FACTORS INFLUENCING THE DIETARY INTAKE OF COMBAT RATIONS BY SOLDIERS IN THE CANADIAN ARMED FORCES WORKING IN THE ARCTIC

FLORENCE VIGNOLA LAVERGNE, BSc, RD

Thesis submitted to the University of Ottawa
in partial fulfillment of the requirements for the
Master of Science in Interdisciplinary Health Sciences

Interdisciplinary School of Health Sciences
Faculty of Health Sciences
University of Ottawa

ABSTRACT

Purpose: This study aimed to identify the factors influencing the dietary intake of combat rations by soldiers in the Canadian Armed Forces training in the Arctic, and to measure their energy intake as well as weight and body composition changes.

Methods: Soldiers' perceptions (n=48) were initially collected with an online national survey sent between July and September 2018. Additionally, individual semi-structured interviews were conducted in March 2019 (n=16). Measurements of 14 participants were taken at different time-points during an Arctic military course from January to March 2019: weight was measured using a digital scale, and body composition with bioelectrical impedance analysis. Energy intake was measured using a 24-hour food diary.

Results: The survey revealed that eating on-the-move; the equipment required for food preparation and consumption; as well as the weather and environmental conditions most negatively affected dietary intake. Also, 65% of survey respondents self-reported losing weight during their training. Interviewed participants reported six main factors influencing dietary intake: food and water temperature, time needed to prepare meals, water availability, personal preferences, variety of food, and soldier mood and team morale. Twelve of the 14 participants lost weight (3.9±3.0 kg) during the first portion of the course. However, body composition did not change from beginning to end of the course. Energy intake was 2799±835 kcal/day compared to estimated energy requirements of 5577±681 kcal/day, representing an average energy deficit of 49.8±19.2%.

Conclusion: The Arctic is a challenging environment, making it difficult to adequately meet energy needs of soldiers with combat rations. Intake was below energy requirements, and weight losses were observed. Many interrelated factors influenced soldiers' dietary intake. Combat rations adapted for soldiers' work in the Arctic environment could help optimize consumption. In addition, further assessment of ration suitability and exploration of other factors related to soldiers' intake in the field could be evaluated in order to enhance dietary intake.

***Keywords**: Army, Military, Arctic, Ration, Dietary Intake, Body Composition*

RÉSUMÉ

But : Cette étude avait pour but d'identifier les facteurs qui influencent l'apport alimentaire en rations de combat de soldats des Forces armées canadiennes qui s'entrainent dans l'Arctique, et de mesurer leur apport énergétique en plus de leur poids et composition corporelle.

Méthodes : La perception des soldats (n=48) a d'abord été documentée avec un sondage national électronique envoyé entre juillet et septembre 2018. De plus, des entrevues individuelles semi-structurées ont été menées en mars 2019 (n=16). Les mesures de 14 participants ont été prises à différents moments durant un entrainement militaire en Arctique de janvier à mars 2019 : le poids a été mesuré avec une balance digitale et la composition corporelle par analyse d'impédance bioélectrique. L'apport énergétique a été mesuré à l'aide d'un journal alimentaire de 24 heures.

Résultats : Le sondage a dévoilé que manger lors de déplacements; l'équipement nécessaire pour la préparation et consommation des repas; ainsi que la température et conditions environnementales ont le plus négativement affecté l'apport alimentaire. De plus, 65% des répondants du sondage ont rapporté une perte de poids durant leur entrainement. Les participants interviewés ont rapporté six facteurs principaux influençant l'apport alimentaire : la température de la nourriture et de l'eau, le temps nécessaire pour préparer les repas, la disponibilité de l'eau, les préférences personnelles, la variété d'aliments, ainsi que l'humeur des soldats et le moral de l'équipe. Douze participants ont perdu du poids (3.9±3.0 kg) durant la première partie de l'entrainement.

