in LAC are also overstretched with their time, which limits their ability to effectively translate research findings to policy decision makers (Padilla-Moseley J, 2021); a commonly documented barrier related to nutrition policy research in LMICs in general (Hyder et al., 2011; Yamey, 2012).

In 2015, the International Development Research Centre (IDRC), a Crown corporation of the Canadian federal government, created a "Food, Environment and Health" research funding program. The funds were in support of research on healthy food systems in LMICs, with an aim of reducing the health, social and economic burdens of diet-related NCDs. Under this program the IDRC funded a five country Latin American consortium to conduct research to inform public health policy innovations for dietary sodium reduction (IDRC Grant 108167). The consortium was led by the Costa Rican Institute of Research and Teaching in Nutrition and Health (INCIENSA, Principal Investigator: A.B.M) with support from the University of Toronto and Ontario Tech University. The consortium included numerous researchers from Argentina, Brazil, Paraguay and Peru and stakeholders from non-governmental organizations across the region (IDRC, n.d). Multiple research program objectives were funded, focusing on assessing the sodium content of packaged foods using food labels (program objective 1A); assessing the sodium content levels in artisanal, street and fast foods using chemical analysis (program objective 1B); creating a social marketing strategy based on research conducted to identify local barriers and facilitators to individual-level sodium reduction (program objective 2); assessing the health and economic impacts of population-wide

sodium reduction (program objective 3); developing and executing country-specific knowledge translation strategies (program objective 4); and conducting a program evaluation of the funded consortium (program objective 5). Program objective 5 is the basis of this paper, which aims to share the overall impacts of the funded research program. Concurrently this paper offers a unique contribution to the literature by demonstrating if a funded research consortium in LMICs can effectively lead to advancements in dietary sodium reduction policies, among other benefits to the countries and the researchers (Smits & Denis, 2014). The IDRC funding was administered from 2016 to 2020 to five LACs. It was hypothesized that this "intervention" would stimulate collaboration and capacity building in conducting research and accelerate dietary sodium reduction policy development and implementation, ultimately improving health outcomes. Specifically, this program evaluation assessed if the following consortium-level outcomes (i.e., short-term outcomes) were achieved:

1. The creation of scientific evidence and innovations across multiple research program objectives that can be scaled-up to produce policy changes across multiple LAC;

2. The formation of multi-sectoral and multi-disciplinary partnerships;

3. The formation of equitable, diverse and inclusive partnerships;

4. The enhancement of consortium researchers' confidence, capacity, and scientific abilities in conducting research to address public health nutrition issues in LACs.

The program evaluation also assessed intermediate program outcomes which were defined as sodium reduction policy and program changes (e.g., a policy commitment

from the food industry and addition of sodium reduction to a political agenda); however it was unexpected that would occur over the relatively short 3.5-year funding period.

5.2 **Methods**

A summative program evaluation took place at the end of the consortium funding period. The evaluation took a multiple method approach using quantitative and qualitative data from diverse sources consisting of a document review, program evaluation survey, team meetings and qualitative interviews. The program evaluation was guided by a logic model (Figure 1) developed in 2016, as well as the Public Health Agency of Canada's Planning Public Health Programs (Public Health Agency of Canada, 2015) and the Centers for Disease Control's program evaluation framework (Salabarría-Peña et al., 2007; U.S. Department of Health and Human Services Centers for Disease Control and Prevention, 2011). The logic model defined process indicators, consortium outcomes (i.e. short term outcomes), intermediate and long-term outcomes ("A Comparative Analysis of Evaluation Utilization and its Cognate Fields of Inquiry: Current Issues and Trends1," 2006; King et al., 2007). Consortium researchers provided iterative feedback of the logic model to ensure the LAC contextual factors were considered.

Figure 5.1: Research Program Logic Model

	Objective 1A	Objective 1B	Objective 2	Objective 3	Objective 4	Objective 5
Activities	Assess the sodium content declared in nutritional labeling of local packaged foods and the proportion that meet sodium reduction targets.	Determine the sodium content of local key artisanal, street & fast foods by direct analysis.	Identify local consumer-related barriers and facilitators to discretionary salt reduction and develop a regional social marketing and communication strategy.	Determine the health and economic benefits of population-wide sodium initiatives to inform sodium reduction policies.	Disseminate research findings using a knowledge translation (KT) strategy that is specific to each country and research objective.	Establish structures, processes and strategies for project administration and partnership building, to ensure overall project success.
Process Indicators: Resources and Training	• FLIP app and database training conducted • Protocol manual and FLIP-LAC guide developed • Agreements for data collection obtained	• Protocol manual developed • Laboratory conditions and experience documented, recommendations for each country developed	• Trainings and workshops conducted • Research protocols developed	• Training on health impact and cost-effectiveness • Analysis conducted on health impact and cost-effectiveness	• KT training and mentoring conducted • A KT workbook for researchers developed for each research objective	• Logic model and timelines to guide project implementation developed
Process Indicators: Research Indicators	• Pilot study completed • A brand-specific database in each country developed • Data analyzed and results tabulated	• Proficiency testing completed • Foods identified and collected for analysis • Samples analyzed and results tabulated	• Ethics approvals obtained • Data collected and analyzed • Regional social marketing and communication plan established	• Development of models (PRIME and IMPACT) • Analyses conducted and results tabulated	• A KT strategy that is specific to each country and research objective developed • The developed KT strategies implemented	• Monthly core group meetings conducted • Biannual meetings with all countries conducted • Progress reports submitted to IDRC
Short Term Research Outcomes	Knowledge of the sodium content of packaged foods established and of the proportion of foods meeting the PAHO and/or national sodium targets	Knowledge of the sodium content of street, artisanal and fast foods	Knowledge of the barriers and facilitators to discretionary salt reduction. A regional social marketing and communication plan for discretionary salt reduction.	Knowledge of the estimated health impact and economic benefits of sodium reduction programs	Dissemination outputs and activities for optimal uptake and adoption in policy and practice.	Successful project implementation and scale up of sodium reduction research to achieve of Short Term Research and Consortium Outcomes

Short Term Consortium Outcomes

- Resources, research methodologies and innovations created by and for the Consortium are scaled-up and adapted for the participating countries.
- Multi-sectoral and multi-disciplinary partnerships are newly formed and/or strengthened, engaged and activated.
- Partnerships and collaborations formed are equitable, diverse and inclusive.
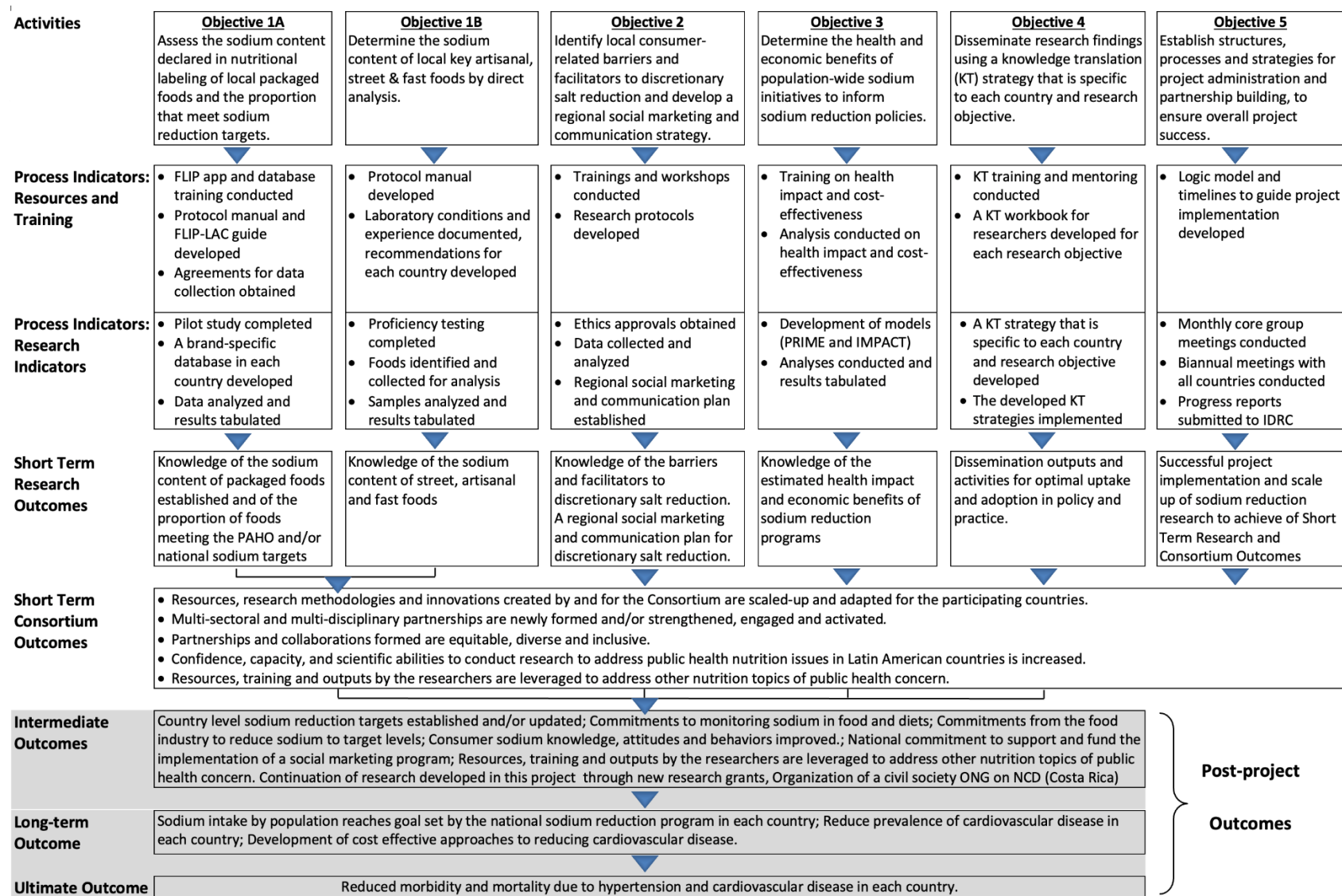- Confidence, capacity, and scientific abilities to conduct research to address public health nutrition issues in Latin American countries is increased.
- Resources, training and outputs by the researchers are leveraged to address other nutrition topics of public health concern.

Intermediate Outcomes

Country level sodium reduction targets established and/or updated; Commitments to monitoring sodium in food and diets; Commitments from the food industry to reduce sodium to target levels; Consumer sodium knowledge, attitudes and behaviors improved.; National commitment to support and fund the implementation of a social marketing program; Resources, training and outputs by the researchers are leveraged to address other nutrition topics of public health concern. Continuation of research developed in this project through new research grants, Organization of a civil society ONG on NCD (Costa Rica)

Long-term Outcome

Sodium intake by population reaches goal set by the national sodium reduction program in each country; Reduce prevalence of cardiovascular disease in each country; Development of cost effective approaches to reducing cardiovascular disease.

Ultimate Outcome

Reduced morbidity and mortality due to hypertension and cardiovascular disease in each country.

Post-project Outcomes

5.2.1 Data collection

Program outcomes were evaluated with multiple methods. This data added a variety of insights to the evaluation, including social, cultural, and historical contexts on the research landscape in a country.

5.2.1.1 Document Review

Several types of documents were reviewed, including the original grant application, interim progress reports, a compendium of knowledge translation activities conducted, meeting notes, memos, and country-level data on existing programs and policies from the PAHO (Flexner et al., 2020).

5.2.1.2 Program Evaluation Survey

In January 2020, a web-based survey was sent to the consortium researchers (n=18). The survey evaluated consortium-level outcomes related to partnerships, capacity, and the overall experiences as a consortium researcher. The ESSENCE framework (Essence on Health Research, 2016) and Larkan's et al (2016) (Larkan et al., 2016) attributes informed the survey questions related to partnerships. Included were 10 multiple choice questions based on a 5-point Likert scale and eight open-ended questions. Two external independent reviewers assessed the survey for face and content validity. A response rate of 61% was achieved, with responses received each participating country.

5.2.1.3 Team meetings

In February 2019, the leadership team at INCIENSA hosted an interim team meeting with all consortium researchers and stakeholder partners. Researchers from each country presented preliminary study results and sought feedback and input from their peers and partners. During these meetings, challenges and successes with research were

documented. In January 2020, a one-week face-to-face meeting in Costa Rica took place

with the leadership team at INCIENSA, where they were interviewed about the project

outcomes. Meeting notes were used to inform the evaluation report. Three additional

informal interviews were conducted with consortium researchers, via video conference,

to expand upon and add clarity to the outcomes assessed in this evaluation.

5.2.1.4 Qualitative interviews

From November 2019 to February 2020, a qualitative case study utilized one-on-

one semi-structured interviews with the consortium leads (n=5) and Ministry of Health

officers (n=4) from each participating country. The methodology and results have been

described previously in another qualitative study (Padilla-Moseley J, 2021). The Ministry

of Health officers were arm's length to the research and were interviewed due to their

role in policy decision making. The interviews were 45 to 60 minutes in duration and

explored the barriers and facilitators to implementing sodium reduction policies and

programs in the consortium countries. Themes from Trostle's et al. (1999) (Trostle et al.,

1999) and the Diffusion of Innovation (DOI) Theory (Rogers, 2003) informed the

interview guide. Verbatim transcripts underwent a deductive thematic analysis where two

independent researchers coded the transcripts.

5.2.2   Data Analysis

Qualitative data was analyzed using a thematic deductive analysis obtained from

the documents, transcripts from meetings and interviews and open-ended survey

responses. These data were organized and coded with Nvivo Software (Version 12),

using codes and a codebook that were established a priori using the DOI, Trostle's et al

(1999) themes and consortium and intermediate level outcomes from the logic model.

Quantitative data were analyzed using descriptive statistics. Evaluation data were triangulated through multiple data sources that ensured validation, credibility and added to the depth and breadth of the findings.

5.3 **Results**

The consortium consisted of researchers from the government, academia and NGO from Argentina, Brazil, Costa Rica, Paraguay and Peru. Each country had an assigned lead researcher (n=5) who oversaw the research activities alongside other researchers and funded research assistants. The Costa Rican Institute for Research and Teaching in Nutrition and Health (INCIENSA) was the technical and financial coordination and leadership site and led the consortium (Principal Investigator A.B.M). A governance group provided scientific, knowledge translation, and project governance support to the consortium team and the principal researcher, which included representatives from the Pan American Health Organization (PAHO), the University of Toronto, and Ontario Tech University.

5.3.1   Consortium outcomes (Short term)

5.3.1.1 Outcome 1: Research conducted, data generated and innovations scaled-up or created.

This evaluation outcome assessed the research conducted, data generated and innovations that were scaled-up in the consortium countries. Consortium countries chose which research objectives they participated in, which was impacted by national priorities

and the availability (or lack of availability) of pre-existing research. Specifically, program objectives 1A to 4 were assessed:

Program objectives 1A and 1B: Sodium Content of Packaged, Artisanal, Street and Fast Food Products (Argentina, Brazil, Costa Rica, Paraguay, Peru).

Comprehensive data on the sodium content of packaged foods was unavailable in some participating countries, and the extent to which they were meeting their national and/or the regional sodium reduction targets was unknown. In addition, a systematic and standardized approach with state-of-the-art technology for data collection and analysis of the sodium content of packaged foods was not available in LAC. These research gaps were addressed by adapting data collection and analysis innovations and implementing them across the consortium.

With the IDRC funding, the University of Toronto's Food Label Information Program (FLIP) mobile application and web-based software for collecting data from packaged food labels was adapted for use by the consortium. The modified application/software was called FLIP-LAC and it included training manuals (Schermel, 2018), guides (L'Abbe, 2018) and standardized procedures on food label and data collection. The data generated from FLIP-LAC led to the development of large brand-specific databases containing the nutrient (sodium) composition of food products sold in each consortium country; except for Brazil which used a slightly different method that was considered more appropriate for their country context. The use of FLIP-LAC afforded a unique ability to collect not only information about sodium, but on all nutrients reported on food labels, the individual ingredients and on front-of-package labelling and marketing.

The use of FLIP-LAC led to the systematically collected and analyzed data on

sodium content of 8314 packaged food products in four countries (with one package size

per food product included in the analysis). Mean sodium content was assessed (mg/100 g)

for commonly consumed sources of sodium, with the results being compared to 2015

PAHO regional targets. The latter analysis found that Paraguay had 87.9% of food

products meeting regional sodium targets, followed by Argentina (87.0%), Peru (85.5%),

Costa Rica (83.9%) (Blanco-Metzler, Vega-Solano, et al., 2021). In a separate analysis, it

was found that 81.2% of Brazil's food products met the regional sodium targets (Arcand

et al., 2019). The findings also demonstrated high variability in the sodium content of

foods within single food categories, suggesting high potential for reformulation of higher

sodium products within a food category. This finding, along with the observed high

proportion of products already meeting the regional sodium targets, highlighted the need

for more stringent regional sodium reduction targets, to accelerate sodium intakes in LAC

(Allemandi et al., 2019b; Arcand et al., 2019; Blanco-Metzler, Vega-Solano, et al., 2021;

Vega-Solano et al., 2019). On completion of the IDRC grant, FLIP-LAC was scaled up

and made broadly accessible across LAC through another funding source, and results

were used to update PAHO regional targets.

Under program objective 1B, data on the sodium content of street, artisanal and fast

foods were assessed using chemical analysis. The importance of this research is

emphasized by the nearly complete lack of sodium content data on these culturally

specific foods. Using standardized chemical analysis procedures and protocols, street and

fast food products were sampled based on national consumption patterns and availability.

A manual for food chemical analysis of sodium was created to standardize procedures

and conditions for the analysis (Montero Campos & Benavides Aguilar, 2020). This was an important step given observation that there were highly variable experience levels of technicians and laboratory standards and procedures for chemical analysis across the consortium countries. The sodium content analysis on over 100 artisanal, street and fast food led to novel data on frequently consumed foods in LAC; demonstrating sodium levels in the moderate to high range. These data were submitted to the Latin American Network on Food Data System (LATINFOODS) database for researchers, nutritionists and food technologists to access.

Overall, program objectives 1A and 1B achieved a high degree of success with the evaluation outcomes, but some challenges were experienced. Challenges in obtaining approval for data collection from grocery stores led to setbacks and delays. This was a necessary step in all countries in order to initiate data collection. A high turnover rate of the grocery store staff contributed to communication break downs, where new staff had no knowledge transfer that authorization was received. Despite attempts at standardization and procedures to optimize analytic performance, some countries had variations in laboratory conditions and techniques for food chemical analysis which may impact the validity and comparability of the results. For example, some countries performed analysis with food additions such as salsas, seasonings, dressings and hot peppers; while other countries did not. Also, the methodology used to estimate sodium varied in all countries.

Program Objective 2: Social Marketing and Communication Strategy (Brazil, Costa Rica, Paraguay, Peru).

Since a relatively higher proportion of sodium intake comes from discretionary salt in LAC, it is essential to engage the public in changing their personal behaviors related to added sodium; however, little research had previously been conducted. Therefore, consortium researchers conducted formative research on consumer behaviors and created regional social marketing and communication strategies to drive population-wide behavioral changes related to dietary sodium. Expert social marketers and researchers from the University of South Florida led an innovative hybrid training program adapted for LAC with consortium researchers from Costa Rica, Brazil, Peru and Paraguay. The training consisted of a virtual course on social marketing concepts and qualitative data analysis, followed by face-to-face workshops. The training program was developed specifically for the LAC context and scaled-up to the consortium countries; where no other training program previously existed. After the training, consortium researchers prepared their own formative research proposals to conduct focus groups and interviews with a defined target audience to examine barriers, facilitators, beliefs, values and motivations related to discretionary salt use. These activities informed a regional social marketing and communication plan that was created by researchers at the University of South Florida. The social marketing training program and communication plan was a significant innovation created for the consortium countries. Multiple articles were published about this research (Blanco-Metzler, Núñez-Rivas, et al., 2021; Ponce-Lucero et al., 2020). After the consortium funding period, researchers at the University of South Florida developed a follow-up 4-module course for researchers interested in advanced-level social marketing training. All LAC can now access this training program on the

PAHO Virtual Campus. Costa Rica is currently adapting the regional plan to their national context with funding from LINKS-Resolve to Save Lives.

Program objective 3: Assessing the health and economic benefits of dietary sodium reduction.

Brazil and Costa Rica used health and economic data to quantify the attributable health impact and economic burden of excess sodium consumption in their countries. This data was not widely available in LAC, and few researchers had expertise to conduct such analyses. Two different modeling scenarios were applied. One model was the Preventable Risk Integrated ModEl (PRIME), developed by the University of Oxford, that was used to conduct analysis on avoidable deaths due to excess sodium. The other model used was IMPACT food model (economic impact), to conduct health and economic impact assessments on CVD deaths and cases prevented or postponed in different modeling scenarios related to sodium reduction over time (Nilson, Metlzer, et al., 2020).

A Brazilian researcher received in-person training on IMPACT at the University of Liverpool; training that was later relayed to the Costa Rican research team. Researchers from Costa Rica and Brazil both received face-to-face training on the use of PRIME from the Université Laval, followed by two webinars. The findings from this research were published (Nilson, da Silva, et al., 2020; Nilson, Metlzer, et al., 2020; Nilson et al., 2021; Vega-Solano et al., 2021), and used to form strong arguments with policy decision makers on setting upper limits on sodium in food products. In addition to the data generated, the capacity built can be applied towards the creation of health and economic data related to other public health priorities. These models provided a pragmatic and cost-

effective way for countries with limited resources and missing data to conduct analysis.