La composition corporelle n'a cependant pas changé entre le début et la fin de l'entrainement. L'apport énergétique était de 2799±835 kcal/jour comparé à des besoins estimés de 5577±681 kcal/jour, ce qui équivaut à un déficit énergétique moyen de 49.8±19.2%.

Conclusion : L'Arctique est un environnement extrême où il est difficile de rencontrer les besoins énergétiques des soldats avec les rations de combat. L'apport était sous les besoins énergétiques et une perte de poids a été observée. De nombreux facteurs interreliés ont influencés l'apport alimentaire des soldats. Des rations de combat adaptées au travail des soldats dans l'environnement Arctique pourraient aider à optimiser leur consommation. De plus, l'évaluation de l'adéquation des rations et l'exploration d'autres facteurs reliés à l'apport des soldats pourraient être évaluées afin d'améliorer leur apport alimentaire.

***Mots-clés** : Armée, Militaire, Arctique, Ration, Apport alimentaire, Composition corporelle*

ACKNOWLEDGMENTS

I would like to thank many people whom have played a key role in the completion of this thesis.

Above all, I would like to thank my thesis supervisor, Pr Isabelle Giroux (PhD, RD), for her incredible support and continuous guidance during my undergraduate studies and throughout my Master's project. I truly appreciate the countless hours devoted towards my project. Her mentorship has greatly shaped the way in which I approach research and the dietetic profession in general.

I would like to thank my co-supervisor, Dr Denis Prud'homme (MD), for his insight and feedback to help me improve the quality of my research project.

I would also like to thank the members of my thesis advisory committee, Dr Jeff Jutai and Dr Glen Kenny, for their contribution and suggestions.

A special thanks to the whole Canadian Armed Forces Strat J4 Food Services team, especially LCdr Lynda Hinch (RD), Hilda-Anne Troupe (RD), LCol Victoria Fraser (RD), and Édith Jutras, who played a key role in this project, from internal administrative logistics to the data collection. I am grateful to the research participants and the Arctic Operations Advisor course instructors for enabling me to carry out this research project during their military training.

I want to express my appreciation to administrative personnel at the University of Ottawa (Stéphanie Breau-Godwin and Marie-France Chayer) and the Institut du Savoir Montfort (Stéphanie Garcia).

A special thank you to the numerous undergraduate students and colleagues who have contributed at various points of my Master's: Celeste Bouchaud, Melissa Zoght,

Camille St-Jean, Raphaëlle Laroche-Nantel, Inès Auclair Mangliar, Joie Shaw, Alena McBain, Karine Brousseau, Alexandra Bodnaruc, and Mylène Rosa.

Finally, I would like to thank my friends, especially Stéphanie Boily, Catherine Mongenais, and Christine de Baets, as well as my family (Papa, Maman, Béatrice, Francis and Constance) for their ongoing support, encouragements, and prayers. I could not have accomplished this without each one of you. Merci!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACCRONYMS

AOA	Arctic Operations Advisor course
CAF	Canadian Armed Forces
e.g.	*Exempli gratia* (for example)
etc.	*Et cetera* (and so forth)
FFM	Fat-free mass
FM	Fat mass
i.e.	*Id est* (in other words)
IMP	Individual Meal Pack
LMC	Light Meal Combat ration

LIST OF SYMBOLS AND ABBREVIATIONS

>	Above
~	Approximately
<	Below
≥	Equal or above
≤	Equal or below
cm	Centimeter(s)
d	Day(s)
°	Degree
°C	Degree Celsius
g	Gram(s)
kcal	Kilocalorie(s)
kg	Kilogram(s)
±	More or less
%	Percent
SD	Standard deviation
Δ	Change

THESIS OUTLINE

This thesis has eight distinct chapters:

Chapter 1 introduces the research project, presenting some background information and an overview of the study.

In **Chapter 2**, an overview of the literature on the topic of military nutrition and key concepts to understanding the overall research project are presented.

Chapter 3 provides the research gaps, the main research objective, the specific objectives, the hypotheses as well as the significance of this study.

In **Chapter 4**, a summary of the methodology of Phases 1 and 2 is explained. Methodologies are described in greater depth in the original articles presented in Chapters 5, 6, and 7.

The following chapter (**Chapter 5**), presents an original article titled "Factors Influencing Canadian Soldiers' Dietary Intake of Combat Rations in the Arctic: A National Survey" which will be submitted to the *Canadian Journal of Dietetic Practice and Research*. This article covers Phase 1 of the study.

Chapter 6 includes another original article titled "Energy Intake, Weight, and Body Composition of Canadian Soldiers Participating in an Arctic Course". It will be submitted for publication to *Military Medicine*. This article presents the quantitative portion of Phase 2 of the study.

As for **Chapter 7**, it includes a third original article titled "Canadian Armed Forces Soldiers' Perception of Combat Ration Use in the Arctic: A Qualitative Study". It

will be submitted for publication to the *Journal of the Academy of Nutrition and Dietetics*. This article presents the qualitative portion of Phase 2.

Finally, **Chapter 8** presents the general discussion and summary of the key findings. The study strengths and limitations, as well as the implications for policy are also presented along with future directions for research. The chapter ends with a conclusion of the study.

CHAPTER 1. INTRODUCTION

1.1. Background

The Canadian Armed Forces (CAF) work in many extreme environments where soldiers face additional challenges in comparison to temperate climates. Such an environment is the Arctic, where military trainings and operations occur every year to prepare and equip soldiers to adequately conduct cold-weather operations (Goodman et al., 2015; Lackenbauer & Lajeunesse, 2016).

Whenever there is no access to a kitchen and fresh food cannot be offered, combat rations are provided to CAF members. These pre-packed meals are designed to meet the energy requirements of military individuals, which are generally higher than civilians (Tharion et al., 2005). However, energy needs are even more elevated in cold environments, mainly because of additional effort needed to move in snow- and/or ice-covered terrain and the weight of heavy clothing and equipment (Mandic & Jacobs, 2013). Energy needs therefore become harder to reach in cold environment like the Arctic. This becomes even more problematic when military frequently do not consume all combat rations and consequently do not meet their daily energy requirements (Castellani et al., 2017; Marriott, 1995).

Due to the harsh conditions in extreme environments such as the Arctic and underconsumption, numerous physiological effects can affect overall performance and health, like unintended weight loss, fatigue, and cognitive impairments (Edwards et al., 1995; Mandic & Jacobs, 2013). Understanding the specific challenges soldiers face in

meeting their energy requirements in the Arctic is paramount to finding solutions to optimize their nutritional status. Indeed, factors influencing dietary intake of rations in a Canadian context need to be documented in greater depth to understand the underlying reasons of underconsumption often observed in a military population.

1.2. Overview of the study

This study used a mixed-method approach. The overall objective was to identify the factors influencing dietary intake of combat rations by soldiers in the CAF working in the Arctic.

The research project presented in this thesis was completed in two phases, with the first phase informing the second one. In Phase 1, a national survey was sent to obtain feedback from the research population and help guide the remainder of the study.

As for Phase 2, weight and body composition measurements were taken for CAF members participating in a military course in the Arctic. Also, dietary intake was measured, and individual interviews were conducted to deepen understanding of soldiers' experiences using combat rations in the Arctic.

CHAPTER 2. LITERATURE REVIEW

To expand on the background information presented above, a literature review was done to further explore the knowledge base of military nutrition, combat ration consumption, factors influencing dietary intake and eating practices of military members.

2.1. The Canadian Armed Forces in the Arctic

The Canadian Armed Forces (CAF) carry out missions in many different environments, whether it be in countries around the globe or on Canadian soil. In fact, the CAF are present in the Canadian Arctic for surveillance, security and sovereignty purposes (Lajeunesse & Canadian Defence and Foreign Affairs Institute, 2015). The Arctic is also increasingly used as a shipping route because of more open water caused by environmental and climate changes (Lackenbauer & Lajeunesse, 2016). Although the possibility of short-term threats is evaluated as very low, the CAF aims to maintain its ability to respond to unexpected situations in those regions and operate effectively (Lackenbauer & Lajeunesse, 2016).