There were unexpected challenges with the use of the PRIME model as the consortium

researchers required in-depth statistical analysis to review long term trends and risks over

time. Also, the IMPACT model required more data inputs which were not always

available from health information custodians; requiring some assumptions to be made in

the model.

Program Objective 4: Knowledge translation (KT) strategies.

Most consortium researchers noted that formal KT strategies were a new concept

and that culturally-specific tools were needed. As part of the consortium, a customized

KT workbook was developed to ensure maximal usability and uptake of research data.

The KT workbooks considered the research and regional context, including translation of

key terms in Spanish. The customized KT workbooks were peer reviewed, piloted and

validated for use by the researchers, to optimize communication and knowledge

dissemination tactics for their research. This was an important scalable innovation that

can be used in future studies. Consortium researchers noted that KT training enabled their

thinking about ways to engage policy makers earlier in the research process: "when we

have any research grants for small funded projects, we have added something that was

actually inspired by the IDRC project...is that this communication plan…this knowledge

transfer. It is something that is very important for presenting the results, making the

results easier to understand for any audience.". With the technical assistance of the

InterAmerican Heart Foundation, a policy brief was developed in English and Spanish

(Madriz K. et al., 2020), which was disseminated to decision makers at Ministries of

Health, the food industry and other key stakeholders. The benefits of policy briefs were

also realized as part of the process. The Costa Rican researchers noted that they now embed policy briefs as a key dissemination output for their studies. A limitation to the KT training and KT plan development was that it was introduced early in the second year of the funding period, which is a relatively late stage to incorporate rigorous integrated KT strategies. KT strategy development at the onset of the grant would have involved policymakers and other stakeholders early in the research development process, to promote maximal impact of the data on policy development and implementation.

Most of the grey literature and papers generated from this consortium is published and available in IDRC Digital Library (https://idl-bnc-idrc.dspacedirect.org/discover) which is available for policy makers and researchers.

5.3.1.2 Outcome 2: Multi-sectoral and multi-disciplinary partnerships were newly formed, strengthened, engaged and activated

Consortium researchers and governance committee.

The consortium included multi-sectoral and multi-disciplinary partnerships to drive dietary sodium research and policy. The PI, with support from PAHO, invited other several LMIC in Latin America to join the consortium, with Argentina, Brazil, Costa Rica, Paraguay and Peru expressing interest. During consortium formation, researchers from the University of Toronto, Ontario Tech University and PAHO provided technical expertise to the PI on the development of the grant application (e.g., writing support, protocol development). Under the leadership of the PI (ABM), an advisory governance committee was formed, including public health nutrition researchers, experts and from INCIENSA, the University of Toronto, Ontario Tech University and PAHO. This group established a framework to support the operations and decision making of the project.

They held periodic meetings to support guidance on leadership, technical and scientific aspects of the consortium. Consortium researchers reported that PAHO, Canadian and European educational institutions were significant partners who supported research success.

Partnerships formed to execute research and drive policy.

Outside of the consortium researchers and the governance committee, the greatest number of partnerships and collaborations formed were with national governments (81.8%), educational institutions (81.8%), non-governmental organizations (72.7%), research institutions (63.6%), scientific community (54.5%), regional government (54.5%), civil society (45.5%) and food industry (36.4%). Buy-in and support to carry out the program objectives was contingent on governmental support. For example, the Minister of Health in Costa Rica deemed the project as a public health priority which facilitated with data collection in grocery stores. The Minister of Health in Paraguay contributed additional human resources and support to carry out the research. Despite the strong partnerships formed, consortium researchers found the communication lines with the government were often unclear and required multiple points of contact in order to reach an individual of interest.

Consortium researcher experiences with partnerships.

All consortium researchers reported a high level of satisfaction (very satisfied or satisfied) with their involvement in the consortium which led to engaged and activated partnerships throughout the program. All researchers felt respected, established trust for others and gained confidence to overcome challenges. One consortium researcher

identified collaborators as friends. Also, all researchers of the consortium understood the beliefs or values of each partner's organization. The majority felt that communication with other researchers was consistent, transparent and open. Overall, 90.9% of researchers felt that common goals were shared and 81.8% felt that other researchers were committed to the research and consortium goals. Ultimately, the formation of a funded LAC consortium fostered a supportive and productive culture amongst collaborators and team researchers that led to high satisfaction levels, loyalty and commitment to advance sodium reduction research.

Partnership challenges.

Misaligned expectations and team turnovers challenged partnerships. Select consortium researchers where disappointed when only one regional social marketing plan was created that required adaptations to specific countries when their expectation was that they would have the opportunity to generate country-specific social marketing plans. Most consortium countries had stable leadership over the grant period; however, Paraguay experienced changeover with research team members which resulted in delayed productivity due to recruitment and the duplication of training efforts. In contrast, another country experienced frequent government changes which resulted in shifts of political views and focus. In another situation, Brazil experienced logistical issues related to distribution of grant funds which limited Brazil's participation in program objective 1B.

5.3.1.3 Outcome 3: Equity, diversity and inclusivity

Principles of equity, diversity and inclusivity were incorporated into the funding program. All consortium countries had equal access to funds, resources and training to

support the research. All consortium countries were from a LMIC and they were supported by researchers from high income countries. Researchers, public health officers, non-governmental representatives, scientists, academics and trainees had diverse skillsets, expertise and represented different geographical areas. The team was diverse in gender, capacity, career stage and had varying access to resources. Three out of 5 country leads identified as women and there was a high proportion of women who led research activities within the countries. In contrast, most government partners with a decision making role were men. This underscores a need to build capacity, confidence and opportunities for women to hold these senior positions. Consortium researchers were at various stages of their career, which allowed for mentorship, training and development of scientific and technical skillsets. Additionally, 25 trainees consisting of undergraduate (n=7), graduate (n=16) and postdoctoral fellows (n=2) worked on the consortium research. The inclusion of trainees enabled the funding program to build capacity in the next generation of public health researchers.

Resources, training and development materials were translated into Spanish. Simultaneous interpretations into Spanish were made available for webinars, team meetings and virtual courses. At the onset of KT training, consortium researchers identified commonly used KT terms in North America, such as "audience", "agents of change", where the original meaning in English was different in Spanish. For comprehensive purposes, the KT training materials and workbook were revised to add definitions with illustrative examples on commonly used KT terms.

All consortium countries had equal access to funds, resources and training to support the research. There were also equal opportunities to disseminate research.

However, in at least one instance there were disagreements on authorship when manuscripts were submitted for publication at the end of the funding period. Researchers were disappointed when they were excluded from publications. Having an a priori authorship agreement could have increased transparency and fairness when opportunities to publish arose.

5.3.1.4 Outcome 4: Consortium researchers gained confidence and enhanced capacity to conduct research to address public health nutrition issues in LAC.

Quantitative and analytic skills. One of the most significant achievements of the funded consortium was training opportunities that strengthened scientific capacity in the participating LAC. Scientific development opportunities related to quantitative data collection and analysis strengthened competencies and established new expertise that can be applied to support numerous public health nutrition priorities. The University of Toronto, Ontario Tech University and Laval University in Canada, University of South Florida in the United States, and the University of Liverpool in the UK, led training to strengthen knowledge and skills related to protocols, procedures, data collection and analysis techniques for research program objectives 1A, 1B, 2, and 3. These activities resulted in 90.9% of consortium researchers reporting enhanced skills and capacity to collect data and manage large data sets. Capacity development extended to leadership, networking, project management, communication and knowledge translation. All (100%) consortium researchers were satisfied or very satisfied with the training and development sessions offered in the research program. Table 1 outlines the training and skillset development observed during the grant.

Social marketing and qualitative research. Many consortium researchers found the social

marketing training and development to be the most novel and educational. At the onset of

the grant, researchers had varying levels of experience in social marketing, with a

majority being introduced to the concept for the first time. Over 26 researchers enrolled

in the initial social marketing training course with an 85.0% completion rate. The training

had a focus on qualitative research and social marketing principles, led by researchers

from the University of South Florida. Several consortium researchers indicated: "I

learned the most in this [social marketing] objective". Also, consortium researchers

expressed a deeper appreciation for the social marketing research experience beyond

training and knowledge creation, which included the formation of meaningful

collaborations and a sense of community. A partnership with the Association Latin

Americana de Mercadeo Social, further supported the development of social marketing

skills and stimulated collaborations with other LAC social marketing researchers.

Knowledge translation skills. The evaluation survey found that 90.9% of researchers

reported a significant improvement in their knowledge and skills related to KT principles,

concepts and their application (Padilla-Moseley, 2020). For a majority of consortium

researchers, KT was a new concept. Researchers reported that the KT workbooks helped

them identify target audiences, generate strategic and impactful KT activities, and

demonstrate that opportunities for information sharing can occur at multiple time points

throughout the project cycle. The training led to practice changes for some. One

researcher expressed "…when we have any research grants for small projects that would

be funded...an idea [from the] IDRC [grant] is this communication plan…this knowledge

transfer is something that is very important for presenting the results, making the results

easier to understand for any audience." Overall, 81.9% of researchers also agreed or

strongly agreed that they enhanced their skills in preparing and submitting manuscripts to

peer reviewed journals. At the conclusion of the funding period, consortium researchers

generated numerous outputs to various target audiences, related to the consortium

research activities, in the form of peer reviewed publications, meetings with decision

makers and partners, technical reports, policy briefs and presentations (Table 5.2).

Table 5.1. Consortium researchers' training and skills set development[1]

Program Objective	Organized Training	Scientific Skills Acquired
Objective 1A and 1B	• 2 online sessions (Obj 1A) • 2 online sessions (Obj 1B) • Additional one-on-one training, as needed	• Enhanced abilities to collect, analyze and manage large datasets with the FLIP-LAC app and database • Conduct quality assurance measures, statistical analysis, and reporting and presentation of data • Knowledge front of package labelling • Knowledge of how to prepare for and conduct chemical analysis procedures for sodium
Objective 2	• 3 online sessions • 2 face-to-face workshops • 1 online course • Additional one-on-one training, as needed	1. Knowledge of the principles and concepts of social marketing research 2. Knowledge and skills in identifying target behaviors and populations 3. Qualitative research skills: creating a qualitative interview guide, conduct interviews and focus groups, coding transcripts 4. Translating the formative research into a social marketing strategy 5. Skills in creating a Creative Brief 6. Creativity
Objective 3	• 2 week face-to-face training (1 country) • 1 face-to-face workshop • Additional one-on-one training, as needed	• Knowledge and training of the principles, concepts and the application of health and economic modeling using the PRIME model and IMPACT model.

[1] Consortium researchers reported organized training and scientific skills acquired

Table 5.2 Summary of KT outputs across different target audiences

Summary of KT Outputs[2]						
Program Objective	Government	Health and Education	Food Industry	Civil Society	Scientists	International	TOTAL
Objective 1A	26	9	10	41	34	16	136
Objective 1B	11	10	15	5	20	13	74
Objective 2	11	9	0	10	36	4	70
Objective 3	2	1	0	0	6	5	14
Objective 4	6	14	4	43	5	4	76
Objective 5	4	35	2	41	19	19	120
TOTAL	60	78	31	140	120	61	

[2] KT outputs include peer reviewed publications, meetings with decision makers and partners, technical reports, policy briefs and presentations. KT outputs summarized may overlap across different audience sectors.

5.3.2 Intermediate outcomes

The researchers' dedication enabled them to achieve several intermediate outcomes, defined by the logic model (Figure 1), which were not expected during the grant period since they often take time to achieve. In Argentina, Costa Rica and Paraguay strong governmental support led to policy changes that informed their national plans on NCDs. In particular, the office of the Minister of Health in Peru added sodium reduction to their political agenda after communications with the consortium researchers, which was an notable achievement since in the past anemia and diabetes were the primary government priorities. In Peru the research was used to evaluate nutritional labelling so that updates on front-of-package label policies could be made (Meza-Hernández et al., 2020). At the regional level, data on the sodium content of foods led to a commitment from PAHO during the funding period to develop a set of revised targets, which was completed in 2021. This data also led to updated sodium targets in Argentina (Allemandi et al., 2019b). A renewed and strengthened partnership with the food industry was a key driver to support sodium reduction in the food supply. In June 2019, Costa Rica's Ministry of

Health and CACIA, Cámara Costarricense de la Industria Alimentaria (Costa Rican Chamber of the Food Industry) renewed their alliance and commitment to continue with sodium reduction efforts. This partnership involved joint action plans on setting national sodium goals, updates to sodium targets for packaged food products, and future plans for sodium reduction.

National commitments to support and fund the implementation of social marketing program were achieved. In Paraguay, municipal governments used the qualitative research to inform a social marketing plan focused on banning saltshakers in food service establishments. Costa Rica obtained funding from Resolve to Save Lives to adapt the regional social marketing plan to their national context. Finally, the resources, training and outputs by the consortium researchers were leveraged to address other nutrition topics of public health concern and stimulated partnerships and collaborations. A six-month grant extension from the IDRC enabled researchers to conduct analyses on other nutrients associated with non-communicable diseases. This included the analysis of already nutrient data collected with FLIP-LAC. Analyses related to nutrients (e.g., energy, sugar, saturated fat), the overall nutritional quality of packaged foods, and use of low sodium claims on the front of package were conducted. Finally, the Organization for Economic Co-operation and Development invited the Principal Investigator to participate in a case study focused on best practices to reduce excess sodium consumption to mitigate CVD. This was a major achievement for future research in Costa Rica as the country did not have collaborations with civil society.

5.4 **Discussion**

This program evaluation demonstrated that a funded research consortium was an impactful way to build capacity and collaboration, and to generate evidence to inform population wide public health policies and programs for dietary sodium reduction. Specifically, this program evaluation demonstrated that all consortium level objectives were achieved for the duration of the program. With the IDRC's investment in a funded research consortium, a significant amount of country and regionally specific evidence was generated from the five Latin American country participants. Policy change is rarely based on a single empirical research study (Grimshaw et al., 2012); however, in a short period of time the funded consortium translated their research data to impact national strategies and single policies within each country. To our knowledge, this is the first multi-country government funded research consortium that was assembled to address sodium reduction policies in the Latin American region. Other multi-national Latin American consortiums focused on obesity (Bautista et al., 2009) , cardiometabolic risk factors (Miranda, 2020) and neurodegenerative conditions (Ibanez et al., 2021) using data sets from population-based studies. Consortium-based research projects are emerging as an effective way to address complex public health issues on NCDs (Bautista et al., 2009; Ibanez et al., 2021; Miranda, 2020). In the current consortium, researchers engaged in a participatory approach to multi-method data collection and analysis with training on social marketing and knowledge translation, which is unique to this consortium. Capacity development in social marketing is particularly important since discretionary sodium is a primary source in many LAC, making population-level behavior changes essential to decreasing sodium consumption and preventing NCD-related morbidity and mortality.

Actions to reduce population-wide sodium intakes require multiple interventions that work synergistically, if countries are to achieve the WHO global target of 30% sodium reduction by 2025 (Hyseni et al., 2017). At least 75 countries have developed a national strategy for dietary sodium reduction. Interventions identified under these national strategies commonly included one of the WHO "Best Buy" interventions, which have an average cost-effectiveness ratio of ≤ $100 per disability-adjusted life years averted in LMICs. In 2019, a review found that 96 countries globally had a national sodium reduction program; however, only 6 LAC (Argentina, Canada, Chile, Colombia, Costa Rica and the United States) had implemented one to date (Santos et al., 2021). In LAC, many countries have implemented at least one sodium policy, but not all have implemented one of the WHO "Best Buy" interventions (Pan American Health Organization, 2021b). Overall, 38% of countries have implemented food reformulation policies (voluntary or mandatory), 38% had policies for public settings, 15% had front-of-package labelling policies, and none had a national education campaign (Santos et al., 2021). Despite the gradual introduction of dietary sodium reduction policies and programs on political agendas in LAC and globally, only a few countries have reported reduced mean sodium intakes and, to our knowledge, no LAC have met the WHO's global sodium target (Santos et al., 2021). These findings demonstrate the need for the implementation of evidence-informed, effective and progressive policies. Collaborative consortium-based research is a plausible approach to support complex policies for a public health challenge such as dietary sodium reduction; as seen with another consortiums focused on applied mental health systems research to produce health policies and services in low-income countries.

The funded consortium examined in this program evaluation allowed researchers and policy decision makers to form a community of practice with a shared focus on sodium reduction public health policies. This was a strength of the funded consortium as the community of practice that was created fostered learning interactions, shared knowledge, training and development efforts. It also created a rich environment to understand and make sense of new knowledge and training efforts, outcomes observed when communities of practices have strong and mutually respectful relationships. In other fields, a community of practice model has been utilized to promote practice changes in the clinical settings (Barwick et al., 2009) and to improve policy and practice in cancer control (Micheli et al., 2009). The funded consortium encouraged scientific productivity and professional growth through access to scientific and technical experts in sodium reduction. Self-directed learning, consultation with experts, and between-country collaboration enabled opportunities for learning and mentorship - factors leading to the achievement of consortium goals. This finding is consistent with another Canadian community of practice that focused on translating evidence related to renal healthcare in vulnerable communities into clinical practice and policies (Milat et al., 2014). To date, the consortium researchers continue to work together as a community of practice to advance knowledge, disseminate peer reviewed publications and best practices in other public health areas. The consortium model should be considered for new opportunities to address other public health areas, including other nutrition policy priorities.

The funded consortium integrated KT training and strategies for all the research program objectives, which is one factor leading to consortium success. Funding agencies can provide mechanisms to promote knowledge exchange through agency mandates on

KT. One study found that 18 of 23 national and international funding agencies described some aspect of KT in their mandate (Cordero et al., 2008). It is well documented that policy development and KT in LAC are complex and slow (Cordero et al., 2008). Policy is further impacted by barriers to adoption such as limited resources, poor communication and dissemination methods and a lack of capacity to understand technical data (Akhlaq et al., 2016; Cordero et al., 2008; Hyder et al., 2011). This calls for resource allocation to support knowledge translation, better "packaging" of research results and for researchers and policy makers to develop technical capacity in understanding scientific data (Hyder et al., 2011). A larger issue are failures to use research in policy-making that contributed to $200 billion of wasted funds, which is detrimental in LMICs where resources are scarce. One study found that 18 of 23 national and international funding agencies described some aspect of KT in their mandate(Cordero et al., 2008). This funded consortium resulted in almost 500 KT outputs through systematic planning efforts, including many published manuscripts, that reached several sectors involved in policies and program development and implementation. The early policy advances the consortium observed are likely attributable to this large number of KT outputs. A limitation identified with the current consortium is that stronger integrated KT plans may have further enhanced policy and program impact, which would allow stakeholders and decision makers to have greater involvement in research planning, further increasing the usability of the data. Future consortium projects should allocate time and resources to build KT plans at the beginning of the funding period, using tools like the KT workbooks, to maximize impact of the findings at an earlier stage of the grant.

The use of a logic model framework was a strength of the program, which guided

consortium actions and supported this evaluation. Only a few published studies have used

a program evaluation framework, where most evaluations relied on observation designs

(Brusco & Frawley, 2019). Existing literature has criticized the logic model for its failure

in capturing contextual factors and its utility in large community-based projects and

initiatives (Ebenso et al., 2019; Hill & Thies, 2010). Consortium researchers developed

the logic model through an iterative feedback approach to ensure Latin American

perspectives on contextual program factors was accounted for, an approach that has been

widely utilized in other program evaluations (Cullen et al., 2016; Hill & Thies, 2010). By

embedding contextual analysis and collaborations in the construction of the logic model,

this grounded the program's outcomes with IDRC's program strategy and reinforced

recommendations for best practices on how future funded programs would be

implemented to a LA context (Ebenso et al., 2019).

5.5 **Conclusions**

This program evaluation illustrates the benefits of collaborative work in research -

carried out by a consortium of LMIC countries in Latin America, with the support of

international technical assistance - to facilitate the development and implementation of

dietary sodium reduction policies, with an ultimate goal of reducing the burden of

hypertension and cardiovascular disease. The dedicated efforts of the multidisciplinary

team generated local and regionally scientific evidence for decision-making in sodium

reduction policies and programs, innovations in food systems, using innovative

technological and methodological approaches. The consortium is a model for other public

health interventions that require new techniques for food policy analysis and consumer behavior, as well as the dissemination of key findings. The findings of this evaluation can be applied to the development of future consortium research partnerships and activities designed to address the burden of NCDs in the region.

Chapter 6: Factors impacting the uptake of dietary sodium research into sodium reduction policies in five Latin American countries: A Qualitative Study

Abstract

Background: Diets high in sodium are a risk factor for cardiovascular disease (CVD) morbidity and mortality. Sodium consumption in Latin American countries (LAC) is more than double the recommended levels. The uptake of dietary sodium-related research into public health policies, to address this public health challenge, has been inconsistent across LAC and factors impacting research use and uptake are largely unknown. The objective of this study was to describe the barriers and facilitators to the uptake of research into sodium reduction policies in five LAC (Argentina, Brazil, Costa Rica, Paraguay and Peru) who participated in a dietary sodium research consortium funded by the International Development Research Centre (IDRC).

Methods: A qualitative case study approach was used. Participants included five researchers and four Ministry of Health officers from the funded countries. The Diffusion of Innovation (DOI) informed the semi-structured interview guide. Dimensions from Trostle's framework of Actors, Content, Context, and Process and DOI informed the data analysis. One-on-one interviews were completed from November 2019 to January 2020. Transcribed interviews were validated by participants. Two researchers coded the transcripts and thematically analyzed it using NVivo software.

Results: Key barriers included food industry and some government actors, where conflict of interests impeded policy advancements; government turnover resulting in policy and personnel changes; a lack of human and financial resources; and communication gaps among key actors. Principle facilitators were the content and quality of health economic,

food supply and qualitative data that supported advances of policies, regulations, and alliances with key actors. The government, non-governmental organizations and international experts were also viewed as highly supportive, providing technical assistance to researchers. Additionally, researchers enhanced their skillsets which enabled stronger communication and dissemination with policy makers.

Conclusion: There are several barriers and facilitators faced by researchers and policy makers that impact adoption of research into policies and programs in LAC. Several IDRC-funded research program components positively influenced and advanced sodium reduction policies. Future LAC studies can draw from the insights and lessons learned from this research and apply it to future efforts on policy nutrition to promote healthy eating and reduce CVD risks.

Key words (3-10 words): diet, nutrition, public health policy, health promotion, sodium, implementation science

6.1 Introduction

Globally, excess dietary sodium is responsible for approximately 3 million deaths annually (Afshin et al., 2019). High sodium intake increases blood pressure and risk of hypertension, cardiovascular disease, stroke, cancer, and kidney disease (Aburto et al., 2013). In low and middle-income countries, diets high in sodium are responsible for 70 deaths per 100, 000 individuals (Afshin et al., 2019). This risk is particularly concerning in Latin American countries (LAC) where up to 40% of adults have hypertension, which are rates among the highest in the world (Abreu, 2019; Kearney et al., 2005). Additionally, sodium intakes in LACs are often more than double the recommended level of 2000 mg/day of sodium/day (5 g/day of salt) (World Health Organization, 2012a). For example, mean population sodium intakes in Argentina are 4480 mg/day, Brazil are 4720 mg/day, Costa Rica are 4600 mg/day, Paraguay are 5480 mg/day, and Peru are 3880 mg/day (Amalia Pesantes et al., 2017; Blanco-Metzler et al., 2017; Ferrante et al., 2011; Lamelas et al., 2019; Madriz K. et al., 2020; Nilson et al., 2017; WHO, 2018).

The World Health Organization (WHO) has encouraged member states to reduce population sodium intakes by 30% by 2025, as one of nine voluntary global targets for non-communicable disease (NCD) prevention (WHO, 2013a). Moreover, the WHO recognized reducing dietary sodium as a "best buy" public health intervention to reduce NCDs since it is highly cost-effective and is relatively feasible to implement (Beaglehole et al., 2011; World Health Organization, 2012b, 2017). For instance, in Argentina, sodium reduction policies would avert 55,000 total deaths, 27,000 stroke related deaths, 16,000 coronary heart disease, 5,000 stroke, 38,000 myocardial infarction cases over a 10-year period (World Health Organization, 2012b). In Brazil, reducing population sodium intakes to

2000 mg/day in adults would lead to a projected $102 million USD cost savings from reduced cardiovascular disease hospitalization (Nilson, da Silva, et al., 2020). In Costa Rica, reducing population intakes to 2000 mg sodium/person/day would lead to prevention of 13% of deaths from cardiovascular disease (CVD) if the country's National Plan for the Reduction of Salt and Sodium is met by 2021 (Vega-Solano et al., 2021). National population-wide sodium reduction policy interventions have been implemented in at least 75 countries (Santos et al., 2021) which commonly include food reformulation, consumer education, front-of-pack labeling, and taxing salt and foods high in sodium (Dodd et al., 2020) . Approximately 60% of these initiatives involved regulatory approaches (Santos et al., 2021), such as food labelling and taxation; however, most countries have taken voluntary approaches to setting sodium reduction targets in processed and packaged food. Despite an increase in sodium reduction policies and programs, only a few countries have reported reduce mean sodium intake (Santos et al., 2021), and to our knowledge, no LAC have met the WHO's global sodium target, suggesting that the implementation of more effective and progressive policies may be needed (Santos et al., 2021).

While high-quality research is critical to guide public health policy (Canadian Institutes of Health Research, 2010; Hawkes et al., 2015; Rabadan-Diehl, 2017), evidence-informed policy making is complex and unique, especially in low- and middle-income countries (LMIC) (Carden, 2009). A lack of available evidence, time constraints, policy maker skills in interpreting research and transferring knowledge, financial resources, private sector influence (e.g., funding and/or lobbying) and competing political priorities were identified as barriers in LMIC to the uptake of research into policies (Langlois et al., 2017; Latu et al., 2018; Oliver et al., 2014). In LMICs, the complexities

of policy making are exacerbated (Oliver et al., 2014) by resource constraints and unpredictable political climates (Rabadan-Diehl, 2017). There are only a few known facilitators such as access to relevant research and engagement with stakeholders at the onset of the research cycle (Langlois et al., 2017; Oliver et al., 2014). Likewise, there are very few studies that have identified the factors that influence the use of research to inform sodium reduction policies in LMIC and LACs, where contextual factors may present unique challenges compared to other countries and regions. Therefore, the aim of this study is to describe the barriers and facilitators to the uptake of dietary sodium reduction research into public health policies in five LMIC in Latin America. To achieve this aim, activities carried by a LAC dietary sodium research consortium was examined. The consortium consisted of several health and academic institutions and organizations from Argentina, Brazil, Costa Rica, Paraguay, and Peru and was funded by the International Development Research Centre (IDRC). The core objective of the consortium was to generate and mobilize sodium reduction research that included food supply, social marketing and health and economic impact analyses, to inform sodium policy in each of the participating countries. This funding led to several dietary sodium policy and program changes in the participating countries, as highlighted in a program evaluation report (Padilla-Moseley, 2020). This served as an ideal case to examine barriers and facilitators to dietary sodium research uptake.

6.2 **Methods**

6.2.1   Research Design

A constructivist approach informed a single qualitative instrumental case study where interviews took place between November 2019 to February 2020 via one-on-one interviews with key public health researchers and Ministry of Health (MOH) officers. A case study approach was chosen to explore how research outputs produced from a funded research program influenced policy development, which subsequently informed an evaluation of the program. Case studies of this nature describe the real-life context of when an implemented intervention is applied (i.e. funded research program) (Yin, 2018).

6.2.1.1 Case

The case is a research project funded by the IDRC from September 2016 to March 2020 (IDRC 18167). The IDRC is a Crown corporation of the Canadian government with a mandate to provide resources for research knowledge advancements in resource-limited regions. The case included a multi-country Latin American research consortium consisting of researchers and knowledge users from Argentina, Brazil, Costa Rica, Paraguay and Peru (referred to as the "funded countries"). The consortium countries, led by the Costa Rican Institute of Research and Teaching in Nutrition and Health and with technical support from the University of Toronto and Ontario Tech University, received funding to conduct and disseminate research to inform sodium reduction policies and programs in each country. The funded countries are the unit of analysis for this case.

6.2.1.2 Study Participants and Recruitment

A purposive sampling was utilized to recruit 5 public health researchers, one from each funded country, who carried out the research activities under the funded project. The key researchers provided cultural (e.g., social standards, experiences, beliefs and traditions) and contextual (e.g. external situational) information to inform the discussion. Using a snowball sampling approach, the researchers facilitated recruitment of MOH officers from each funded country. A MOH officer was eligible to participate if they were responsible for the development and/or implementation of NCD policies. Eligible participants were invited to participate in the study via email invitation.

6.2.1.3 Data Collection

Information sources included one-on-one interviews, the interviewer's reflective memos and a policy map developed by the Pan-American Health Organization (PAHO) that catalogued sodium reduction policies in each country (Pan American Health Organization, 2021c). A 45 to 60-minute semi-structured interview took place via videoconference. Interviewers recorded reflective memos on ideas, insights, observations and a self-critique of performance post interview (Groenewald, 2008). Questions about the policy map (Pan American Health Organization, 2021a) for each country were embedded into the interview guide, providing a basis to explore the country-specific sodium-policy context and the changes in dietary sodium related policies, programs, interventions, and regulations that occurred during the grant period. Participants received the interview guide (available in Spanish and English) and a country-specific policy map prior to the interview.

Separate semi-structured interview guides were created for the researchers (20 questions) and the MOH officers (16 questions). Two interview guides were created for each participant pool with variations in the questions in order to adjust the language according to the respondent. The interview guides probed on developments and changes on dietary sodium reduction policies in the countries that occurred over a 3.5-year funding period, and inquired about the barriers and facilitators to implementing dietary sodium reduction policies and programs. The Diffusion of Innovation (DOI) Theory (Rogers, 2003) informed the interview guide and served as prompts to questions. The DOI theory constructs identified how research has been adopted within organizations (Armstrong et al., 2013). The DOI and Trostle's et al (1999) dimensions of content, actors, process and context was used to inform the codes for data analysis (Trostle et al., 1999). Trostle's et al (1999) dimensions were used in similar research on policy implementation in LAC. The guides were validated among the research team (JPM, JA, BG) to ensure clarity of questions, accurate choice of words, appropriate tone and freedom from leading questions.

Interviews were conducted in English (JPM) or Spanish (NF). Interviews were audio-recorded with Audacity. Recordings were transcribed verbatim by two researchers (JPM, BS) and the transcript validation was completed through comparisons to the recorded interview. A translator transcribed the Spanish interviews and then translated the transcripts into English for analysis. All direct and indirect identifiers were removed from the transcripts when participants expressed opinions, direct quotes or identifiable information in the quote. Study participants were identified by their professional role (e.g. public health researcher or MOH officer) and an assigned country code (Country A

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to E) to respect confidentiality. Country names were only used when stating publicly available information about the country.

6.2.2 Research Team and Reflexivity

The research team consisted of two graduate students (JPM and BS), two Associate Professors with expertise in sodium research, policy and qualitative methods (JA, BG), and three public health professionals (NF, RG, AB) from the Pan American Health Organization (PAHO) and INCIENSA in Costa Rica. Research team members (JA, JPM, NF, RG, AB) were international research collaborators who served as subject matter experts on the IDRC grant and had a pre-existing relationship with the public health researchers. This involvement established an authentic connection and rapport with the researchers (Allen, 2017), who became participants in this study. There was no previous relationship between the MOH officers and the research team.

6.2.3 Data Analysis

Interviewers conducted a post-interview debrief discussion with each participant to explore preliminary interpretations and conclusions. Prior to analysis, participants member checked their transcript and confirmed no changes were required. NVivo Software (Version 12) was used for data organization and analysis. Codes and a codebook were established a priori using the DOI and Trostle's themes. The codes were expanded with sub-codes to identify emergent themes. Two independent coders (JPM, BS) deductively coded the transcripts and applied codes to relevant segmented sentences and paragraphs on participant views and experiences, as well as direct quotes. Intercoder agreement was reached through discussion and consensus, with a third researcher (JA)

used to resolve any disagreements. Data authenticity was supported with the

interviewer's reflective memos and the use of a second coder.

6.3 **Results**

Nine participants consisting of 5 key public health researchers and 4 MOH officers

from Argentina, Brazil, Costa Rica, Paraguay, and Peru participated (two men, seven

women). Participants were a mix of early career and senior researchers. MOH officers

were included from each country; however, the participant from Brazil was unable to

participate due to scheduling conflicts. The identified barriers and facilitators to dietary

sodium research uptake into policy are found in Table 6.1.

Table 6.1 Overview of barriers and facilitators to dietary sodium research uptake into policy in LAC

Dimension (Trostle et al., 1999)	Definition	Barriers	Facilitators
Actors	An individual or group who are directly or indirectly involved in the policy and program process. The governments, private organizations, non-governmental organizations, civil society, and academia are considered actors.	● Food industry	● Government Political will ● Research experts ● Dual roles ● Non-governmental organizations ● International support ● Media
Content	Attributes of the research data.		● Research data generated under the IDRC project ● Qualitative research
Context	Social, economic, cultural factors and historical	● Changes in government	● Country size and

		context.	and public health priorities	cultural context
Process		Actions and outputs related to the policy process; communication channels used; dissemination of results; and resources.	● Human Resources ● Communication	● Knowledge translation (KT)

6.3.1 Barriers to the integration of research into sodium reduction policy

6.3.1.1 Actors

Food industry. Every country noted the food industry as a barrier to policy development (e.g., setting sodium targets, mandatory versus voluntary) and implementation (e.g., manufacturer reductions in the sodium content of food). A participant from Country A commented that the food industry has a good understanding of the research evidence available on the health effects of decreased sodium consumption; however, no action took place that progressed to making further reductions on sodium content levels in food products. Country A participant noted that the food industry often has conflicts of interest which hinders progress. This participant did not elaborate on the specific conflicts of interest out of fear for negative repercussions. In Country C, conversations between public health officials and the food industry were historically met with lobbying and resistance. This was a similar experience when funded countries were in conversations with the government on the application of taxes on foods and beverages

with high sugar content and voluntary or mandatory sodium reduction target levels in food products (Santos et al., 2021).

The food industry is viewed as a highly influential partner in dietary sodium reduction policy implementation, and their competing priorities on their own company's economic growth were seen to impede or delay policy implementation related to food reformulation. For instance, in Country D, the food industry was concerned about the acceptability of product taste when sodium was reduced in baked goods, with a concern for the potential for reduced sales and job losses. A MOH officer from Country D noted that criticisms from the food industry were: "It won't taste good", "people won't buy it", "people won't like it". To mitigate this concern, Country D partnered with a food technology team to create food products of varying sodium levels and conducted taste tests among consumers. The tests found that incremental decreases in sodium over time would not impact consumer taste preferences or negatively impact product acceptance. In Country E, one company's major revenue source derived from commonly purchased condiments; however, these products had high concentrations of sodium. It was reported that the food industry in Country E had similar concerns of sodium reduction leading to changes in consumer buying patterns. This was a major impediment to their willingness to reduce the sodium content of condiments.

All countries also expressed concerns when working with the food industry on policy and program approaches to improve the nutritional profile of imported and domestically produced exported food products. Despite the research on the sodium content of packaged foods generated by the IDRC-funded research project, Country A noted that a major barrier to the effective implementation of sodium reduction policy was

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that approximately half of the food products sold in the country are imported. A

participant from Country A noted that this was common in many LAC, especially those

that are small, and highlighted the importance of industry engagement (especially large

exporters) across the Region.

6.3.1.2 Process

Human Resources. A lack of human resources reduced the use of research findings into

policy development and change. Two MOH officers from Country C and D reported

being overstretched with their time: "Our involvement in so many projects could have

slowed down this process because no one was exclusively devoted to this project [IDRC

research project], everyone had to split their hours between several projects." [MOH

Officer, Country D]. They also noted that dedicated full time human resources were

required to support sodium reduction policy work as individuals worked on multiple

public health priorities: "Probably this [resource] is a big barrier. It is a team that is

working on several things on non-communicable diseases that was important in this

project [IDRC research project] but probably we need more people working in research."

[MOH Officer, Country D]. Meanwhile, Country A's momentum on sodium reduction

policies and initiatives were at risk, as a number of researchers in the field were at

retirement age with no succession plan in place. A researcher from Country A noted that

a lack of continuity would compromise previous sodium reduction efforts and

achievements. Challenges with human resources were also observed at the leadership

level. At the start of the IDRC-funded consortium, respondents noted that PAHO

demonstrated strong support in mobilizing efforts and resources on sodium reduction

policies. However, PAHO's involvement as a knowledge user in the IDRC-funded

consortium was impacted by economic and human resource constraints when their institutional efforts were re-distributed among other regional public health priorities, reducing the amount of time available for sodium reduction. During the interview period, participants reported that this shift in focus compromised the work required to complete the updates to the regional sodium reduction targets. Several months later, PAHO recently published and launched updated regional sodium reduction targets using the research data acquired from this project (Pan American Health Organization, 2021d).

Communication. Communication challenges led to a lack of research being integrated into policy development and changes, as reported by Countries A, D and E. In Country A, decisions stagnated with the MOH due to untimely and unanswered communications. In Countries D and E, critical information from the researchers did not flow through the proper verbal and written communication channels and decision makers. A MOH officer from Country E noted that they often felt "divorced from the private sector, from academia". Meanwhile, a researcher from the same country acknowledged that researchers and MOH worked in silos prior to the IDRC-funded consortium. This researcher acknowledged that the consortium triggered a change in research communication strategies, as a result of training in knowledge translation (KT). This researcher also noted that they have now designed future projects to include "dedicated time and space" for end-of-project KT activities.

6.3.1.3 Context

Frequent changes in the government. Frequent changes in the government created shifts in public policy focus, which negatively impacted the uptake of research findings into policy. In Country C, a government changeover resulted in significant shifts in political

views and focus. This changeover took longer than anticipated to replace positions. Once

positions were filled, researchers underwent extraordinary efforts to re-engage with

decision makers and re-start conversations on sodium reduction policy.

Country E experienced a high number of turnovers at the Health Minister level. A

researcher in Country E found it challenging to work with government individuals who

did not hold a position in the office long enough to engage in public health policies.   On

average, an incumbent held a position for less than a year when the usual term is five

years. Country E's MOH officer noted that the MOH preferred timely results to coincide

with the Minister's term in office. As such, a researcher from Country E noted that the

Minister wanted to observe the immediate effects of their health policies; however, public

health efforts involving NCDs have a long latency period for observable impacts, noting:

> "[...] they want results for this year for example, they want to reduce...I don't
> know something like five points this year because they want to give results to the
> population and next time they will have more votes. However, in chronic diseases
> you can't see the results very soon. But with chronic diseases it takes decades to
> see results."

In contrast, Country E's MOH officer did not perceive the high turnover rate as a barrier

and noted that, "Despite the fact that we have had so many Ministers at the Ministry of

Health, our goals have remained unchanged".

6.3.2   Facilitators to the integration of research into sodium reduction policy

6.3.2.1 Content

Research data generated under the IDRC-funded consortium. The research data

generated under the IDRC project was collected using robust methods. For Countries A

and C, the health and economic impact data acquired for sodium reduced diets, was considered a strong facilitator that generated interest from key decision makers in the country. Country C noted that this data was used to break resistance and lobbying efforts from the food industry and initiated conversations on sodium reduction targets. A researcher from Country C noted:

> "…that we are planting a seed for the future and trying to build a stronger case with…so that we can evaluate. We have something we are working on...as sort of an impact on regulation. It's a report on the regulatory impact of any kind of measures and that it must include a strong case of health and economic evidence so we are trying to build that part so we can fight that battle, so to say, and in the near future."

A MOH officer from Country A emphasized that a combination of short- or long-term data demonstrating the cost effectiveness of sodium reduction policies will generate interest from policy makers, stating:

"You have to demonstrate, you have to have evidence, if you have the evidence and you have the data of course, that will help policy makers to make decisions and that will be credible. Because if you don't have the data, there will be no interest in the integration of the policy and programs".

Country D, and others, also highlighted that the quantitative data related to the sodium content of the food supply impacted decision makers. A MOH from country D noted:

> "with respect to the data of our current project [IDRC project], in fact, the data we obtained is quite solid because the process was done rigorously, it was carried out properly. It was partly innovative because we used technologies, like FLIP [data collection app and food database], that we learned and got to know here. The scientific community is interested in knowing and learning about such things. […] The data we obtained from the research we carried out during the IDRC project has been very important, it is the evidence we are going to use to reach decision-

makers above us, who are the ones setting the standards in terms of policies and everything else. We also collaborate in the formulation of laws, resolutions, etc., but it is ultimately up to the top decision-maker".

Qualitative research data generated under the IDRC-funded consortium. Qualitative data was believed to be influential, alongside the quantitative data for Countries D and E. The MOH in Country D found the qualitative data provided insights into consumer needs and opinions related to sodium, data that did not previously exist. For instance, the qualitative data found that consumers viewed iodized salt as necessary for good health due to past public health initiatives to address goiter. Country D also noted that this data provided insights on how to connect with a hard-to-reach adult population, where changing behaviors has been historically challenging. In Country E, researchers noted that the strength of the qualitative research data highlighted the root causes of people's health practices and food purchasing patterns which was not easily identified with quantitative research methods.

6.3.2.2 Actors

Government Political Will. The governments' strong political will manifested through outreach efforts, commitments and mobilization of resources to support sodium reduction policies and programs in the funded countries. This was a foundation to advance political agendas on sodium reduction in the funded countries. In Argentina, a Senator contacted researchers to initiate regulatory work on sodium reduction in food products. In Peru, the IDRC study results activated the MOH's interest in sodium reduction for the first time. This was viewed as a significant achievement in Peru, as the government's primary focus was directed to anemia and diabetes. Both participants in Costa Rica noted that the

government deemed the IDRC-funded consortium research to have national importance and committed to sodium reduction policies and programs in the country, which supported research efforts. Also, the Costa Rican Ministry of Health and the CACIA, Cámara Costarricense de la Industria Alimentaria (Costa Rican Chamber of the Food Industry) renewed their alliance and shared a commitment to sodium reduction in the food supply, which included updates to the sodium targets for the packaged food supply. The government in Brazil committed to addressing NCDs regardless of the political party in charge. The MOH from Paraguay mobilized additional human and financial resources to support NCD initiatives and created a new department to support the work of the IDRC-funded research consortium.

Research experts. Within each funded country, the expertise of regional and international researchers was seen as influential in creating opportunities to advance research into sodium reduction policies and programs. For example, in Country A the government drew on the expertise of nutrition researchers to advise and participate in advisory boards and technical expert groups to inform sodium target levels and national strategies. The researchers generated evidence with a responsibility "for translating the technical aspects [of the research] into something understandable for decision makers" [Researcher, Country B].

International researchers who supported the IDRC grant were also recognized as highly influential "to have these heroes by our side [from the University of Toronto and Ontario Tech University], and because they are also communicators and they help a lot with advocacy", as noted by a researcher from Country C. In Brazil, international researchers participated in round table discussions with the Inter-American Heart

Foundation, NCD Alliance and the IDRC. These discussions ultimately led to NCD

strategies for the LA region, which supported the integration of the IDRC data into

national sodium reduction policies. The international recognition and credibility of

researchers in Argentina and Costa Rica also led to continuous research funding

commitments from international agencies, like the IDRC, to continue with sodium

reduction research to inform policies and programs.