In order to expect the CAF to efficiently work in this region, military trainings and operations occur every year in the Arctic to prepare and equip soldiers to adequately conduct cold-weather operations (Goodman et al., 2015; Lackenbauer & Lajeunesse, 2016; Lajeunesse & Canadian Defence and Foreign Affairs Institute, 2015). Appropriate training helps avoid sending unacclimated soldiers to environments that are physically

more demanding, and require specific preparation and knowledge (Murthy & Singh, 2003; Sullivan-Kwantes & Fung, 2018).

In the military literature, a cold environment is most often defined as an environment with temperatures below 0°C (Askew, 1995; Mandic & Jacobs, 2013; NATO Research and Technology Organisation, 2010). It would, however, seem more appropriate to consider the Arctic an extremely cold environment, since the temperature in Resolute (Nunavut) is well below -30°C in winter months (Environment and Climate Change Canada, 2019).

Many definitions exist to refer to northern regions such as the "Arctic" and "High-Arctic". The following terminology will be used, based on the Canadian military's definitions:

- "The **North** is defined as the area encompassing the sub-Arctic region [and] the Arctic region to include the Arctic Circle and High Arctic.
- The **Arctic Region** extends from Alaska in the west to Davis Strait in the east and from 60 degrees north to over 83 degrees north [latitude]. It consists of the Yukon, the Northwest Territories, Nunavut, Nunavik (northern Quebec), and all of Labrador. It also includes the Arctic Archipelago and represents about 40 percent of the country's landmass and two-thirds of its coastline.
- The **Sub-Arctic Region** is defined as the area between 55 to 60 degrees north latitude encompassing what the Royal Commission on Aboriginal Peoples identified as "Mid-North" and includes large areas of British Columbia,

Alberta, Saskatchewan, Manitoba, Ontario, and Quebec where northern conditions prevail.

- The **Arctic Circle** is defined as being 66.5 degrees north latitude.
- **High Arctic** is defined as the region above the Arctic Circle."

(Lackenbauer & Nicol, 2017)

2.2. Feeding in the CAF and dietary recommendations

2.2.1. Combat rations

Feeding the military worldwide is a challenge. Different feeding options are available depending on the location, length of stay and available resources. One such option is feeding in garrison, where military members have access to dining facilities. In these cafeteria-style services, the majority of foods provided are prepared on-site using standard recipes (Mandic & Jacobs, 2013).

Another option is field feeding with a kitchen. In this case, fresh meals are prepared in Mobile Kitchen Trailers or Relocatable Tented Camps, depending on the mission needs and duration. Mobile Kitchen Trailers have a smaller production capacity and are very mobile, whereas Relocatable Tented Camps require weeks to install and are more permanent (Mandic & Jacobs, 2013).

Whenever there is no access to a kitchen and fresh food cannot be offered, soldiers are given combat rations (also referred to as field rations) called Individual Meal Packs (IMPs), containing pre-packed and ready-to-eat foods, and others called Light Meal Combat rations (LMCs).

Figure 2.1. A sample Individual Meal Pack (IMP)

Figure 2.2. A sample Light Meal Combat ration (LMC)