Dual roles. Individuals with dual roles as researchers and MOH officers were valuable

liaisons that led to strong planning and coordination of the IDRC-funded consortium

research activities, as well as use of the data in policymaking. In Brazil, the dual roles

allowed researchers to be privy to insider information, which allowed them to be in a

better position to hold discussions with policy makers and key stakeholders, and to more

effectively generate and transfer relevant, audience-specific research data.

In Paraguay, the MOH participated in social marketing research, which allowed

them to directly apply the research findings into an awareness campaign, in addition to

dissemination to academia and scientific organizations. In parallel, Paraguay's MOH

involvement with research activities enhanced their credibility and ability to advocate for

use of the sodium reduction research with decision makers, noting:

> "Our cooperation with academia would be a facilitator because people respect
> researchers and scientists; they are perceived as more knowledgeable and
> trustworthy. If they take our results and information that will work in our favor, it
> will be a facilitator in all the measures we need."

Non-Governmental Organizations. Many countries had a positive perception of

international non-governmental organizations such as the Food and Agriculture

Organization of the United Nations and PAHO. All countries perceived PAHO as

positive and highly credible. As such, any endorsements of the research from PAHO

were viewed as a strong facilitator of change that led to uptake of research findings into

policies. A MOH officer from Country D mentioned that:

> "There is a positive perception of PAHO's support at the Ministry of Health. People
> trust their opinion; they believe that if PAHO supports something it must be
> reliable; it must be true. The technical support they provide is really important
> during the entire process, mostly when we first approach academia and when we
> start showing scientific evidence. Thanks to their support we can count on foreign
> experts who come, share their experience and support us with what we are starting
> right now."

International Support.   Scientific evidence generation in NCD for use in policy making

is highly dependent on external funds and support from international agencies like the

IDRC. All countries mentioned that the IDRC's funding and support enabled them to

generate sodium reduction research and motivated conversations in the LAC on sodium

reduction targets in food products. Country B's participant noted that if, "IDRC had not

funded our project, we would not been able to start working in this field". All

participants from each funded country expressed their accolades for the IDRC and their

commitment to fund research and innovation in developing regions. Country B's public

health researcher stated, "IDRC is not any like other funders, they are very interested in

funding future research to monitor processed sodium level in processed foods that may

become an obstacle or barrier for us to be able to continue monitoring the policy."

Media. The media was viewed as a strong vehicle to garner public interest to stimulate

policy development and change. In Country B, the media disseminated the funded

research data which drew attention to the high sodium levels in the food supply. Both the

MOH officer and researcher from Country B believed that the media was key in the implementation of sodium regulations, and that they planned to leverage the impact of the media in the future. Additionally, the media in Country C was used to re-start conversations on public health issues that are not permanently in the spotlight and easily overlooked, such as setting new sodium reduction targets and disseminating the monitoring results. In Country E, the media was similarly viewed as a catalyst to drive changes with sodium reduction efforts, similar to how the media was previously used to stimulate changes to food policy and nutrition legislation. In Paraguay, the media was useful in promoting communications on the social marketing plan developed under the IDRC funding.

6.3.2.3 Process

Knowledge Translation Training and Implementation. Activities under the IDRC-funded consortium research introduced a new way of disseminating research through formalized KT training and strategy development. Researchers noted that an integrated KT approach enabled new ways of early engagement between researchers and policy makers during the research process:

> "when we have any research grants for small funded projects, we have added something that was actually inspired by the IDRC project...is that this communication plan…this knowledge transfer. It is something that is very important for presenting the results, making the results easier to understand for any audience." [Researcher, Country C]

In Countries B and E, this new approach shifted communication from being at the end of the grant, to earlier in the research process, offering opportunities to obtain feedback from decision makers to ensure that their data is relevant for policy development. In Countries

A and E, early engagement with the government resulted in support for data collection, which helped with study progression and resolved set-backs experienced in the early stages of the project.

Perspectives varied in Country D on the ideal timing for communication between key stakeholders. A researcher in Country D preferred communication with decision makers when the results were available as human resources were not available to support early communications. Whereas, the MOH officer preferred discussions at the initial stages of the research process. The MOH officer from Country D found value in early communications to support the coordination of the project results with internal departments at the MOH.

6.3.2.4 Context

Country size and cultural context. Costa Rica, being a small country with a solid health system, enabled easier facilitation of research adoption into policy and program changes. Both MOH and the researcher from Costa Rica noted that the lines of communication were clear and direct compared to larger countries. Having fewer people involved in the research and policy making arena allowed timely action of outputs. Also, the Costa Rican population was described as a facilitator of change as they modelled a lifestyle of healthy eating habits. A researcher from Costa Rica noted that, "I think there's an increased interest in health from the population...they are eating or interested in eating foods that are healthier."

6.4 **Discussion**

This is one of the first known studies to examine factors related to the uptake of sodium reduction research into policies and programs in LAC, a topic of interest given the high prevalence of hypertension and cardiovascular diseases, alongside high intakes of sodium in this population. One other study conducted a retrospective policy analysis based on reviews of existing reports and semi-structured interviews in 4 LMICs to understand the factors that influenced the implementation of existing salt reduction interventions in each country (Webster et al., 2021). The current study and the policy analysis identified similar factors that impact the development and implementation of sodium reduction policies, such as strong leadership and support from the government and other international agencies, as well as adequate resources. The current study took a case study qualitative approach and uniquely capitalized on the context of a funded research consortium of five LAC to explore the barriers and facilitators to the integration of research into the policy process, considering the views of both researchers and MOH officers. This study demonstrated that partnerships between researchers and policy decision makers can promote and/or impede the use of research into sodium reduction policies and programs. Leadership and support from the government, international non-governmental organizations such as PAHO, the IDRC, as well as KT plans (e.g., integrated and/or end-of grant) supported mobilization of research information for use into policy and program development. The food industry's conflicts and competing interests, and persuasive power over the government were observed as strong barriers to research adoption into nutrition policy and program development and changes. A policy mapping study conducted by PAHO (Pan American Health Organization, 2021c) found

that at least sixteen countries in the Americas Region have at least one dietary sodium reduction regulation in place that is in line with the WHO "Best Buys", which is the most cost-effective recommendations for the prevention and control of diet-related NCDs to reduce population sodium overconsumption (Santos et al., 2021). Globally, countries have acted to reduce population sodium consumption using policies; however, these actions are not progressing fast enough to meet WHO's global targets for addressing diet related NCD morbidity and mortality (Santos et al., 2021). These policies include those focused-on monitoring sodium content of the food supply, use of social marketing to design public health programs aiming to reduce sodium intake at the population level and evaluation of health-economic variables, which are all areas of research funded under the IDRC consortium research project of interest in this study.

Leadership and support from the government are strong facilitators to sodium reduction changes in policies in LMIC (Latu et al., 2018; Oliver et al., 2014). This study, and others, found that there is a strong likelihood that research evidence will be adopted by policy decision makers if there is strong buy-in and support from governing bodies (Latu et al., 2018; Oliver et al., 2014). All countries from the IDRC consortium had strong governmental support. Despite human resource challenges, governmental support led to the acquisition of high-quality data that, in some countries, was integrated into sodium reduction policies (Padilla-Moseley, 2020). Other studies found that leadership and authority were key facilitators to the use of research in policymaking (Oliver et al., 2014). Evidence suggests that when MOH officers have close relationships with academic institutions, policy changes are more likely to occur, as documented in the Oceanic region for the implementation of palm oil, fruit and vegetable policies (Latu et

al., 2018). These considerations have been documented with other public health policy topics, such as in Kenya where strong political commitment and leadership was a key factor for the implementation of tobacco control policies (Mohamed et al., 2018).

Despite having partnerships with the government, the food industry has strong influence over policy advocacy efforts which has been widely cited as a global barrier to nutrition policy development and change (Cullerton et al., 2016; Vandenbrink et al., 2020). This research confirmed that sodium reduction work is also met with lobbying efforts and resistance from the food industry. Some participants in this study averted questions related to the nature and type of resistance imposed by the food industry out of fear of negative repercussions. The food industry's influence is a systemic issue and dates back as early as 1990 in the UK. In the UK, the food industry pressured the government to reject the recommended sodium intake of less than 2000 mg/day out of fear that the food industry would withdraw political funding (He et al., 2014). Similarly, a Canadian study involving a document review of correspondences and exchanges related to Health Canada's Healthy Eating Strategy observed a high number of interactions initiated by the food industry (Vandenbrink et al., 2020). Of the documented exchanges, the food industry utilized a wide variety of tactics to influence Canada's nutrition policy (Vandenbrink et al., 2020). These are examples from high-income countries; however, we assume that the food industry's pressure and influence are amplified in LMIC where resources are constraint, a lack of competencies in technical knowledge and political unpredictability are common (Rabadan-Diehl, 2017). A limitation of this case study is the lack of representation from the food industry as study participants. Interviews from the food industry would strengthen this work by providing a holistic view from the key

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actors involved in food reformulation and front of pack policies which should be considered for future work.

Researchers and policy makers can utilize the food industry's persuasive power over the government to their advantage, to sway public health nutrition efforts in their favor. This research found that it is possible to shift the food industry's perception and attitude on sodium reduction as seen in Costa Rica. During the grant period, the Costa Rican government and food industry renewed an alliance and commitment to further reduce sodium in food products based on the research generated from the IDRC-funded consortium research. This was possible as the researchers offered iterative feedback and communication with key stakeholders, where expectations were defined and concerns were addressed as they arose. This is similar to how the UK government was eventually able to work collaboratively with the food industry, and used the influence of businesses to engage with consumers, by forming a partnership with them and other stakeholders to meet public health goals related to food, alcohol, health activity and other health behaviours (Buttriss, 2013). This progress further demonstrates that relationship management with multiple parties can advance public health goals, especially when each stakeholder has competing interests.

The PAHO/WHO's leadership and commitment to improve and protect health of the Americas positively impacted research use in policy-making. The WHO/PAHO has a long-standing history of promoting and developing capacity on the use of research data and evidence in policy making and health systems (Pantoja et al., 2018). The Evidence-Informed Policy Network (EVIPNet) program that PAHO/WHO adopted over a decade ago, has created positive impacts of this program and networks related to numerous

public health policies (Pantoja et al., 2018). Most importantly, the IDRC's funding and support for sodium reduction research in LAC informed the WHO's recent Global Sodium Benchmarks for Processed Foods. The data acquired from the IDRC research consortium was also used to develop PAHO's new and revised sodium targets, recently released in October 2021 (Pan American Health Organization, 2021a). This was possible through the IDRC-funded consortium research and lessons learned from several countries who have developed national and regional sodium reduction targets. The development of harmonized regional and global sodium reduction targets is a critical step to further strengthen country-level policies and programs and support Member States in achieving a 30% reduction in mean population sodium intakes by 2025.

The KT strategies developed, and high-quality research data generated, had complementary effects that enabled researchers to generate discussions with policy makers and the food industry. Integrated and end-of-grant KT principles and strategies synthesize and disseminate research at various time points in the research cycle into audience specific, relevant and understandable information and tactics so that the evidence is more likely to be effectively adopted by end-users (Barwick et al., 2020). In this study, KT capacity building among the funded countries was considered a major gain for future research. Overall, it has been reported that it takes an average of 17 years for evidence-based practices to be incorporated into general practice (Bauer et al., 2015). Research used to inform policies in LMIC could follow a similar lag time pattern. The researchers developed their skillset and capacity on KT principles under this project, which included multiple training sessions, and country and project specific KT workbooks that supported researchers in strategizing dissemination efforts. For a

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majority of the researchers in the IDRC project, KT was a new concept, but researchers quickly learned how to apply the principles. Future research initiatives in LMIC and LAC should embed integrated and end-of-grant KT activities to strategize the uptake of research findings into cultural and political contexts so that decision makers can best use the research to support policy and program development and change.

In addition to its originality, a strength of this study is the case study approach, which allowed for a level of flexibility with wide diversity in design, such as data collection through remote means (Hyett et al., 2014). Some may consider that a limitation of this work is the remote, online nature in which this was conducted; however, this is a feasible and economical alternative approach that is shown to produce similar findings to face-to-face interviews (Archibald et al., 2019; Janghorban et al., 2014). An internet connection issue was experienced in one instance with a respondent which interrupted the flow of the conversation; however, reconnection was established in a timely manner. The same participant conducted the interview with their camera off due to the weak internet connection, which limited the interviewer from capturing facial expressions and emotions from the respondents. However, expressions and emotions were captured from audio cues which included the participants interjections (e.g. use of, "umm", "hmmm" and sighs). The research team consisted of an English, Portuguese and Spanish speaking multi-disciplinary team from North, Central and South America which was a strength of this study (Berman & Tyyskä, 2011). The public health researchers of Central and South American origin were valuable contributors as they provided cultural understanding and different perspectives to this work. The inclusion of Spanish-speaking project team members further enhanced trustworthiness and rigour of this cross-language research

(Berman & Tyyskä, 2011). To enhance effective communications, Spanish-speaking team members should have been utilized to conduct the interviews in Spanish, the participant's first language. A majority of the interviews were conducted in English as the preferred choice, and only a few interviews were conducted in Spanish. Despite this limiting factor, interview guides were translated into Spanish and sent to participants in advance of the interview. This allowed participants to prepare and have a better idea of the nature of questions to be asked, which is a practice that has been used in other qualitative studies (Meho, 2006).

6.5 Conclusion

Researchers and policy makers are faced with several barriers and facilitators on how research is adopted into policies and programs for dietary sodium reduction. Although barriers and facilitators experienced in each country have cultural and political roots, the awareness and insights gained from this study will help guide countries in working through these issues in the future. Other countries can extrapolate and customize the facilitators to meet their own country's need to continue the efforts on policy nutrition to promote healthy eating and reduce CVD risks.

DECLARATIONS

Ethics approval and consent: Participants provided informed consent prior to the interview and for dissemination of case study findings. The Ontario Tech University Research Ethics Board granted an ethics review exemption under the Article 2.5 of the Tri-Council Policy Statement 2 (File # 14970).

Chapter 7. Discussion

7.1 General Discussion

This chapter describes the key findings on impactful approaches for research uptake into complex policy changes. Research consortiums and knowledge translation strategies were found to be effective approaches to developing complex policy. Also, leadership and governmental support were identified to be strong facilitators to sodium reduction policies. A description of the strengths and limitations of the study and implications for future research and policy development conclude this chapter.

7.1.1   A research consortium is one approach for policy and program development and
         changes

Consortium-based research projects are emerging as an impactful way to address complex public health issues on NCDs, especially in LMIC (Bautista et al., 2009; Ibanez et al., 2021; Miranda, 2020). Most multi-national Latin American consortiums have addressed public health challenges focused on obesity (Bautista et al., 2009), cardiometabolic risk factors (Miranda, 2020) and neurodegenerative conditions (Ibanez et al., 2021). While the IDRC has previously funded dietary sodium research in individual LAC on a country-by-country basis (Allemandi et al., 2019a, 2019b; Allemandi et al., 2015; Blanco-Metzler et al., 2017), this study is the first multi-country research consortium with the objective of addressing sodium reduction policies in the Latin American region. The formation of a consortium enabled the development of a community of practice to foster learning interactions, sharing knowledge, training and

development efforts. This community of practice also created a rich environment to understand new knowledge and training efforts acquired. Research consortium members developed and enhanced their research skills and capacity in social marketing, as social marketing researchers can better inform effective behavioral interventions, which are needed to understand how to better influence people of dietary sodium consumption.

At the population level, discretionary sodium is a primary source in many LAC, making behavior changes essential to decreasing sodium consumption and preventing NCD-related morbidity and mortality. Since the sources of sodium are common in LAC, a multi-country research consortium that anchored program objectives to the WHO's "Best Buys" interventions were strengths of this research. The WHO's "Best Buy" interventions involving reformulation of food products to upper limits of sodium target levels (program objectives 1A and 1B); front of pack labelling to promote healthy food choices (program objectives 1A, 1B); policies to promote healthy eating in the public setting (program objectives 1A, 1B, 2, 3 and 4); and mass media campaigns (program objective 2) were embedded to drive the outputs and outcomes of the consortium. Collectively, the research consortium generated a high number of novel data that persuaded policy decision makers to add sodium reduction to their political agenda and/or actionize sodium reduction policies that have been planned and/or developed but stagnated. This consortium can be a model for other public health interventions that require research for food policy and consumer behavior analysis, as well as translating key findings to the broader community. It is also the first study to examine factors related to the uptake of sodium reduction research into policies and programs in LAC, a

topic of significant interest given the high prevalence of hypertension and cardiovascular diseases, alongside high intakes of sodium in this population.

7.1.2   Knowledge translation strategies facilitate with use of research evidence

Knowledge translation strategies are impactful approaches to increase the use of research evidence into policies (Grimshaw et al., 2012). Policy makers require clear research evidence on the impact on population health to inform their decision making (Hyseni et al., 2017). Knowledge translation is highly encouraged to be embedded into research projects to ensure evidence is transferred and integrated into its end users, and ideally integrated into policies and programs (Lavis et al., 2003). These approaches are critical as it takes an average of 17 years for evidence-based practices to be incorporated into general practice (Bauer et al., 2015). Policy development and knowledge translation are complex and slow and have followed a similar lag period, especially in LAC (Cordero et al., 2008). However, policy development is further impacted by resource limitations, poor communication and dissemination methods and a lack of capacity to understand technical data (Akhlaq et al., 2016; Cordero et al., 2008; Hyder et al., 2011). As such, allocating proper resources is required to support knowledge translation to better "package" research results into actionable information, as well as for researchers and policy makers to develop technical capacity in understanding scientific data (Hyder et al., 2011). The IDRC is one of 18 of 23 national and international funding agencies that integrates some aspect of KT in their mandate (Cordero et al., 2008). Research consortium members in this consortium developed and expanded skills on KT principles, which included multiple training sessions and KT workbooks customized to a LA setting

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that supported researchers in strategizing dissemination efforts. Hence, knowledge translation skillset development and enhancement among the consortium countries was considered a major gain for future research.

The research consortium members in the participating countries experienced paradigm shifts related to communication tactics with policy decision makers. This consortium integrated and end-of-grant knowledge translation strategies to inform policy development with relevant and audience-specific research evidence. A large number of outputs (e.g., peer reviewed publications, meetings with decision makers and partners, technical reports, policy briefs and presentations) were generated from this consortium that reached sectors such as the government, health and education, civil society, scientists and international organizations involved in dietary sodium policies and programs. For instance, in Paraguay, data acquired from the IDRC research consortium was disseminated to the top political decision makers. The high-quality data generated under robust and rigorous scientific methods facilitated this communication, and was a major achievement as researchers experience challenges with knowledge mobilization to this group. The early policy advances the consortium observed in Argentina, Costa Rica, Paraguay and Peru are likely attributable to this large number of KT outputs. The integrated KT strategies are one factor leading to achievement of the short and intermediary outcomes in this evaluation.

7.1.3   Governmental leadership and support are facilitators to research

Consortium researchers do not have dedicated time to collect the much-needed research evidence that is used by policy makers to inform decision making. However,

governmental support can mobilize human and financial resources to facilitate research

uptake into policy development. For example, in 1994 the Government of South Africa

strongly supported research uptake and enhanced the national maternal healthcare policy

on the management of pre-eclampsia and eclampsia, when there was no central policy

(Daniels & Lewin, 2008). The South African government provided human resources to

appoint academics into position in the National Department of Health, which facilitated a

central maternal management policy (Daniels & Lewin, 2008). Similarly, Paraguay's

Minister of Health mobilized additional human and financial resources through the

creation of a new department to drive NCD initiatives, generated under this IDRC

consortium. Overall, at the onset of this program, the consortium researchers in all the

countries were not expecting to have direct and immediate effects on policy. However,

the IDRC's funding for this research resulted in a significant amount of country and

regionally-specific evidence generated, which led to regional sodium reduction targets

and benchmarks being updated in several LAC (Santos et al., 2021). Argentina for

instance made progress with updating regional sodium targets based on the robust data

acquired through the research consortium (Allemandi et al., 2019b).

Collaborative efforts from leaders in multiple sectors can enable health promotion and

prevention interventions (Appel et al., 2012). In one instance related to tobacco policy, a

multidisciplinary approach was used to successfully bridge scientific discovery and

translation for tobacco research through engagement with several stakeholders in

advertising, policy, business, economics, medical science and behavioral science groups

(Appel et al., 2012). Likewise, collaborative relationships and partnerships were

observed across this consortium. For example, the Costa Rican Ministry of Health and the

CACIA, Cámara Costarricense de la Industria Alimentaria (Costa Rican Chamber of the Food Industry) renewed their alliance and shared a commitment to sodium reduction in the food supply, which included updates to the sodium targets for the packaged food supply. Multi-sectoral collaborations are important when it comes to health policies as these partnerships can break resistance from lobbyist as mentioned in select participating countries in the research consortium. Importantly, research consortium members continue collaborating and sharing information beyond the grant period to promote knowledge exchange, generate a number of peer reviewed publications and continue to offer professional development opportunities for research team members.

7.2 Thesis strengths and limitations

The use of a logic model that carefully considered the research consortium and regional context was a major strength of this program. Only a few published studies have used a program evaluation framework, where most evaluations relied on observation designs (Brusco & Frawley, 2019). A formative evaluation in New South Wales explored systematic factors that contributed to barriers for Indigenous groups to acquire a driver's license as a crucial first step in the logic model creation. An exploration of the underlying factors and barriers for the group informed the program goals (Cullen et al., 2016). For this research consortium, construction of the logic model was informed by consortium members' iterative feedback and perspectives on contextual program factors in the LA setting, which is an approach that has been widely utilized in other program evaluations (Cullen et al., 2016; Hill & Thies, 2010). By embedding contextual analysis and collaborations in the construction of the logic model, the program's outcomes along

with IDRC's program strategy have reinforced recommendations for best practices on how future funded consortiums could be implemented in Latin America (Ebenso et al., 2019).

To our knowledge, this is the IDRC's first funded research consortium in LAC with a focus on sodium reduction policies. The IDRC's financial and technical support made it possible to generate research outputs, especially in countries with limited resources and financial means. Globally, countries have experienced lesser disbursement of funds for development assistance for health to address NCD related burden, where global health priorities for HIV/AIDs, child and newborn health and maternal health received the highest global financial donations (Dieleman et al., 2016). In the Latin American region, the IDRC's financial resources led to structural changes in MOH departments and research organizations in the funded research countries to enable research evidence to be generated for NCD related policies. The positive outcomes of this program demonstrated that it is feasible to make policy changes through a funded research consortium. It is important to note that future funding opportunities would benefit other LAC who are in most need of resources.

The research consortium experienced challenges despite the high degree of success. The KT planning and development was introduced in the second year of the grant period, which was considered to be a relatively late stage to incorporate rigorous integrated KT strategies. Future consortium work should embed KT planning and development strategies at the onset of the project to promote maximal impact of the data on policy development and implementation. If possible, a central support person overseeing the facilitation of all aspects of KT coordination and activities should be considered for

future work. In Brazil, logistical issues related to the distribution of grant funds from INCIENSA to the Brazilian country lead, hindered Brazil's participation in program objective 1B. Contract negotiations between institutions took an extraordinary amount of time to resolve, which resulted in delays and a lack of participation from select program objectives. Notably, misaligned expectations among research consortium members resulted in partnership challenges. Select consortium researchers were disappointed when only one regional social marketing plan was created. Consortium researchers expected the country-specific social marketing plans to be jointly developed during the grant period, rather than country leads independently adapting the regional plan to each consortium country post grant. Agreements that explicitly outline the project deliverables would mitigate future disappointments.

The purposive sampling strategy and small sample size in the qualitative case study (study 2) is a limitation of this thesis. The philosophical assumption and qualitative inquiry informed the sampling strategy and size. A case study approach oriented in a constructivist lens has a focus on the historical and cultural context in which people live and work. Constructivism in relation to case study methodology relies on a smaller sample to permit in-depth case-oriented analysis, where a case involving a single participant can provide in-depth insight on the topic of interest. A qualitative case study purposively sampled consortium researchers in the five LAC who participated in a funded research consortium. The 5 country leads were the population of interest based on their unique role and contributions to the grant, where they led the research activities in their country. There are no other eligible participants who could speak to the factors on the uptake of research evidence generated under the funded project into policies. In

addition, MOH officers were selected based on their role with NCD development and implementation in the five funded countries, where incumbents occupying this role are limited or absent. In addition, sample size determination was based on the bounds of the case which included all funded countries, a common practice in case study research. As such, it was not feasible to recruit more than 5 researchers and 5 MOH officers from each country.

7.3 Implications for research and policy making

   This thesis investigates factors related to research uptake into policy development and implementation. Investigating the implementation factors related to dietary sodium reduction policies in LAC is a practical next step to ensure that the research findings used to inform policies are actionized to address NCD burden. Globally, countries have dietary sodium reduction policies planned and/or developed, but their implementation is slow, while population wide sodium intake values remain high (Tekle et al., 2020). There are knowledge gaps on a general understanding of the factors which influence research evidence implementation into dietary sodium policy development in LAC. However, much of the effort is directed to evaluate factors that influence implementation of general public health policies. Effective leadership and guidance were highlighted as a significant influential factor in both the development and implementation of policy and programs (Weiss et al., 2016). Investigating contextual factors, such as political, environmental and economical factors, are important to consider as they can identify dimensions that may impact how interventions are implemented, translated and scaled-up (Craig P et al., 2018). This thesis further highlights that each region has unique contextual factors as to

why policies are implemented or not. Identifying which factors affect the implementation of dietary sodium reduction policies can assist other LMICs, who developed plans for sodium reduction strategies but failed with implementation, as seen in Nigeria and Mauritius (Tekle et al., 2020). In resource limited countries, understanding implementation factors will avert further wasted funds on research policy making, where $200 billion of funds have been wasted due to lack of translating research knowledge into policy development and implementation (Cordero et al., 2008). Findings from this research can be applied to develop future consortium research partnerships designed to address and implement NCD prevention initiatives in the region. In addition, the KT and social marketing capacity building was highlighted by consortium researchers to be the objective that they learned the most. The KT training and capacity development led to a high number of knowledge outputs that reached top decision makers and evoked change at the policy level. An expansion study involving a frame-work analysis and in-depth validation of the customized KT workbook developed under program objective 4, would benefit LAC researchers as many have adopted the KT workbook and embedded its use as standard practice in research studies.

7.4 Conclusions

In conclusion, this thesis found that the IDRC's funding and support for sodium research in LAC has been a facilitator to research adoption into sodium reduction policies. Interdisciplinary work through a funded research consortium had synergistic effects to knowledge creation and policy development, which was enabled by capacity building, partnership development, knowledge translation and the application of the

principles of equity, diversity and inclusion. It is evident from this thesis that integrated and end-of grant knowledge translation strategies are effective approaches to increase the use of research evidence into policies. Mentorship and training of research consortium members on knowledge translation created paradigm shifts in communication and dissemination of research findings. As a result, a large number of KT products were developed collectively for this consortium study and disseminated to policy decision makers. As such, intermediate outcomes involving policy changes on dietary sodium were unexpectedly achieved. Most importantly, leadership and support from the government on sodium reduction policies was instrumental in moving this work forward by removing barriers to achieve the objectives of the IDRC-funded research consortium. In Costa Rica, the government even deemed the IDRC research consortium as having national importance, which granted authorization to researchers to collect data in grocery stores. Overall, this thesis provides insights that can assist researchers, decision makers' and funding agencies on future efforts to develop and implement evidence informed dietary sodium reduction policies. In addition, the strengths, limitations and lessons learned from the IDRC research consortium can be used as a blueprint for future consortium work that can eliminate redundant efforts and mitigate challenges that were experienced during the program implementation.

Appendix A

A1. Recruitment Email for program evaluation survey (Study 1)

Dear [Name of study participant),

RE: Recruitment for study participants in salt reduction program evaluation study

By way of background, I am Janice Moseley, Master of Health Science (MHSc) candidate from the University of Ontario Institute of Technology (UOIT) in Oshawa, Canada. Dr. JoAnne Arcand, Assistant Professor, UOIT and I are working on a salt reduction study with Ms. Adriana Blanco Metzler, INCIENSA. Adriana suggested that I invite you to participate in our program evaluation for the study entitled "Scaling-up and Evaluating Salt/Sodium Reduction Policies and Programs in Latin American Countries" since you are involved with Non-communicable Diseases programs and working on salt reduction programs.

The study will involve a research consortium of five Latin American Countries (Argentina, Brazil, Costa Rica, Paraguay and Peru), funded by the International Development Research Centre (IDRC) and was initiated by the Pan America Health Organization (PAHO).

Study Objectives:

This study aims to use a logic model to evaluate research, knowledge translation, policy and program outcomes associated with dietary salt reduction research in Argentina, Brazil, Costa Rica, Paraguay and Peru. Specifically, we will evaluate the following areas:

- assessing the outcomes of data related to the food supply, industry or government commitments or action, sodium reduction targets, or revised targets, set. These are intermediate outcomes in the logic model. Also related to this will be evaluation of knowledge translation aspects like number papers published;

- knowledge, perception and behaviors on sodium and health; and

- evaluate the progress of project components.

Description of Program Evaluation Procedures:

Study participants will complete two surveys at the mid-way (summer of 2018) and end of the study (fall of 2019) to collect data and evaluate success and adoption of dietary salt reduction policy and programs, and knowledge translation activities that were developed by the consortium in Latin America.   The mid-way and end-of-study survey data will be validated by follow up interviews at a later time.

Each survey will be completed using google forms [link to google forms inserted here] and will take 40 minutes to complete.

Your participation in this study is voluntary. You may decide not to be in this study, or to be in the study now, and then change your mind later. You may leave the study at any time without affecting your relationship with the program evaluation team members or funding support for this project.

If you decide to leave the study, you have the right to request withdrawal of your survey and interview responses. Please let me know if you decide to withdraw from the study.

If you decide to accept this invitation, I will be in touch to send you the survey link and accompanying consent form for participation in the program evaluation.

If you have further questions about the study, please feel free to contact me at Janice Padilla-Moseley at [phone number] or janice.padillamoseley@ontariotechu.net; or Dr. JoAnne Arcand at (905) 721-8668 ext. 3796 or joanne.arcand@uoit.ca ; or Adriana Blanco Metzler (506) 2279-9911 Ext. 146, or ablanco@inciensa.sa.cr

Kind Regards,

Janice Moseley, MHSc (candidate)

A2. Recruitment email for qualitative interviews (study 2)

Dear [Name of participant],

RE: Recruitment for one-on-one interviews for sodium reduction study

I am Janice Moseley, Master of Health Science (MHSc) candidate from the University of Ontario Institute of Technology (Ontario Tech) in Oshawa, Canada. Dr. JoAnne Arcand, Assistant Professor, Ontario Tech and I are working on a sodium reduction study with Ms. Adriana Blanco-Metzler from the Costa Rican Institute for Research and Teaching in Nutrition and Health (INCIENSA). You have been invited to participate in one-on-one interviews as part of our program evaluation for the study entitled **"Scaling-up and Evaluating Salt/Sodium Reduction Policies and Programs in Latin American Countries"** because [insert rationale for study eligibility] .

This study involves a research consortium of five Latin American Countries (Argentina, Brazil, Costa Rica, Paraguay and Peru), which is funded by the International Development Research Centre (IDRC) and was initiated by the Pan America Health Organization (PAHO). The IDRC is a Canadian federal Crown funding agency.

One-on-one web interviews

For this study, IDRC requires an end-of-study project evaluation report. Our aim is to investigate the influence of the research consortium on policy and/or program changes on sodium reduction for front of label (FOL) packaging, voluntary and regulated targets, social marketing and food procurement standards since the onset of the IDRC project in 2016, and learn about the enabling or constraining factors of implementing programs and policies related to dietary sodium in your countries.

The interview will last approximately **45 minutes** and will be conducted **via web-call**. The interview can be conducted in **English or Spanish**. We are looking to conduct interviews throughout the months of **November and December** as the report will be written immediately after.

Participation

Your participation in the interview is voluntary. **If you decide to accept this invitation, kindly indicate your availability via the doodle poll link:**

[doodle poll link]

In addition, please indicate if you prefer to conduct the interview in English or Spanish.

If you have further questions about the study, please feel free to contact me at Janice Padilla-Moseley at janice.padillamoseley@ontariotechu.net or WhatsApp call at [phone number] . In addition, if you have other project inquiries, please feel free to contact Dr.

JoAnne Arcand at joanne.arcand@uoit.ca ; or Adriana Blanco Metzler (506) 2279-9911 Ext. 146, or ablanco@inciensa.sa.cr

Kind Regards,

Janice Moseley, MHSc (candidate)
Faculty of Health Sciences
Ontario Tech University
janice.padillamoseley@ontariotechu.net

Appendix B

B1.   Consent form for qualitative interviews (study 2)

Study Title: Scaling-up and Evaluating Salt/Sodium Reduction Policies and Programs in Latin American Countries.

Lead Principal Investigator: Ms. Adriana Blanco Metzler, INCIENSA

Contact information: (506) 2279-9911 Ext. 146, or ablanco@inciensa.sa.cr

Study Team members:

1. Dr. JoAnne Arcand, Assistant Professor, University of Ontario Institute of Technology (Ontario Tech)
    Contact Information: JoAnne.Arcand@uoit.ca, or 905-721-8668 ext 3796

2. Janice Padilla-Moseley, Graduate Student, University of Ontario Institute of Technology
    Contact Information: Janice.PadillaMoseley@ontariotechu.ca,

3. Karla Francela Benavides Aguilar, Regional Administrative Coordinator, INCIENSA
    Contact Information: (506) 2279-9911 Ext. 170, or kbenavides@inciensa.sa.cr

External Funder/Sponsor: International Development Research Centre (IDRC)

You are invited to participate in a program evaluation of the study entitled "Scaling-up and Evaluating Salt/Sodium Reduction Policies and Programs in Latin American Countries". This study has been reviewed the University of Ontario Institute of Technology Research Ethics Board (REB #14970).

Please read this consent form carefully, and feel free to ask the researcher any questions that you might have about the study.

Background and Purpose:

Globally, hypertension is the culprit for approximately millions of pre-mature death per year. In fact, hypertension is the leading cause of death in Latin America. Excessive dietary salt consumption is directly linked to hypertension.

The WHO, recommends that adults consume 5 g of salt per day. This is not the case in Latin America, where dietary salt consumption values for adults ranges between 9 g to 12 g of salt/day, which is more than double the recommended values.

This project will research knowledge translation, policy and program outcomes associated with dietary salt reduction research programs in five Latin American countries (Argentina, Brazil, Costa Rica, Peru, and Paraguay). You are being invited to participate in the study as you are currently leading and/or working with the non-communicable diseases programs, and are involved in policy and program decision making and/or implementation

Program Evaluation Procedures:

For this program evaluation, IDRC requires an end-of-study project evaluation report. In the evaluation report, the study team would like to interview key informants who work at the Ministry of Health with an aim to:

    a. investigate the influence of this research consortium on policy and/or program changes on sodium reduction for front of label (FOL) packaging, voluntary and regulated targets, social marketing and food procurement standards since the onset of the IDRC project in 2016, and

    b. learn about the enabling or constraining factors of implementing programs and policies related to dietary sodium in your countries.

The interview will last approximately 45 minutes and will be conducted via web-call. The interview can be conducted in English or Spanish. We are looking to conduct interviews throughout the months of November and December as the report will be written immediately after.

The interviews will be audio recorded so that the moderator (Ontario Tech graduate student) can be an active participant in the discussion without having to take notes. The audio recording will be transcribed and then permanently deleted immediately.

Potential Benefits:

You may not receive direct benefit from being in this study. Information learned from this study might help the countries involved in this project develop policies and programs in the future that will address the hypertension.

Potential Risk or Discomforts:

There are no known risks to take part in this study. However, there may be possibility of risks that we do not know about and have not experienced to date.

A foreseeable risk to a potential study participant is that one can self-identify themselves in published reports since participants will be purposefully selected for participation based on their role in various sectors. As a result, quotes and interview responses may be linked back to you in publications since the study participants selected are known to work in salt reduction policy and programs and are affiliated with PAHO and the Salt Smart Consortium. To mitigate these risks, the quotes will be re-phrased and de-identified so that the likelihood of quotes being linked back to you is low.

Please call the Principal Investigator or study team personnel if you have if you experience any risk or harm as a result of this study.

Additional considerations are that the security of e-mail messages are not guaranteed. Messages may be forged, forwarded, kept indefinitely, or seen by others using the internet. Email must not be used to discuss sensitive information.

Confidentiality and Storage of Data:

The study team will collect information related to salt reduction policies and programs in your country. These questions will include implementation questions on these initiatives and general experiences. In addition, quotes from the interview will be used; however, the quotes will be re-phrased and de-identified so that the likelihood of quotes being linked back to you is low.

The interviews will be audio recorded and stored on a secured network storage. The audio recording will be transcribed and then deleted immediately. Only the graduate student, my graduate supervisor or the transcriber will have access to the recording and will be responsible for permanently deleting the audio file.

The Principal Investigator and program evaluation team will keep all other evaluation information about you in a secure and confidential location for 7 years post study completion and then destroyed.

Some study information will be sent outside of the study team to the study funder. Any information about you that is sent out of the study team will have a number and will not show any information that directly identifies you.

The study funder may use the study information and share it with its research partners or with national and international regulatory agencies to help answer the study question and to develop future studies on this product or for research related to this study.

You will not be named in any reports, publications, or presentations that may come from this study. Your privacy shall be respected. No information about your identity will be shared or published without your permission, unless required by law. Confidentiality will be provided to the fullest extent possible by law, professional practice, and ethical codes

of conduct. Please note that confidentiality cannot be guaranteed while data are in transit over the Internet.

Right to Withdraw:

Your participation is voluntary, and you can answer only those questions that you are comfortable with answering. The information that is shared will be held in strict confidence and discussed only with the evaluation team.

You may decide not to be in this study, or to be in the study now, and then change your mind later. You may leave the study at any time without affecting your relationship with the evaluation study team, IDRC, PAHO, Salt Smart Consortium or the country you represent. We will give you new information that is learned during the study that might affect your decision to stay in the study.

If you decide to leave the study, you have the right to request withdrawal of information collected about you. Let your study Principal Investigator know.

Conflict of Interest:

Evaluators have an interest in completing this study. Their interests should not influence your decision to participate in this study.

Compensation:

There will be no compensation for participation in this study.

Debriefing and Dissemination of Results:

A copy of the final IDRC report and publications will be shared with study participants once available.

Participant Concerns and Reporting:

If you have any questions concerning the program evaluation or experience any discomfort related to the study, please contact the Adriana Blanco Metzler, Principal Investigator at (506) 2279-9911 Ext. 146, or ablanco@inciensa.sa.cr

If you have any questions about your rights as a participant in this study, please contact the University of Ontario Institute of Technology Research Ethics Board Chair at 905 721 8668 ext. 3835 or ruth.milman@uoit.ca

By consenting, you do not waive any rights to legal recourse in the event of study-related harm.

Consent to Participate:

1. I have read the consent form and understand the study being described.
2. I have had an opportunity to ask questions and my questions have been answered. I am free to ask questions about the study in the future.
3. I freely consent to participate in the evaluation study, understanding that I may discontinue participation at any time without penalty. A copy of this Consent Form has been made available to me.

☐   I Agree

Appendix C

C1.   Country lead interview script

1. Can you please tell me your position, title?
    a. What is your involvement with policies, strategies and practices in your country?
    b. How long have you been in this position?
Influence of IDRC research project on policies and program (e.g. program/practice changes) on sodium reduction

2. Please tell me about any other research projects you are aware of that focus on informing sodium reduction policies and programs in your country or in Latin America?

3. How does research knowledge influence your government's likelihood of adopting a sodium reduction policy/program?
    Probe:
    a. Create local awareness.
    b. Policy agenda setting, policy content and direction, evaluation of policy.
    c. Can you think of other examples where research knowledge informed policies and programs in your government?
        i.   Why do you think these policies were adopted?
        ii. What inputs, in the form of key activities, and resources were required to implement the policy/program?
        iii. Were all of these inputs and resources available?

4. In relation to the research conducted as part of this IDRC grant, please tell me about the kind of interactions you have had with policy makers during the grant period? (E.g., forums to hear about research findings, invitations to speak to policy makers, invitations to be active members in policy development).

Probe:
    a. What did you learn from these exchanges with policy makers?
    b. How do you feel about interacting with policymakers (knowledge users) about your research findings on sodium reduction and NCDs for policy development?
    c. Can you think of time points in the research cycle where you could exchange information with policy makers? (E.g. idea generation, design, data collection, analysis, and application/dissemination of knowledge.)

d. When are appropriate time points to engage with policy makers to exchange information? (E.g. idea generation, design, data collection, analysis, and application/dissemination of knowledge.)

Sodium focused policy and initiative changes from the onset of the project in 2016

5. Based on a survey and mapping exercise led by the Pan American Health Organization (PAHO) on policies and initiatives focused on dietary sodium consumption in Latin American countries, the following policies and initiatives were found: [See country specific country profile].

6. Based on the country profiles, you have these policies and initiatives. Referring to the country profile, to your knowledge, what changes, if any, have occurred to this policy or program in your country since the start of the IDRC grant period in 2016?

If change(s) occurred or new policy generated:
   a. How would you describe the change(s) to the new policies and programs?
   b. In your opinion, to what extent did the IDRC research influence this policy or program?

If no changes:
   c. What was the last known update or status of the policy or program?
   d. Can you tell me why no changes have been made since 2016 (the start of the grant period)?

Probe the factors involving:
   i.   Maturity of the research results (e.g. too early to see outcomes).
   ii.   Planning (e.g. project time lines or term in office).
   iii. Leadership (e.g. change in roles, champions to lead change, active involvement).
   iv.   Resources (e.g. capacity, monitoring of adoption to ensure sustained changes, time challenges).
   v.   Priority (e.g., change in priority, focus on different policies).
   vi.   Challenges in political environment (e.g. electoral uncertainty, policy instability, weak governance practices, violent conflict, humanitarian crisis).

   e. In your opinion, what changes would you like to see with the policy or program?

If unsure of changes:

f. What was the last known update or status of the policy or program?

g. In your opinion, what changes would you like to see with the policy or program?

h. What are the proposed future plans for the policy or program, if any?

Facilitators and barriers of implementing policies and programs in the IDRC countries.

7. I am going to ask you about the barriers that impede the adoption of research into policies and programs. One type of barrier is **context,** which includes:

- social;
- economic and cultural factors;
- national and local policies;
- trends or governance; and
- historical context.

These contextual factors may influence policy development and implementation related to sodium reduction. Please describe any context barriers that would influence the adoption of sodium reduction policies and programs in your country.

> *Probe the importance of*:
> a. Challenges in political environment (e.g. electoral uncertainty, policy instability, weak governance practices, violent conflict, humanitarian crisis).
> b. Changes in administration.
> c. State structure and the relationship between the executive and legislative branches.
> d. Restrictions in economic resources.