Both types of rations are different and were developed for distinct purposes. The CAF has a total of 21 different menus of IMPs: seven breakfasts, seven lunches, and seven suppers. When soldiers are given rations, they have little leeway outside of their provided diet; they can exchange items with fellow soldiers, and some bring food from home with them (Hatton, 2005). Each IMP provides on average 1600 kcal, for approximately 4800 kcal/d. The macronutrients of the IMPs are distributed as follows: 50% of the calories are from carbohydrates, 15% from proteins, and a maximum of 35% coming from fats (Mandic & Jacobs, 2013). The IMPs are designed in accordance with the Dietary Reference Intakes (Mandic & Jacobs, 2013; NATO Research and Technology Organisation, 2010). Each IMP weighs approximately 900 g; a day's worth of food therefore weighs about 2.7 kg. The combat rations are not meant to be consumed for over 30 consecutive days, as per military guidelines (NATO Research and Technology Organisation, 2010). The rations include wet-pack items in pouches (e.g. main entrées) and ready-to-eat foods (e.g. trail mix), with some items requiring rehydration (e.g. powdered beverages). All items can be eaten hot or cold, although heating some foods may increase their palatability and appreciation (NATO Research and Technology Organisation, 2010).

As for the LMCs, there are three menus, each providing approximately 1000 kcal. They consist of snacks and low-preparation items that can be eaten in addition to three IMPs when the latter may not cover the daily energy requirements (Mandic & Jacobs, 2013). In other words, the IMPs are the main rations consumed and cover the daily energy needs, whereas the LMCs are supplemental foods. The CAF provides the same combat rations to Canadian soldiers throughout the world, with no meals designed for

specific environments such as the cold, unlike other countries like the United States, Norway, and the Netherlands that have "regular" rations providing ~3600-4000 kcal/d, and rations for cold environments providing ~4000-5200 kcal/d, some of which contain freeze-dried items (NATO Research and Technology Organisation, 2010).

2.2.2. Energy needs for a military population

2.2.2.1. General military energy needs

The military differs greatly from the civilian population, in terms of day to day activity and physical demands, to name a few. Consequently, military members generally have higher energy needs than the average population (Marriott & Carlson, 1996). In fact, daily energy expenditure is 38% higher in military versus civilian men, and approximately 17% higher with military versus civilian women (Tharion et al., 2005).

The recommended energy needs for the North Atlantic Treaty Organisation (NATO) Response Force is evaluated at 3595 kcal/d in normal operations[1] (Sluik et al., 2008). Several other studies have reported daily energy expenditure to range from 3343 to 4179 kcal/d, averaging 3630 kcal/d (Tharion et al., 2005). Similarly, the American Military Dietary Reference Intakes for energy are evaluated at 3250 kcal/d for men (Baker-Fulco et al., 2001; Medical Services, 2001). Based on these recommendations, the Canadian IMPs therefore provide sufficient daily energy (i.e. approximately 4800 kcal/d).

[1] "Normal operations" refer to "missions comparable to urban police and peace keeping, fire fighting or construction work" (NATO Research and Technology Organisation, 2010, p. 53).

Also, a recent study measured energy requirements for soldiers in the Special Operations Forces, an elite branch of the American Army, to be 4468 kcal/d (Barringer et al., 2018).

2.2.2.2. Energy needs in cold environments

In cold environment, the human body tries to maintain its core temperature by reducing blood flow to the skin, namely vasoconstriction (Osilla & Sharma, 2019). Moreover, metabolic heat is increased by physical activity, and shivering: the involuntary thermoregulatory response to cold (Osilla & Sharma, 2019; Sluik et al., 2008).

The energy requirements are therefore increased in different situations, such as in cold environments or during combat operations[2] (NATO Research and Technology Organisation, 2010). In cold environments, this is mainly due to additional effort required to move in snow- and/or ice-covered terrain as well as the weight of added clothing and equipment (Mandic & Jacobs, 2013). These can increase daily needs by 8-15% (Marriott & Carlson, 1996; Sluik et al., 2008; Tharion et al., 2005).

In cold climates, estimated energy expenditure ranges from 3630 to 7116 kcal/d in various studies, and is consequently estimated at 4905 kcal/d on average (Tharion et al., 2005). This matches the average energy expenditure of 4844±549 kcal/d reported in a review of seven studies measuring energy requirements in cold environments using the doubly labelled water technique (Mandic & Jacobs, 2013). Also, a study on male Marines

[2] "Combat operations" refer to "missions involving sustained, dismounted light-infantry or Special Forces operations" (NATO Research and Technology Organisation, 2010, p. 53). They are the most physiologically stressful conditions.

doing cold-weather field exercise measured energy expenditure at 4919 kcal/d (Hoyt et al., 1991).