8. Now I would like to ask you about facilitators, which are factors that help or enable the uptake of research into policies and programs related to sodium reduction. What are **context facilitators** that have influenced the adoption research into policies and programs in your country?

Probe:
a. Organization's attitudes and perceptions of research utilization.
b. Observing other Latin American countries adopt research data to create policies or laws to regulate sodium content in food sources.

9. Next, I would like to ask you about any **barriers** specifically related to the **content (or attributes) of the research data** on dietary sodium. For example, content of research data includes the:

- strength of the data;
- innovation of the research;
- gaps in the evidence, and
- relevance of the data to your country.

Please describe any barriers related to the content of research data that have influenced sodium reduction policies and programs in your country.

Probes:
   a. Challenges with interpreting the research data.
   b. Language too technical and statistical.
   c. Value on NCD prevention is not clear.
   d. Innovative findings.
   e. Lack of credibility of research findings.

10. Now I would like to ask you about any **facilitators** related to **the content (or attributes) of the research data** that may influence the adoption into sodium reduction policies and programs. Please describe any facilitators related to the content of the research data that have influenced sodium reduction policies in your country.

Probe:
   a. Type of research approach (e.g. biomedical or clinical research versus social science observational research).
   b. Maturity of research in the field (e.g. empirical research, journals, conferences, presence of experienced researchers in the field),
   c. Specificity of the research (e.g. targeted, short-term results, cost effective benefits).
   d. Communication training on developing policy briefs, delivering testimonies to legislative bodies, executive branch members, or policymaking groups.
   e. Information sources (e.g. media, emails, and brief publications).

11. I would like to ask you about **barriers** related to **policy actors** which are any individual or group who are directly or indirectly involved in the policy process. To name a few, policy actors may include:

- Governments;

- private organizations;
- non-governmental organizations;
- civil society; and
- academia.

Please describe any **<u>barriers</u>** related to the **<u>actors</u>** involved that would influence the creation of policies and programs related to dietary sodium.

Probe:
 a. Research driven by the public sector versus academia.
 b. Political culture (e.g. decision making based on experience and immediate pressures, rather than research evidence).
 c. Technical background to understand and interpret research results.
 d. Industry lobbying or interference.

12. Now, please describe any **<u>facilitators</u>** related to the **<u>policy actors</u>** involved that would influence the creation of policies and programs related to dietary sodium.

Probe:
 a. Inter-professional social networks and collaborations. E.g. non-governmental organizations, official research organizations in the health sector
 b. A dedicated facilitator or liaison (e.g. someone that is familiar with your country's political climate),
 c. Mass media.
 d. Key interest groups (E.g. members of the public, private industry).
 e. International support (e.g. foreign donors).

13. I would like to ask you about any **<u>process barriers</u>** that may influence the creation of policies and programs on sodium reduction. Process factors are:

- actions and outputs related to the policy process;
- what policy actors do and why;
- communication channels used;
- dissemination of results; and
- resources that are used to promote or impede the use of research in policy.

Please describe any process barriers that may influence the creation of policies and programs on sodium reduction in your country.

Probe:

a. Complex process.
b. Resources (e.g. funding, adequate personnel, capable personnel, time constraints).
c. Poor communication channels between researchers (knowledge generators) and decision-makers (knowledge users).
    i. What changes can be made to promote optimal communication?
d. How does research results move (disseminate) within and across organizations?

14. Now, I would like to ask you about any **<u>process facilitators</u>** (e.g. actions and outcomes). Please describe any process facilitators that may influence the creation of policies and programs in your country.

Probe:
a. Communication channels (e.g. formal versus informal).
b. International support for research (e.g. financial support).
c. Advocacy efforts.

15. Policies and programs are one way to reduce dietary sodium at a population level. Tell me about any other types of sodium reduction interventions that you think would be helpful in reducing dietary sodium intake.

16. Do you have any further comments you would like to add before concluding our conversation today?

Thank you for your time.

C2.   Ministry of Health Officer interview script

1. Can you please tell me your position, title?
   c. What is your involvement with policies, strategies and practices in your country?
   d. How long have you been in this position?

Influence of IDRC research project on policies and initiatives (e.g. program/practice changes) on sodium reduction

2. Please tell me about any other research projects that you are aware of which focus on informing sodium reduction policies and programs in your country or Latin American.

3. How does research knowledge influence your government's likelihood of adopting a sodium reduction policy or program?
   Probe:
   d. Create local awareness.
   e. Policy agenda setting, policy content and direction, evaluation of policy.
   f. Can you think of other examples where research knowledge informed policies and programs in your government?
      i. Why do you think these policies were adopted?
      ii. What inputs, in the form of key activities, and resources were required to implement the policy/program?
      iii. Were all of these inputs and resources available?

4. What information sources are considered before your government adopts the information into policy and programs? E.g., peer review articles, systematic reviews, conferences.

5. In relation to the research conducted as part of this IDRC grant, or any other research project, please tell me about the kind of interactions you have had with researchers during the grant period, or for any other research project. (E.g., forums to hear about research findings, invitations to speak to researchers, invitations to be active members in research projects).

Probe:
   e. What did you learn from these exchanges with researchers?
   f. How do you feel about interacting with researchers about initiatives on sodium reduction and NCDs for policy development?

g. Can you think of time points in the policy cycle where you could exchange information with researchers? (E.g. needs assessment, policy identification, policy creation, stakeholder consultation, policy evaluation).

6. Based on the research outputs of the IDRC project [name a few outputs on meetings, publications and conferences], how do you think this information will be used in policy and program action going forward?

7. In your view, how could sodium reduction policies be prioritized to the top?
Sodium focused policy and initiative changes from the onset of the project in 2016

8. Based on a survey and mapping exercise led by the Pan American Health Organization (PAHO) on policies and initiatives focused on dietary sodium consumption in Latin American countries, the following policies and initiatives were found: [See Nadia's country profile].

9. Based on the country profiles, you have these policies and initiatives in your country. Referring to the country profile, to your knowledge, what changes, if any, have occurred to this policy or program in your country since the start of the IDRC grant period in 2016?

If change(s) occurred or new policy generated:
  i. How would you describe the change(s) or the new policy or program?
  j. In your opinion, to what extent did the IDRC research, or any other research project, influence this policy or program?

If no changes:
  k. What was the last known update or status of the policy or program?
  l. Can you tell me which of the following factors may or may not have contributed to no changes have been made since 2016 (the start of the grant period)?

  Probe the factors involving:
       vii. Maturity of the research results (e.g. too early to see outcomes).
      viii. Planning (e.g. project time lines or term in office).
        ix. Leadership (e.g. change in roles, champions to lead change, active involvement).
         x. Resources (e.g. capacity, monitoring of adoption to ensure sustained changes, time challenges).
        xi. Priority (e.g., change in priority, focus on different policies).

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      xii.   Challenges in political environment (e.g. electoral uncertainty, policy instability, weak governance practices, violent conflict, humanitarian crisis).

      xiii.   Not aware of research outputs from this project.

m. In your opinion, what changes would you like to see with the policy or program?

If unsure of changes:

n. What was the last known update or status of the policy or program?

o. In your opinion, what changes would you like to see with the policy or program?

p. What are the proposed future plans for the policy or program, if any?

Facilitators and barriers of implementing policies and programs in the IDRC countries.

10. I am going to ask you about the barriers that impede the adoption of research into policies and programs. One type of barrier is **context,** which includes:

- social;
- economic and cultural factors;
- national and local policies;
- trends or governance; and
- historical context.

These contextual factors may influence policy development and implementation related to sodium reduction. Please describe any context barriers that would influence the adoption of sodium reduction policies and programs in your country.

Probe the importance of:

e. Challenges in political environment (e.g. electoral uncertainty, policy instability, weak governance practices, violent conflict, humanitarian crisis).

f. Changes in administration.

g. State structure and the relationship between the executive and legislative branches.

h. Restrictions in economic resources.

i. Key interest groups (e.g. members of the public, private industry).

11. Now I would like to ask you about facilitators, which are factors that help or enable the uptake of research into policies and programs related to sodium reduction. What are **context facilitators** that have influenced the adoption research into policies and programs in your country?

Probe:

c. Organization's attitudes and perceptions of research utilization.
d. Observing other Latin American countries adopt research data to create policies or laws to regulate sodium content in food sources.
e. Key interest groups (e.g. members of the public, private industry).

12. Next, I would like to ask you about any **barriers** specifically related to the **content (or attributes) of the research data** on dietary sodium. For example, content of research data includes the:

- strength of the data;
- innovation of the research;
- gaps in the evidence, and
- relevance of the data to your country.

Please describe any **barriers** related to the content of research data that may have negatively influenced sodium reduction policies and programs in your country.

Probes:
f. Challenges with interpreting the research data.
g. Language too technical and statistical.
h. Value on NCD prevention is not clear.
i. Innovative findings.
j. Lack of credibility of research findings.

13. Now I would like to ask you about any **facilitators** related to **the content (or attributes) of the research data** that may be helpful in influencing the adoption into sodium reduction policies and programs. Please describe any facilitators related to the content of the research data that have influenced sodium reduction policies in your country.

Probe:
f. Type of research approach (e.g. biomedical or clinical research versus social science observational research).
g. Maturity of research in the field (e.g. empirical research, journals, conferences, presence of experienced researchers in the field),
h. Specificity of the research (e.g. timely, targeted and short-term results; cost effective benefits).
i. Information sources (e.g. media, emails, and brief publications).

14. Can you describe an example when research data drove political action in your country?

Probe:
    a. What was the role of civil society in the uptake of research into political action? (E.g. engagement, support).

15. I would like to ask you about **<u>barriers</u>** related to **<u>policy actors</u>** which are any individual or group who are directly or indirectly involved in the policy process. To name a few, policy actors may include:
- Governments;
- private organizations;
- non-governmental organizations;
- civil society; and
- academia.

Please describe any **<u>barriers</u>** related to the **<u>actors</u>** involved that would negatively influence the creation of policies and programs related to dietary sodium.

Probe:
    e. Research driven by the public sector, civil society and academia.
         a. How do you perceive these groups to work together in policy action?
    f. Political culture (e.g. decision making based on experience and immediate pressures, rather than research evidence).
    g. Technical background and capacity building in certain research areas (E.g. to understand and interpret research results).
    h. Industry lobbying or interference.

16. Now, please describe any **<u>facilitators</u>** related to the **<u>policy actors</u>** involved that would be helpful in influencing the creation of policies and programs related to dietary sodium.

Probe:
    f. Inter-professional social networks and collaborations (e.g. non-governmental organizations, official research organizations in the health sector).
    g. A dedicated facilitator or liaison (e.g. someone that is familiar with your country's political and research climate).
    h. Mass media.
    i. Key interest groups (e.g. members of the public, private industry).
    j. International support (e.g. foreign donors).

17. I would like to ask you about any **<u>process barriers</u>** that may negatively influence the creation of policies and programs on sodium reduction. Process factors are:

- actions and outputs related to the policy process;
- what policy actors do and why;
- communication channels used;
- dissemination of results; and
- resources that are used to promote or impede the use of research in policy.

Please describe any process barriers that may influence the creation of policies and programs on sodium reduction in your country.

Probe:
- e. Complex process.
- f. Resources (e.g. funding, adequate personnel, capable personnel, time constraints).
- g. Poor communication channels between researchers (knowledge generators) and decision-makers (knowledge users). Do these channels need to be rebuilt?
- h. How does research results move (e.g. disseminate) within and across your organization?

18. Now, I would like to ask you about any **<u>process facilitators</u>** (e.g. actions and outcomes). Please describe any process facilitators that may be helpful in influencing the creation of policies and programs in your country.

Probe:
- d. Communication channels (e.g. formal versus informal).
- e. International support for research (e.g. financial support).
- f. Advocacy efforts.

19. Policies and programs are one way to reduce dietary sodium at a population level. Tell me about any other types of sodium reduction interventions that you think would be helpful in reducing dietary sodium intake.

20. Do you have any further comments you would like to add before concluding our conversation today?

Thank you for your time.

Appendix D

D1. IDRC Program Evaluation Survey

Thank you to all IDRC project team members for your hard work on this valuable project.   As the project ends, a program evaluation report shall be written to support IDRC's mission to fund research in developing countries to promote knowledge innovation and drive large-scale positive changes to improve people's lives. This program evaluation report will assist IDRC to strengthen their processes of the research they support, and to increase their understanding of the contribution of this research.

The objectives of this survey are to assess some of the short-term consortium and intermediate outcomes.

This survey will take 30-45 minutes to complete.

We know this is a busy time of year for you, and that you are soon going on vacation! We are asking for your cooperation as we are working on a short timeline. Therefore, we kindly ask that you complete this survey by Wednesday, January 15, 2020, or at your earliest convenience, as your responses are critical inform the project evaluation report for IDRC.

Thank you for your time and please feel free to contact me if you have any questions.

Janice Padilla-Moseley
University of Ontario Institute of Technology (Ontario Tech University)
Email: janice.padillamosley@ontariotechu.ca
Skype: janice.padilla-moseley

Full Name

Email address

Country

Which research objective did you work on? (select all that apply)

☐ Objective 1A: Assess sodium levels in packaged foods
☐ Objective 1B: Assess sodium levels in street, artisanal and restaurant foods
☐ Objective 2: Social Marketing

☐ Objective 3: Health and economic analyses

Consortium Outcome: Multi-sectoral and multi-disciplinary partnerships are newly formed and/or strengthened, engaged and activated.

Partners and collaborators can support the research process in many ways. These partners may be internal to the IDRC grant (i.e., researchers in other countries conducting similar work), or external to the IDRC grant (i.e., the Ministry of Health in your country). The external partners may participate in the research (i.e., inform data collection and analysis) or they may support dissemination of the research findings. The following questions ask about external (outside of the research team) and internal (within the research team) partnerships.

1. Did you form partnership(s) and/or collaboration(s) for this research with external individuals?   (Note: partnerships and collaborations may have been formed at any stage of the research process, from data collection through to knowledge translation)
   ☐ a. National government (e.g. policy decision makers)
   ☐ b. Regional government (e.g. local, municipal, state, provincial)
   ☐ c. Food industry
   ☐ d. Civil society (e.g. individuals, organizations, members of society that are independent of the government, public, consumer)
   ☐ e. Non-governmental organizations (e.g. PAHO, InterAmerican Heart Association, Consumer's International)
   ☐ f. Educational institutions
   ☐ g. Research institutions (e.g. health, nutrition, education and culture).
   ☐ h. Scientific community

2. If you answered YES to Q3 above, please name the organization(s) and indicates what sector they belong to (i.e., food industry, educational institution).

3. At what time point during the research project were the partners/collaborators engaged?

Partner Collaborator	Time point				
	Before project start	**Start of project**	**Mid-way through project**	**At the end of the project**	**Not applicable**
a. National government					

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	(e.g. policy decision makers)				
b.	Regional government (e.g. local, municipal, state, provincial)				
c.	Food industry				
d.	Civil society (e.g. individuals, organizations, members of society that are independent of the government, public, consumer)				
e.	Non-governmental organizations (e.g. PAHO, InterAmerican Heart Association, Consumer's International)				
f.	Educational institutions				
g.	Research institutions (e.g. health, nutrition, education and culture).				
h.	Scientific community				

4. To what extent were the external partners and/or collaborators engaged?

Partner Collaborator	Engagement				
	Not engaged	**Slightly engaged**	**Moderately engaged**	**Engaged**	**Extremely engaged**
a. National government (e.g. policy decision makers)					
b. Regional government (e.g. local, municipal, state, provincial)					
c. Food industry					
d. Civil society (e.g. individuals, organizations, members of society that are independent of the government, public, consumer)					
e. Non-governmental organizations (e.g. PAHO, InterAmerican Heart Association, Consumer's International)					
f. Educational institutions					
g. Research institutions (e.g. health, nutrition, education and culture).					

h. Scientific community				

5. Overall, how satisfied are you with the external partnerships that I formed to support the IDRC research?

☐ Not at all satisfied
☐ Not satisfied
☐ Neither satisfied nor dissatisfied
☐ Satisfied
☐ Very satisfied

Consortium Outcome: Partnerships and collaborations formed are equitable, diverse and inclusive.

6. Please tell us about your experience in participating in this IDRC research consortium

Experience	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Not applicable
a. Overall, my collaborators had a high level of engagement in the project						
b. The collaborations I formed helped execute the project objectives						

7. Thinking about the partnerships and collaborations you have formed in IDRC project, at what time point during the research project were your partners/collaborators engaged.

☐ Before project start
☐ Start of project
☐ Mid-way through project
☐ At the end of the project
☐ Not applicable

8. How much do you agree or disagree with the following statements about the IDRC research consortium that was formed?

Statements	Strongly disagree	Disagree	Neither disagree nor agree	Somewhat agree	Strongly agree
a. The objectives of the consortium were clear.					
b. Members of the consortium had common goals.					
c. Members of the consortium understood the beliefs or values of each partner's organization.					
d. I feel that I could trust members of the consortium.					
e. Other members of the consortium are committed to this research and consortium goals					
f. I feel recognized and					

respected as a consortium member.					
g. My partnerships with consortium members were mutually beneficial.					
h. Communication with my consortium members were transparent and open.					
i. Communication with my consortium members were consistent.					
j. I am satisfied and feel well supported by the IDRC grant leadership					
k. When the consortium experienced challenging times, we overcame these challenges through perseverance and determination.					

Consortium Outcome: Confidence, capacity, and scientific abilities to conduct research to address public health nutrition issues in Latin American countries is increased.

Training and skill building was an important outcome of the IDRC funding. The following questions ask about what you learned by working on the IDRC consortium research projects.

9. Please list the exact knowledge and skills you learned since the research consortium was formed in 2016. These can relate to research skills, content knowledge, knowledge translation abilities, professional skills (i.e., communication, networking) or anything else that you feel is important:

10. Which training opportunities did you find most helpful, or that best supported you, in your role in the project.

11. Training and skill building were an important outcome of the IDRC funding. Please tell us how your knowledge and skills have changed since the beginning of the grant period in 2016 by answering the following statements.

Statements	Strongly disagree	Disagree	Neither disagree nor agree	Somewhat agree	Strongly agree
a. I have a better ability to collect scientific data.					
b. I have a better ability to write scientific papers or reports.					
c. I have a better ability to develop a knowledge translation plan					
d. I have a better ability to implement a knowledge translation plan					

12. Overall how satisfied are you with the training sessions that were included as part of the research process?

Extremely dissatisfied				Extremely satisfied
1	2	3	4	5

13. Please tell us how many (if any) undergraduate, graduate and postdoctoral students participated in the IDRC research, as part of their training program. Please indicate the number of students at each level of training.

Consortium Outcome: Resources, training and outputs by the researchers are leveraged to address other nutrition topics of public health concern.

14. Based on your experience in the consortium, what recommendations do you have for scaling up research processes to other Latin American countries?

Overall Experience

15. What challenges did you experience with implementing the project activities and how did you overcome these challenges?

16. What do you consider to be the greatest successes of the project?

17. How satisfied or not satisfied are you with your experience as the country/research lead for the IDRC project? Please provide a rationale for your response Click or tap here to enter text.

☐ Not at all satisfied
☐ Not satisfied
☐ Neither satisfied nor dissatisfied
☐ Satisfied

☐ Very satisfied

18. Do you have any other comments to share about the research outputs and outcomes of the project that would support and inform the program evaluation report for IDRC?

Thank you for your time!

Appendix E

E1. Confidentiality Agreement

Research Title: Scaling-up and Evaluating Salt/Sodium Reduction Policies and Programs in Latin American Countries.

Principal Investigator: Dr. JoAnne Arcand, Assistant Professor

Student Lead: Janice Padilla-Moseley, MHSc candidate

Transcriber and Translator:

_____

_____

[ ]   I understand that all the material I will be asked to record, analyze, transcribe and/or translate is confidential.

[ ]   I understand that any digital recordings, data, and transcripts can only be discussed with the principal investigator working on this study and may not be shared with others in any format.

[ ]   I will not keep any copies of the information nor allow third parties to access them.

[ ]   I will delete all interview, datasets, and other relevant files from my computer after transcription/use is complete or the completion date of the project has passed.

[ ]   I will keep my computer and any datasets and transcripts password-protected and secure.

[ ]   I will maintain the anonymity of all participants involved in this research study.

[ ]   I will keep any information regarding all participants in this study in the strictest confidence and will discuss any information about the participants only with members of the research group.

Transcriber & Translator

_____   _____   _____
  (print name)   (signature)   (date)

Principal Investigator:

_____   _____   _____
  (print name)   (signature)   (date)

nutrients

MDPI

Article

A Program Evaluation of a Dietary Sodium Reduction Research Consortium of Five Low- and Middle-Income Countries in Latin America

Janice Padilla-Moseley [1], Adriana Blanco-Metzler [2], Mary R. L'Abbé [3] and JoAnne Arcand [1,*]

[1]   Faculty of Health Sciences, Ontario Tech University, 2000 Simcoe Street North, Oshawa, ON L1G 0C5, Canada

[2]   Costa Rican Institute of Research and Teaching in Nutrition and Health (INCIENSA),
      Tres Ríos P.O. Box 4-2250, Costa Rica

[3]   Department of Nutritional Sciences, University of Toronto, 1 King's College Circle,
      Toronto, ON M5S 1A8, Canada

[*]   Correspondence: joanne.arcand@ontariotechu.ca; Tel.: +1-(647)-296-8426

Abstract: Excess dietary sodium is a global public health priority, particularly in low- and middle-income countries where rates of hypertension and cardiovascular disease are high. The International Development Research Centre funded a research consortium of five Latin American countries (LAC) to inform public health policy for dietary sodium reduction (2016–2020). The objective of this study was to determine the outcomes of this funding on short-term (e.g., research, capacity building) and intermediary outcomes (e.g., policies). A summative program evaluation was conducted, using a logic model and multiple data sources including document review, surveys and interviews. Researchers from Argentina, Costa Rica, Brazil, Peru and Paraguay produced a significant amount of scientific evidence to guide decision making on sodium policy related to its content in foods, consumer behaviors (social marketing), and the health and economic benefits of dietary reduction. A substantive number of knowledge translation products were produced. The funding enabled training opportunities for researchers who developed skills that can be scaled-up to other critical nutrients and health issues. It was unexpected that intermediary policy changes would occur, however several countries demonstrated early policy improvements derived from this research. A funded research consortium of LAC is a practical approach to invoke policy innovations.