To sum up, energy requirements are higher in cold environment and become much harder to reach in harsh environments such as the Arctic.

2.2.3. Energy underconsumption

Underconsumption is often seen in a military population. Despite being provided with adequate amounts of food supplying an appropriate total energy content with a suitable macronutrient distribution, the literature from the past few decades shows that military personnel do not reach their daily energy needs (Jones et al., 1993; Marriott, 1995). In a 4-day Arctic training, soldiers received protein or carbohydrate-based snacks (~1000 kcal/d) in addition to three combat rations, yet also faced a negative energy balance (Margolis et al., 2016). Studies using the doubly labelled water technique have shown that daily energy deficits ranged from 500 to 2000 kcal/d (Marriott, 1995). Ten studies between 1986 and 1991 during cold-weather trainings (most of them completed in Alaska) showed the energy deficit was from 950 to 1770 kcal/d, and averaged 1500 kcal/d, when provided with 4500-4900 kcal/d of food (Baker-Fulco, 1995). Wasted food was measured at 1000 to 3000 kcal/d, where only 47-78% of rations were actually being consumed (Baker-Fulco, 1995). As Henning et al. (2011, p. 995) summarize well, “The physiological and nutritional status before and during operations can have a strong impact on military performance in these missions conducted under high-stress environments.”

2.2.3.1. Physical and cognitive impairments

Chronic underconsumption does not come without consequences. An inadequate energy intake to compensate for energy expenditure leads to an energy deficit state where weight losses (including a reduction in body fat and fat-free mass) during extended military operations in cold environments occur time and time again (Hirsch, 1995; King et al., 1993; Marriott, 1995; Tassone & Baker, 2017). To better understand the effects of weight loss, the time span in which this change occurs needs to be taken into consideration. Sixteen soldiers consuming combat rations and participating in an 8-day exercise in Alaska lost on average 3.1% of their weight (Roberts et al., 1989). A review of the typical weight loss in military personnel working in various climates during short term (4-12 days) exercises was only 1.5% of the initial body weight (Mandic & Jacobs, 2013). They had consumed approximately 67% of the energy provided by the rations. Another study over a longer period of time (34 days) found that soldiers who consumed 2159 kcal/d on average lost 4.8% of their initial weight after eating three rations per day during field training (Hirsch, 1995). A systematic review reported a reduction in body weight varying from 0.1% over 8 days to 8.3% over 12 days of field training while consuming combat rations. Fat mass, fat-free mass and percentage body fat were also lowered (Tassone & Baker, 2017). However, a negative energy balance did not change fat-free mass of athletes competing in a 7-12 day ultramarathon in Yukon with harsh environmental conditions (Schalt et al., 2018).

There are insignificant health effects with weight losses of <3% over 7 to 30 days (Fogelholm et al., 1993; Mandic & Jacobs, 2013). However, a rapid weight loss, for

example 3% over 2 days, may be the result of dehydration thus causing symptoms such as fatigue and dizziness, and could also affect overall performance and mood (Hall & Lane, 2001; Marriott, 1995; Weinberg, 1995). In longer military operations (i.e. ≥4 weeks), weight losses are more likely to be higher, which have negative effects on physical and cognitive performance (Marriott, 1995). A reduction in body weight of 10% was linked with altered hormone balance, a decline in memory, attention, morale, skeletal mass, immune function and increased fatigue and risk of injury (e.g. stress fracture) (Franchini et al., 2012; Goodman et al., 2015; Henning et al., 2011; Hodgdon et al., 1991; Marriott, 1995; Montain & Young, 2003; Ramsey et al., 2013). Also, other physiological consequences in extreme environments are deterioration of fine motor coordination and metabolic response, as well as impaired thermoregulation (Murthy & Singh, 2003).