Keywords: program evaluation; diet; nutrition; sodium; policy; public health; knowledge translation; research consortium; community of practice

1. Introduction

Low-and middle-income countries (LMIC) are disproportionately impacted by non-communicable diseases (NCD). Globally, two thirds of deaths annually are attributed to NCDs; while LMICs experience four-fifths of these deaths predominantly due to cardiovascular diseases (CVDs) [1]. NCDs have a high economic burden in LMICs, where direct costs are significantly higher compared to higher income countries [2]. Additionally, several NCD risk factors, including hypertension, are more common in LMICs [3] which adds substantive social and economic burden from NCDs in these resource-constrained settings [4].

Excess dietary sodium is a leading risk factor for NCDs, including hypertension, CVDs, stroke and kidney disease [5,6]. Globally, excess sodium intake is associated with approximately 3.2 million deaths annually and 70 million disability-adjusted life-years [7,8]. Reducing dietary sodium lowers blood pressure and risk of hypertension, CVD and stroke-related deaths, as well as other NCDs related with excessive sodium intake [5,6,9]. The World Health Organization (WHO, Geneva, Switzerland) recommends adults consume less than 2000 mg of sodium/day (equivalent to 5 g of salt/day) [10]; however, intakes in LAC far

exceed these recommendations. For example, the average estimated sodium intake in Argentina is 4480 mg/day [11–13], Brazil is 4720 mg/day [14], Costa Rica is 4600 mg [15], Paraguay is 5480 mg/day [16] and Peru is 3880 mg/day [17]. Dietary sodium sources vary by country. In most LAC, a large proportion of dietary sodium is derived from discretionary sodium (i.e., sodium added via salt during cooking or at the table) [15,18]; whereas in some countries the primary source is from packaged and prepared foods [12].

The WHO set global targets to address NCD risk factors, which included a 30% relative reduction in mean population sodium intake by 2025 [3]. Policy interventions to support dietary sodium reduction are highly cost effective and thus have been labelled as "Best Buys" by the WHO [19]. Not surprisingly, the number of countries with a national level sodium reduction program have increased by 28% since 2014 [20]. These national sodium reduction programs are most often multi-component, incorporating a combination of the WHO's Best Buy interventions, including food reformulation with target sodium levels, consumer education, healthy foods in public settings, and front-of-pack labelling [20]. However, despite country-level commitments to sodium reduction, progress towards the global targets is lagging. Only a few countries have reduced population sodium intakes and none have met WHO's global target for sodium reduction [20,21].

In Latin American countries (LAC), policy development and implementation are complex and often challenging. Up-to-date national-level data that is high quality is frequently unavailable. This includes key data to drive sodium policy such as on the health and economic benefits of sodium reduction policies, the sodium content of foods consumed nationally and the factors influencing dietary sodium behaviors. A recent qualitative study demonstrated that the limited availability of sodium research in LAC is often due to a lack of funding, and limited human resources and infrastructure available to researchers [22]. Researchers in LAC are also overstretched with their time, which limits their ability to effectively translate research findings to policy decision makers [22]; a commonly documented barrier related to nutrition policy research in LMICs in general [23,24].

In 2015, the International Development Research Centre (IDRC), a Crown corporation of the Canadian federal government, created a "Food, Environment and Health" research funding program. The funds were in support of research on healthy food systems in LMICs, with an aim of reducing the health, social and economic burdens of diet-related NCDs. Under this program the IDRC funded a five country Latin American consortium to conduct research to inform public health policy innovations for dietary sodium reduction (IDRC Grant 108167). The consortium was led by the Costa Rican Institute of Research and Teaching in Nutrition and Health (INCIENSA, Principal Investigator: A.B.M) with support from the University of Toronto and Ontario Tech University. The consortium included numerous researchers from Argentina, Brazil, Paraguay and Peru and stakeholders from non-governmental organizations across the region [25]. Multiple research program objectives were funded, focusing on assessing the sodium content of packaged foods using food labels (program objective 1A); assessing the sodium content levels in artisanal, street and fast foods using chemical analysis (program objective 1B); creating a social marketing strategy based on research conducted to identify local barriers and facilitators to individual-level sodium reduction (program objective 2); assessing the health and economic impacts of population-wide sodium reduction (program objective 3); developing and executing country-specific knowledge translation strategies (program objective 4); and conducting a program evaluation of the funded consortium (program objective 5). Program objective 5 is the basis of this paper, which aims to share the overall impacts of the funded research program. Concurrently this paper offers a unique contribution to the literature by demonstrating if a funded research consortium in LMICs can effectively lead to advancements in dietary sodium reduction policies, among other benefits to the countries and the researchers [26]. The IDRC funding was administered from 2016 to 2020 to five LACs. It was hypothesized that this "intervention" would stimulate collaboration and capacity building in conducting research and accelerate dietary sodium reduction policy development and implementation, ultimately improving health outcomes. Specifically, this

program evaluation assessed if the following consortium-level outcomes (i.e., short-term outcomes) were achieved:

1. The creation of scientific evidence and innovations across multiple research program objectives that can be scaled-up to produce policy changes across multiple LAC;
2. The formation of multi-sectoral and multi-disciplinary partnerships;
3. The formation of equitable, diverse and inclusive partnerships;
4. The enhancement of consortium researchers' confidence, capacity, and scientific abilities in conducting research to address public health nutrition issues in LACs.

The program evaluation also assessed intermediate program outcomes which were defined as sodium reduction policy and program changes (e.g., a policy commitment from the food industry and addition of sodium reduction to a political agenda); however it was unexpected that would occur over the relatively short 3.5-year funding period.

2. Methods

A summative program evaluation took place at the end of the consortium funding period. The evaluation took a multiple method approach using quantitative and qualitative data from diverse sources consisting of a document review, program evaluation survey, team meetings and qualitative interviews. The program evaluation was guided by a logic model (Figure **??**) developed in 2016, as well as the Public Health Agency of Canada's Planning Public Health Programs [27] and the Centers for Disease Control's program evaluation framework [28,29]. The logic model defined process indicators, consortium outcomes (i.e., short term outcomes), intermediate and long-term outcomes [30,31]. Consortium researchers provided iterative feedback of the logic model to ensure the LAC contextual factors were considered.

2.1. Data Collection

Program outcomes were evaluated with multiple methods. This data added a variety of insights to the evaluation, including social, cultural, and historical contexts on the research landscape in a country.

Document Review. Several types of documents were reviewed, including the original grant application, interim progress reports, a compendium of knowledge translation activities conducted, meeting notes, memos, and country-level data on existing programs and policies from the PAHO [32].

Program Evaluation Survey. In January 2020, a web-based survey was sent to the consortium researchers (*n* = 18). The survey evaluated consortium-level outcomes related to partnerships, capacity, and the overall experiences as a consortium researcher. The ESSENCE framework [33] and Larkan's et al. (2016) [34] attributes informed the survey questions related to partnerships. Included were 10 multiple choice questions based on a 5-point Likert scale and eight open-ended questions. Two external independent reviewers assessed the survey for face and content validity. A response rate of 61% was achieved, with responses received each participating country.

Team meetings. In February 2019, the leadership team at INCIENSA hosted an interim team meeting with all consortium researchers and stakeholder partners. Researchers from each country presented preliminary study results and sought feedback and input from their peers and partners. During these meetings, challenges and successes with research were documented. In January 2020, a one-week face-to-face meeting in Costa Rica took place with the leadership team at INCIENSA, where they were interviewed about the project outcomes. Meeting notes were used to inform the evaluation report. Three additional informal interviews were conducted with consortium researchers, via video conference, to expand upon and add clarity to the outcomes assessed in this evaluation.
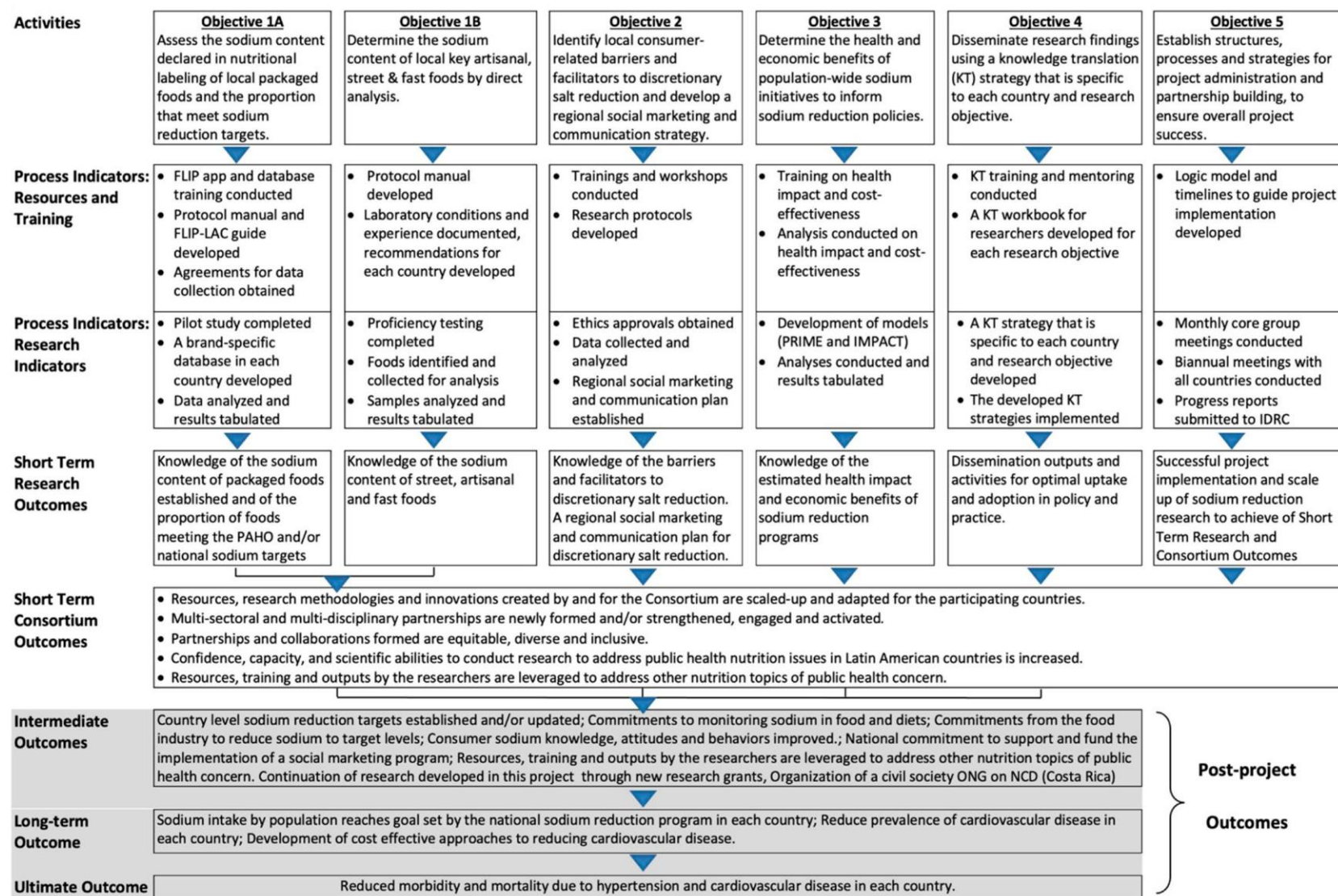
Activities	**Objective 1A** Assess the sodium content declared in nutritional labeling of local packaged foods and the proportion that meet sodium reduction targets.	**Objective 1B** Determine the sodium content of local key artisanal, street & fast foods by direct analysis.	**Objective 2** Identify local consumer-related barriers and facilitators to discretionary salt reduction and develop a regional social marketing and communication strategy.	**Objective 3** Determine the health and economic benefits of population-wide sodium initiatives to inform sodium reduction policies.	**Objective 4** Disseminate research findings using a knowledge translation (KT) strategy that is specific to each country and research objective.	**Objective 5** Establish structures, processes and strategies for project administration and partnership building, to ensure overall project success.
Process Indicators: Resources and Training	• FLIP app and database training conducted • Protocol manual and FLIP-LAC guide developed • Agreements for data collection obtained	• Protocol manual developed • Laboratory conditions and experience documented, recommendations for each country developed	• Trainings and workshops conducted • Research protocols developed	• Training on health impact and cost-effectiveness • Analysis conducted on health impact and cost-effectiveness	• KT training and mentoring conducted • A KT workbook for researchers developed for each research objective	• Logic model and timelines to guide project implementation developed
Process Indicators: Research Indicators	• Pilot study completed • A brand-specific database in each country developed • Data analyzed and results tabulated	• Proficiency testing completed • Foods identified and collected for analysis • Samples analyzed and results tabulated	• Ethics approvals obtained • Data collected and analyzed • Regional social marketing and communication plan established	• Development of models (PRIME and IMPACT) • Analyses conducted and results tabulated	• A KT strategy that is specific to each country and research objective developed • The developed KT strategies implemented	• Monthly core group meetings conducted • Biannual meetings with all countries conducted • Progress reports submitted to IDRC
Short Term Research Outcomes	Knowledge of the sodium content of packaged foods established and of the proportion of foods meeting the PAHO and/or national sodium targets	Knowledge of the sodium content of street, artisanal and fast foods	Knowledge of the barriers and facilitators to discretionary salt reduction. A regional social marketing and communication plan for discretionary salt reduction.	Knowledge of the estimated health impact and economic benefits of sodium reduction programs	Dissemination outputs and activities for optimal uptake and adoption in policy and practice.	Successful project implementation and scale up of sodium reduction research to achieve of Short Term Research and Consortium Outcomes

Short Term Consortium Outcomes	• Resources, research methodologies and innovations created by and for the Consortium are scaled-up and adapted for the participating countries. • Multi-sectoral and multi-disciplinary partnerships are newly formed and/or strengthened, engaged and activated. • Partnerships and collaborations formed are equitable, diverse and inclusive. • Confidence, capacity, and scientific abilities to conduct research to address public health nutrition issues in Latin American countries is increased. • Resources, training and outputs by the researchers are leveraged to address other nutrition topics of public health concern.

Intermediate Outcomes	Country level sodium reduction targets established and/or updated; Commitments to monitoring sodium in food and diets; Commitments from the food industry to reduce sodium to target levels; Consumer sodium knowledge, attitudes and behaviors improved.; National commitment to support and fund the implementation of a social marketing program; Resources, training and outputs by the researchers are leveraged to address other nutrition topics of public health concern. Continuation of research developed in this project through new research grants, Organization of a civil society ONG on NCD (Costa Rica)	**Post-project**
Long-term Outcome	Sodium intake by population reaches goal set by the national sodium reduction program in each country; Reduce prevalence of cardiovascular disease in each country; Development of cost effective approaches to reducing cardiovascular disease.	**Outcomes**
Ultimate Outcome	Reduced morbidity and mortality due to hypertension and cardiovascular disease in each country.	

Figure 1. Research Program Logic

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Qualitative interviews. From November 2019 to February 2020, a qualitative case study utilized one-on-one semi-structured interviews with the consortium leads ($n = 5$) and Ministry of Health officers ($n = 4$) from each participating country. The methodology and results have been described previously in another qualitative study [22]. The Ministry of Health officers were arm's length to the research and were interviewed due to their role in policy decision making. The interviews were 45 to 60 min in duration and explored the barriers and facilitators to implementing sodium reduction policies and programs in the consortium countries. Themes from Trostle's et al. (1999) [35] and the Diffusion of Innovation (DOI) Theory [36] informed the interview guide. Verbatim transcripts underwent a deductive thematic analysis where two independent researchers coded the transcripts.

2.2. Data Analysis

Qualitative data was analyzed using a thematic deductive analysis obtained from the documents, transcripts from meetings and interviews and open-ended survey responses. These data were organized and coded with Nvivo Software (Version 12), using codes and a codebook that were established a priori using the DOI, Trostle's et al. (1999) themes and consortium and intermediate level outcomes from the logic model. Quantitative data were analyzed using descriptive statistics. Evaluation data were triangulated through multiple data sources that ensured validation, credibility and added to the depth and breadth of the findings.

3. Results

The consortium consisted of researchers from the government, academia and NGO from Argentina, Brazil, Costa Rica, Paraguay and Peru. Each country had an assigned lead researcher ($n = 5$) who oversaw the research activities alongside other researchers and funded research assistants. The Costa Rican Institute for Research and Teaching in Nutrition and Health (INCIENSA) was the technical and financial coordination and leadership site and led the consortium (Principal Investigator A.B.M). A governance group provided scientific, knowledge translation, and project governance support to the consortium team and the principal researcher, which included representatives from the Pan American Health Organization (PAHO), the University of Toronto, and Ontario Tech University.

3.1. Consortium Outcomes (Short Term)

3.1.1. Outcome 1: Research Conducted, Data Generated and Innovations Scaled-Up or Created

This evaluation outcome assessed the research conducted, data generated and innovations that were scaled-up in the consortium countries. Consortium countries chose which research objectives they participated in, which was impacted by national priorities and the availability (or lack of availability) of pre-existing research. Specifically, program objectives 1A to 4 were assessed:

Program objectives 1A and 1B: Sodium Content of Packaged, Artisanal, Street and Fast Food Products (Argentina, Brazil, Costa Rica, Paraguay, Peru). Comprehensive data on the sodium content of packaged foods was unavailable in some participating countries, and the extent to which they were meeting their national and/or the regional sodium reduction targets was unknown. In addition, a systematic and standardized approach with state-of-the-art technology for data collection and analysis of the sodium content of packaged foods was not available in LAC. These research gaps were addressed by adapting data collection and analysis innovations and implementing them across the consortium.

With the IDRC funding, the University of Toronto's Food Label Information Program (FLIP) mobile application and web-based software for collecting data from packaged food labels was adapted for use by the consortium. The modified application/software was called FLIP-LAC and it included training manuals [37], guides [38] and standardized procedures on food label and data collection. The data generated from FLIP-LAC led to the development of large brand-specific databases containing the nutrient (sodium)

composition of food products sold in each consortium country; except for Brazil which used a slightly different method that was considered more appropriate for their country context. The use of FLIP-LAC afforded a unique ability to collect not only information about sodium, but on all nutrients reported on food labels, the individual ingredients and on front-of-package labelling and marketing.

The use of FLIP-LAC led to the systematically collected and analyzed data on sodium content of 8314 packaged food products in four countries (with one package size per food product included in the analysis). Mean sodium content was assessed (mg/100 g) for commonly consumed sources of sodium, with the results being compared to 2015 PAHO regional targets. The latter analysis found that Paraguay had 87.9% of food products meeting regional sodium targets, followed by Argentina (87.0%), Peru (85.5%), Costa Rica (83.9%) [39]. In a separate analysis, it was found that 81.2% of Brazil's food products met the regional sodium targets [40]. The findings also demonstrated high variability in the sodium content of foods within single food categories, suggesting high potential for reformulation of higher sodium products within a food category. This finding, along with the observed high proportion of products already meeting the regional sodium targets, highlighted the need for more stringent regional sodium reduction targets, to accelerate sodium intakes in LAC [39–42]. On completion of the IDRC grant, FLIP-LAC was scaled up and made broadly accessible across LAC through another funding source, and results were used to update PAHO regional targets.

Under program objective 1B, data on the sodium content of street, artisanal and fast foods were assessed using chemical analysis. The importance of this research is emphasized by the nearly complete lack of sodium content data on these culturally specific foods. Using standardized chemical analysis procedures and protocols, street and fast food products were sampled based on national consumption patterns and availability. A manual for food chemical analysis of sodium was created to standardize procedures and conditions for the analysis [43]. This was an important step given observation that there were highly variable experience levels of technicians and laboratory standards and procedures for chemical analysis across the consortium countries. The sodium content analysis on over 100 artisanal, street and fast food led to novel data on frequently consumed foods in LAC; demonstrating sodium levels in the moderate to high range. These data were submitted to the Latin American Network on Food Data System (LATINFOODS) database for researchers, nutritionists and food technologists to access.

Overall, program objectives 1A and 1B achieved a high degree of success with the evaluation outcomes, but some challenges were experienced. Challenges in obtaining approval for data collection from grocery stores led to setbacks and delays. This was a necessary step in all countries in order to initiate data collection. A high turnover rate of the grocery store staff contributed to communication break downs, where new staff had no knowledge transfer that authorization was received. Despite attempts at standardization and procedures to optimize analytic performance, some countries had variations in laboratory conditions and techniques for food chemical analysis which may impact the validity and comparability of the results. For example, some countries performed analysis with food additions such as salsas, seasonings, dressings and hot peppers; while other countries did not. Furthermore, the methodology used to estimate sodium varied in all countries.