Furthermore, unintended weight loss and reduced dietary intake are both key indicators used for the screening of malnutrition according to the Canadian Malnutrition Task Force (2014). Hence, soldiers with these signs and symptoms could be at risk of malnutrition.

In brief, poor nutritional status and unintended weight loss is problematic because it can reduce physical and cognitive performance and health, and negatively affect the ability to recover from injuries and sustained efforts. This is especially problematic when soldiers are redeployed prior to full recovery (Mandic & Jacobs, 2013; Marriott, 1995).

2.3. Factors influencing dietary intake

On top of having higher energy demands and an imposed diet, many challenges and various factors can affect the dietary intake of soldiers. To name a few, the

familiarity and variety of food items play an important role in food consumption; people eat more when offered foods they are familiar with, and variety tends to encourage a greater consumption and reduces monotony (Baker-Fulco, 1995; Meiselman, 2010). Another important element to affect intake is the social influence of others and eating together, known as commensality (Hermans et al., 2013). It has been reported that people are likely to consume more food when eating with others rather than alone. The influence of leadership on the nutritional behaviour of soldiers is also an influential factor to food intake (Jackson et al., 2013; Jayne et al., 2019). For instance, leaders may dictate soldiers' food choices and/or rush them to complete meals in very little time to ensure quick return to activities (Jackson et al., 2013). Baker-Fulco explained that "Lack of command emphasis on the importance of ration consumption may be perceived by the troops as an indication that nutrition is not important." (1995, p. 41). Another element to consider is the weight of the rations themselves, which can influence the amount brought by soldiers, especially when they are required to carry a few meals with them. In fact, "The availability of water and food […] often get second priority for carrying of essential equipment, clothing and gear." (Murthy & Singh, 2003). Countless other factors can also influence the dietary intake of military, and need to be further researched.

2.3.1. Three Factor Model

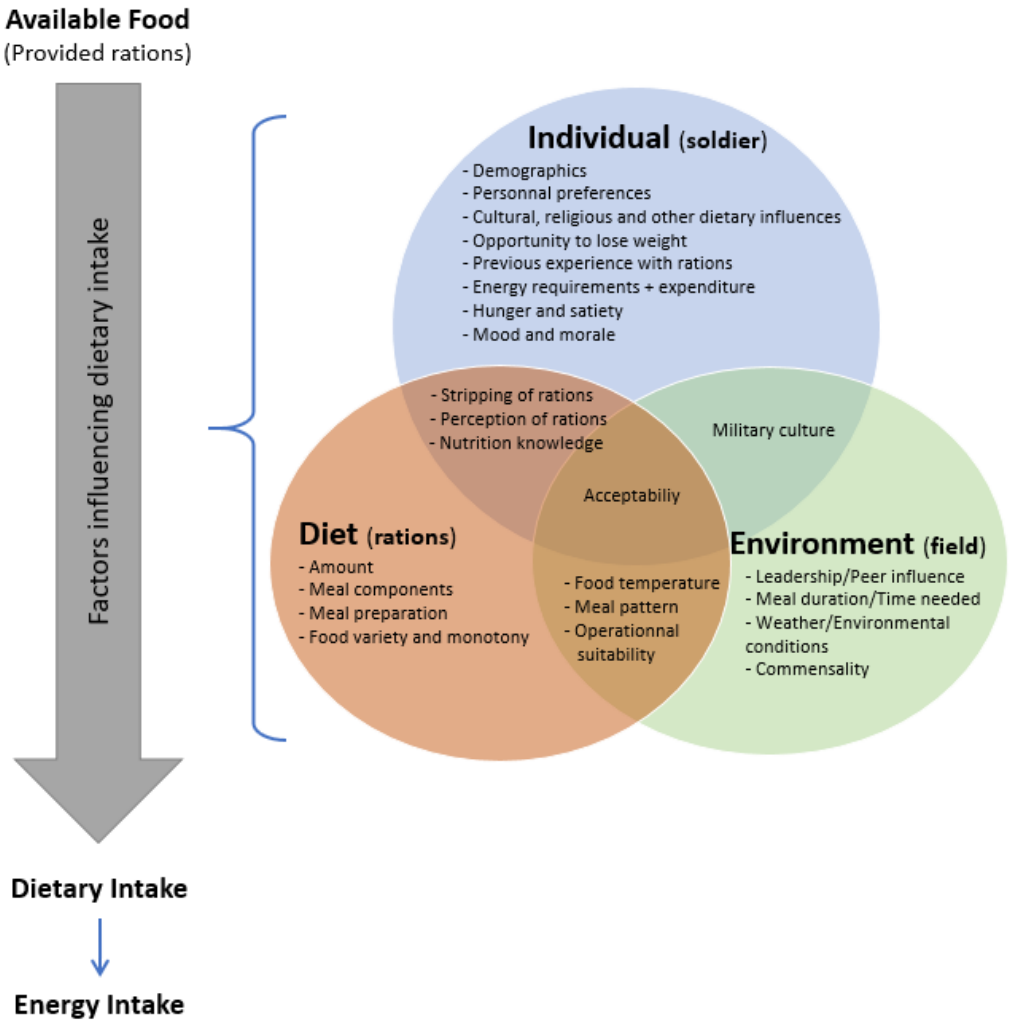
Meiselman (2010) proposed a model to represent the main factors involved in the eating context: the *food*, the *individual* and the *environment*. This model is based on the premise that "food is consumed by individuals in a particular environment" (Carins &