Program Objective 2: Social Marketing and Communication Strategy (Brazil, Costa Rica, Paraguay, Peru). Since a relatively higher proportion of sodium intake comes from discretionary salt in LAC, it is essential to engage the public in changing their personal behaviors related to added sodium; however, little research had previously been conducted. Therefore, consortium researchers conducted formative research on consumer behaviors and created regional social marketing and communication strategies to drive population-wide behavioral changes related to dietary sodium. Expert social marketers and researchers from the University of South Florida led an innovative hybrid training program adapted for LAC with consortium researchers from Costa Rica, Brazil, Peru and Paraguay. The training consisted of a virtual course on social marketing concepts and qualitative data analysis, fol-

lowed by face-to-face workshops. The training program was developed specifically for the LAC context and scaled-up to the consortium countries; where no other training program previously existed. After the training, consortium researchers prepared their own formative research proposals to conduct focus groups and interviews with a defined target audience to examine barriers, facilitators, beliefs, values and motivations related to discretionary salt use. These activities informed a regional social marketing and communication plan that was created by researchers at the University of South Florida. The social marketing training program and communication plan was a significant innovation created for the consortium countries. Multiple articles were published about this research [44,45]. After the consortium funding period, researchers at the University of South Florida developed a follow-up 4-module course for researchers interested in advanced-level social marketing training. All LAC can now access this training program on the PAHO Virtual Campus. Costa Rica is currently adapting the regional plan to their national context with funding from LINKS-Resolve to Save Lives.

Program objective 3: Assessing the health and economic benefits of dietary sodium reduction. Brazil and Costa Rica used health and economic data to quantify the attributable health impact and economic burden of excess sodium consumption in their countries. These data were not widely available in LAC, and few researchers had expertise to conduct such analyses. Two different modeling scenarios were applied. One model was the Preventable Risk Integrated ModEl (PRIME), developed by the University of Oxford, that was used to conduct analysis on avoidable deaths due to excess sodium. The other model used was IMPACT food model (economic impact), to conduct health and economic impact assessments on CVD deaths and cases prevented or postponed in different modeling scenarios related to sodium reduction over time [46].

A Brazilian researcher received in-person training on IMPACT at the University of Liverpool; training that was later relayed to the Costa Rican research team. Researchers from Costa Rica and Brazil both received face-to-face training on the use of PRIME from the Université Laval, followed by two webinars. The findings from this research were published [46–49], and used to form strong arguments with policy decision makers on setting upper limits on sodium in food products. In addition to the data generated, the capacity built can be applied towards the creation of health and economic data related to other public health priorities. These models provided a pragmatic and cost-effective way for countries with limited resources and missing data to conduct analysis. There were unexpected challenges with the use of the PRIME model as the consortium researchers required in-depth statistical analysis to review long term trends and risks over time. Furthermore, the IMPACT model required more data inputs which were not always available from health information custodians; requiring some assumptions to be made in the model.

Program Objective 4: Knowledge translation (KT) strategies. Most consortium researchers noted that formal KT strategies were a new concept and that culturally specific tools were needed. As part of the consortium, a customized KT workbook was developed to ensure maximal usability and uptake of research data. The KT workbooks considered the research and regional context, including translation of key terms in Spanish. The customized KT workbooks were peer reviewed, piloted and validated for use by the researchers, to optimize communication and knowledge dissemination tactics for their research. This was an important scalable innovation that can be used in future studies. Consortium researchers noted that KT training enabled their thinking about ways to engage policy makers earlier in the research process: "when we have any research grants for small funded projects, we have added something that was actually inspired by the IDRC project . . . is that this communication plan . . . this knowledge transfer. It is something that is very important for presenting the results, making the results easier to understand for any audience". With the technical assistance of the InterAmerican Heart Foundation, a policy brief was developed in English and Spanish [50], which was disseminated to decision makers at Ministries of Health, the food industry and other key stakeholders. The benefits of policy briefs were also realized as part of the process. The Costa Rican researchers noted that they now

embed policy briefs as a key dissemination output for their studies. A limitation to the KT training and KT plan development was that it was introduced early in the second year of the funding period, which is a relatively late stage to incorporate rigorous integrated KT strategies. KT strategy development at the onset of the grant would have involved policymakers and other stakeholders early in the research development process, to promote maximal impact of the data on policy development and implementation.

Most of the grey literature and papers generated from this consortium is published and available in IDRC Digital Library (https://idl-bnc-idrc.dspacedirect.org/discover (accessed on 15 August 2022)) which is available for policy makers and researchers.

3.1.2. Outcome 2: Multi-Sectoral and Multi-Disciplinary Partnerships Were Newly Formed, Strengthened, Engaged and Activated

Consortium researchers and governance committee. The consortium included multi-sectoral and multi-disciplinary partnerships to drive dietary sodium research and policy. The PI, with support from PAHO, invited other several LMIC in Latin America to join the consortium, with Argentina, Brazil, Costa Rica, Paraguay and Peru expressing interest. During consortium formation, researchers from the University of Toronto, Ontario Tech University and PAHO provided technical expertise to the PI on the development of the grant application (e.g., writing support, protocol development). Under the leadership of the PI (ABM), an advisory governance committee was formed, including public health nutrition researchers, experts and from INCIENSA, the University of Toronto, Ontario Tech University and PAHO. This group established a framework to support the operations and decision making of the project. They held periodic meetings to support guidance on leadership, technical and scientific aspects of the consortium. Consortium researchers reported that PAHO, Canadian and European educational institutions were significant partners who supported research success.

Partnerships formed to execute research and drive policy. Outside of the consortium researchers and the governance committee, the greatest number of partnerships and collaborations formed were with national governments (81.8%), educational institutions (81.8%), non-governmental organizations (72.7%), research institutions (63.6%), scientific community (54.5%), regional government (54.5%), civil society (45.5%) and food industry (36.4%). Buy-in and support to carry out the program objectives was contingent on governmental support. For example, the Minister of Health in Costa Rica deemed the project as a public health priority which facilitated with data collection in grocery stores. The Minister of Health in Paraguay contributed additional human resources and support to carry out the research. Despite the strong partnerships formed, consortium researchers found the communication lines with the government were often unclear and required multiple points of contact in order to reach an individual of interest.

Consortium researcher experiences with partnerships. All consortium researchers reported a high level of satisfaction (very satisfied or satisfied) with their involvement in the consortium which led to engaged and activated partnerships throughout the program. All researchers felt respected, established trust for others and gained confidence to overcome challenges. One consortium researcher identified collaborators as friends. Furthermore, all researchers of the consortium understood the beliefs or values of each partner's organization. The majority felt that communication with other researchers was consistent, transparent and open. Overall, 90.9% of researchers felt that common goals were shared and 81.8% felt that other researchers were committed to the research and consortium goals. Ultimately, the formation of a funded LAC consortium fostered a supportive and productive culture amongst collaborators and team researchers that led to high satisfaction levels, loyalty and commitment to advance sodium reduction research.

Partnership challenges. Misaligned expectations and team turnovers challenged partnerships. Select consortium researchers where disappointed when only one regional social marketing plan was created that required adaptations to specific countries when their expectation was that they would have the opportunity to generate country-specific social

marketing plans. Most consortium countries had stable leadership over the grant period; however, Paraguay experienced changeover with research team members which resulted in delayed productivity due to recruitment and the duplication of training efforts. In contrast, another country experienced frequent government changes which resulted in shifts of political views and focus. In another situation, Brazil experienced logistical issues related to distribution of grant funds which limited Brazil's participation in program objective 1B.

3.1.3. Outcome 3: Equity, Diversity and Inclusivity

Principles of equity, diversity and inclusivity were incorporated into the funding program. All consortium countries had equal access to funds, resources and training to support the research. All consortium countries were from a LMIC and they were supported by researchers from high income countries. Researchers, public health officers, non-governmental representatives, scientists, academics and trainees had diverse skillsets, expertise and represented different geographical areas. The team was diverse in gender, capacity, career stage and had varying access to resources. Three out of 5 country leads identified as women and there was a high proportion of women who led research activities within the countries. In contrast, most government partners with a decision making role were men. This underscores a need to build capacity, confidence and opportunities for women to hold these senior positions. Consortium researchers were at various stages of their career, which allowed for mentorship, training and development of scientific and technical skillsets. Additionally, 25 trainees consisting of undergraduate ($n = 7$), graduate ($n = 16$) and postdoctoral fellows ($n = 2$) worked on the consortium research. The inclusion of trainees enabled the funding program to build capacity in the next generation of public health researchers.

Resources, training and development materials were translated into Spanish. Simultaneous interpretations into Spanish were made available for webinars, team meetings and virtual courses. At the onset of KT training, consortium researchers identified commonly used KT terms in North America, such as "audience", "agents of change", where the original meaning in English was different in Spanish. For comprehensive purposes, the KT training materials and workbook were revised to add definitions with illustrative examples on commonly used KT terms.

All consortium countries had equal access to funds, resources and training to support the research. There were also equal opportunities to disseminate research. However, in at least one instance there were disagreements on authorship when manuscripts were submitted for publication at the end of the funding period. Researchers were disappointed when they were excluded from publications. Having an a priori authorship agreement could have increased transparency and fairness when opportunities to publish arose.

3.1.4. Outcome 4: Consortium Researchers Gained Confidence and Enhanced Capacity to Conduct Research to Address Public Health Nutrition Issues in LAC

Quantitative and analytic skills. One of the most significant achievements of the funded consortium was training opportunities that strengthened scientific capacity in the participating LAC. Scientific development opportunities related to quantitative data collection and analysis strengthened competencies and established new expertise that can be applied to support numerous public health nutrition priorities. The University of Toronto, Ontario Tech University and Laval University in Canada, University of South Florida in the United States, and the University of Liverpool in the United Kingdom, led training to strengthen knowledge and skills related to protocols, procedures, data collection and analysis techniques for research program objectives 1A, 1B, 2, and 3. These activities resulted in 90.9% of consortium researchers reporting enhanced skills and capacity to collect data and manage large data sets. Capacity development extended to leadership, networking, project management, communication and knowledge translation. All (100%) consortium researchers were satisfied or very satisfied with the training and development sessions offered in the

research program. Table 1 outlines the training and skillset development observed during the grant.

Table 1. Consortium researchers' training and skills set development [1].

Program Objective	Organized Training	Scientific Skills Acquired
Objective 1A and 1B	• 2 online sessions (Obj 1A) • 2 online sessions (Obj 1B) • Additional one-on-one training, as needed	• Enhanced abilities to collect, analyze and manage large datasets with the FLIP-LAC app and database • Conduct quality assurance measures, statistical analysis, and reporting and presentation of data • Knowledge front of package labelling • Knowledge of how to prepare for and conduct chemical analysis procedures for sodium
Objective 2	• 3 online sessions • 2 face-to-face workshops • 1 online course • Additional one-on-one training, as needed	• Knowledge of the principles and concepts of social marketing research • Knowledge and skills in identifying target behaviors and populations • Qualitative research skills: creating a qualitative interview guide, conduct interviews and focus groups, coding transcripts • Translating the formative research into a social marketing strategy • Skills in creating a Creative Brief • Creativity
Objective 3	• 2 week face-to-face training (1 country) • 1 face-to-face workshop • Additional one-on-one training, as needed	• Knowledge and training of the principles, concepts and the application of health and economic modeling using the PRIME model and IMPACT model.

Social marketing and qualitative research. Many consortium researchers found the social marketing training and development to be the most novel and educational. At the onset of the grant, researchers had varying levels of experience in social marketing, with a majority being introduced to the concept for the first time. Over 26 researchers enrolled in the initial social marketing training course with an 85.0% completion rate. The training had a focus on qualitative research and social marketing principles, led by researchers from the University of South Florida. Several consortium researchers indicated: "I learned the most in this [social marketing] objective". Furthermore, consortium researchers expressed a deeper appreciation for the social marketing research experience beyond training and knowledge creation, which included the formation of meaningful collaborations and a sense of community. A partnership with the Association Latin Americana de Mercadeo Social, further supported the development of social marketing skills and stimulated collaborations with other LAC social marketing researchers.

Knowledge translation skills. The evaluation survey found that 90.9% of researchers reported a significant improvement in their knowledge and skills related to KT principles, concepts and their application [51]. For a majority of consortium researchers, KT was a new concept. Researchers reported that the KT workbooks helped them identify target audiences, generate strategic and impactful KT activities, and demonstrate that opportunities for information sharing can occur at multiple time points throughout the project cycle. The training led to practice changes for some. One researcher expressed "... when we have any research grants for small projects that would be funded ... an idea [from the] IDRC [grant] is this communication plan ... this knowledge transfer is something that is very important for presenting the results, making the results easier to understand for any audience". Overall, 81.9% of researchers also agreed or strongly agreed that they enhanced their skills in preparing and submitting manuscripts to peer reviewed journals. At the conclusion of the funding period, consortium researchers generated numerous outputs to various target audiences, related to the consortium research activities, in the form of peer reviewed publications, meetings with decision makers and partners, technical reports, policy briefs and presentations (Table 2).

Table 2. Summary of the reach of KT outputs across different target audiences.

Summary of KT Outputs [2]							
Program Objective	**Government**	**Health and Education**	**Food Industry**	**Civil Society**	**Scientists**	**International**	**TOTAL**
Objective 1A	26	9	10	41	34	16	136
Objective 1B	11	10	15	5	20	13	74
Objective 2	11	9	0	10	36	4	70
Objective 3	2	1	0	0	6	5	14
Objective 4	6	14	4	43	5	4	76
Objective 5	4	35	2	41	19	19	120
TOTAL	60	78	31	140	120	61	

3.2. Intermediate Outcomes

The researchers' dedication enabled them to achieve several intermediate outcomes, defined by the logic model (Figure ??), which were not expected during the grant period since they often take time to achieve. In Argentina, Costa Rica and Paraguay strong governmental support led to policy changes that informed their national plans on NCDs. In particular, the office of the Minister of Health in Peru added sodium reduction to their political agenda after communications with the consortium researchers, which was a notable achievement since in the past anemia and diabetes were the primary government priorities. In Peru the research was used to evaluate nutritional labelling so that updates on front-of-package label policies could be made [52]. At the regional level, data on the sodium content of foods led to a commitment from PAHO during the funding period to develop a set of revised targets, which was completed in 2021. This data also led to updated sodium targets in Argentina [42]. A renewed and strengthened partnership with the food industry was a key driver to support sodium reduction in the food supply. In June 2019, Costa Rica's Ministry of Health and CACIA, Cámara Costarricense de la Industria Alimentaria (Costa Rican Chamber of the Food Industry) renewed their alliance and commitment to continue with sodium reduction efforts. This partnership inovovled joint action plans on setting national sodium goals, updates to sodium targets for packaged food products, and future plans for sodium reduction.

National commitments to support and fund the implementation of social marketing program were achieved. In Paraguay, municipal governments used the qualitative research to inform a social marketing plan focused on banning saltshakers in food service establishments. Costa Rica obtained funding from Resolve to Save Lives to adapt the regional social marketing plan to their national context. Finally, the resources, training and outputs by the consortium researchers were leveraged to address other nutrition topics of public health concern and stimulated partnerships and collaborations. A six-month grant extension from the IDRC enabled researchers to conduct analyses on other nutrients associated with non-communicable diseases. This included the analysis of already nutrient data collected with FLIP-LAC. Analyses related to nutrients (e.g., energy, sugar, saturated fat), the overall nutritional quality of packaged foods, and use of low sodium claims on the front of package were condcuted. Finally, the Organization for Economic Co-operation and Development invited the Principal Investigator to participate in a case study focused on best practices to reduce excess sodium consumption to mitigate CVD. This was a major achievement for future research in Costa Rica as the country did not have collaborations with civil society.

4. Discussion

This program evaluation demonstrated that a funded research consortium was an impactful way to build capacity and collaboration, and to generate evidence to inform population wide public health policies and programs for dietary sodium reduction. Specifically, this program evaluation demonstrated that all consortium level objectives were achieved for the duration of the program. With the IDRC's investment in a funded research consortium, a significant amount of country and regionally specific evidence was generated from the five Latin American country participants. Policy change is rarely based on a single empirical research study [53]; however, in a short period of time the funded consortium translated their research data to impact national strategies and single policies within each country. To our knowledge, this is the first multi-country government funded research consortium that was assembled to address sodium reduction policies in the Latin American region. Other multi-national Latin American consortiums focused on obesity [54], cardiometabolic risk factors [55] and neurodegenerative conditions [56] using data sets from population-based studies. Consortium-based research projects are emerging as an effective way to address complex public health issues on NCDs [54–56]. In the current consortium, researchers engaged in a participatory approach to multi-method data collection and analysis with training on social marketing and knowledge translation, which is unique to this consortium. Capacity development in social marketing is particularly important since discretionary sodium is a primary source in many LAC, making population-level behavior changes essential to decreasing sodium consumption and preventing NCD-related morbidity and mortality.

Actions to reduce population-wide sodium intakes require multiple interventions that work synergistically, if countries are to achieve the WHO global target of 30% sodium reduction by 2025 [57]. At least 75 countries have developed a national strategy for dietary sodium reduction. Interventions identified under these national strategies commonly included one of the WHO "Best Buy" interventions, which have an average cost-effectiveness ratio of ≤$100 per disability-adjusted life years averted in LMICs. In 2019, a review found that 96 countries globally had a national sodium reduction program; however, only 6 LAC (Argentina, Canada, Chile, Colombia, Costa Rica and the United States) had implemented one to date [20]. In LAC, many countries have implemented at least one sodium policy, but not all have implemented one of the WHO "Best Buy" interventions [58]. Overall, 38% of countries have implemented food reformulation policies (voluntary or mandatory), 38% had policies for public settings, 15% had front-of-package labelling policies, and none had a national education campaign [20]. Despite the gradual introduction of dietary sodium reduction policies and programs on political agendas in LAC and globally, only a few countries have reported reduced mean sodium intakes and, to our knowledge, no LAC have met the WHO's global sodium target [20]. These findings demonstrate the need for the implementation of evidence-informed, effective and progressive policies. Collaborative consortium-based research is a plausible approach to support complex policies for a public health challenge such as dietary sodium reduction; as seen with another consortiums focused on applied mental health systems research to produce health policies and services in low-income countries.

The funded consortium examined in this program evaluation allowed researchers and policy decision makers to form a community of practice with a shared focus on sodium reduction public health policies. This was a strength of the funded consortium as the community of practice that was created fostered learning interactions, shared knowledge, training and development efforts. It also created a rich environment to understand and make sense of new knowledge and training efforts, outcomes observed when communities of practices have strong and mutually respectful relationships. In other fields, a community of practice model has been utilized to promote practice changes in the clinical settings [59] and to improve policy and practice in cancer control [60]. The funded consortium encouraged scientific productivity and professional growth through access to scientific and technical experts in sodium reduction. Self-directed learning, consultation with experts, and between-

country collaboration enabled opportunities for learning and mentorship—factors leading to the achievement of consortium goals. This finding is consistent with another Canadian community of practice that focused on translating evidence related to renal healthcare in vulnerable communities into clinical practice and policies [61]. To date, the consortium researchers continue to work together as a community of practice to advance knowledge, disseminate peer reviewed publications and best practices in other public health areas. The consortium model should be considered for new opportunities to address other public health areas, including other nutrition policy priorities.

The funded consortium integrated KT training and strategies for all the research program objectives, which is one factor leading to consortium success. Funding agencies can provide mechanisms to promote knowledge exchange through agency mandates on KT. One study found that 18 of 23 national and international funding agencies described some aspect of KT in their mandate [62]. It is well documented that policy development and KT in LAC are complex and slow [62]. Policy is further impacted by barriers to adoption such as limited resources, poor communication and dissemination methods and a lack of capacity to understand technical data [24,62,63]. This calls for resource allocation to support knowledge translation, better "packaging" of research results and for researchers and policy makers to develop technical capacity in understanding scientific data [24]. A larger issue are failures to use research in policy-making that contributed to $200 billion of wasted funds, which is detrimental in LMICs where resources are scarce. One study found that 18 of 23 national and international funding agencies described some aspect of KT in their mandate [62]. This funded consortium resulted in almost 500 KT outputs through systematic planning efforts, including many published manuscripts, that reached several sectors involved in policies and program development and implementation. The early policy advances the consortium observed are likely attributable to this large number of KT outputs. A limitation identified with the current consortium is that stronger integrated KT plans may have further enhanced policy and program impact, which would allow stakeholders and decision makers to have greater involvement in research planning, further increasing the usability of the data. Future consortium projects should allocate time and resources to build KT plans at the beginning of the funding period, using tools like the KT workbooks, to maximize impact of the findings at an earlier stage of the grant.

The use of a logic model framework was a strength of the program, which guided consortium actions and supported this evaluation. Only a few published studies have used a program evaluation framework, where most evaluations relied on observation designs [64]. Existing literature has criticized the logic model for its failure in capturing contextual factors and its utility in large community-based projects and initiatives [65,66]. Consortium researchers developed the logic model through an iterative feedback approach to ensure Latin American perspectives on contextual program factors was accounted for, an approach that has been widely utilized in other program evaluations [65,67]. By embedding contextual analysis and collaborations in the construction of the logic model, this grounded the program's outcomes with IDRC's program strategy and reinforced recommendations for best practices on how future funded programs would be implemented to a LA context [66].

5. Conclusions

This program evaluation illustrates the benefits of collaborative work in research—carried out by a consortium of LMIC countries in Latin America, with the support of international technical assistance—to facilitate the development and implementation of dietary sodium reduction policies, with an ultimate goal of reducing the burden of hypertension and cardiovascular disease. The dedicated efforts of the multidisciplinary team generated local and regionally scientific evidence for decision-making in sodium reduction policies and programs, innovations in food systems, using innovative technological and methodological approaches. The consortium is a model for other public health interventions that require new techniques for food policy analysis and consumer behavior, as well as the dissemination of key findings. The findings of this evaluation can be applied to the

development of future consortium research partnerships and activities designed to address the burden of NCDs in the region.

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