Kullen, 2011). In a military context, this translates to the ration, the soldier, and the field. The factors can influence intake, either positively or negatively, depending on the context and setting. The *food* includes variables such as portion size, food temperature, food compatibilities, food presentation and food variety. The *individual* includes some of the following variables: age, gender, dietary influences, satiety, and moods and emotions. Finally, the *environment* includes location, appropriateness of food, time of day, price of food, weather, etc. (Meiselman, 2010).

2.3.2. Modified Three Factor Model

Based on this literature review, previous research, grey literature, and personal communications with CAF members, I modified the Three Factor Model in order for it to better correspond to the military population and the context in which they use combat rations. For example, some factors were removed, such as price; this does do not apply to the military consuming rations since they are provided with meals and do not need to purchase them, thus cannot be influenced by the item's price. This model also shows interactions and overlap of factors, all influencing the overall acceptability of food. In other words, food is provided (i.e. combat rations) to soldiers, but many factors influence their actual dietary and energy intake.

Figure 2.3. Modified Three Factor Model, based on Meiselman's model (2010), showing factors influencing dietary intake of soldiers consuming combat rations (Carins & Kullen, 2011; Goodman et al., 2015; Mandic & Jacobs, 2013; Marriott, 1995).



CHAPTER 3. RESEARCH GAPS, RESEARCH OBJECTIVE, SPECIFIC OBJECTIVES, HYPOTHESES, AND SIGNIFICANCE

3.1. Research gaps

Many studies on military nutrition and combat ration consumption have been conducted in the past. The vast majority of the available literature comes from the United States. Although it provides rich and greatly valuable information, it is not necessarily representative of the Canadian context, given the unique and extreme climate of the Arctic. For example, studies in cold environments were often done in sub-zero temperatures without going as low as in the Arctic, thus possibly overlooking specific challenges and elements of working in extremely cold environments.

From the limited Canadian literature available, few studies focused on cold environments. One such study was done with soldiers working near Iqaluit (NU) close to three decades ago (Jones et al., 1993). Another example is a recent study assessing dietary intake of participants doing a military winter training. However, this project was done in Southern Ontario, which likely does not capture the complexity of the Arctic context (Ahmed, 2017). Another Canadian study sought to determine soldiers' consumption patterns and document the feeding logistics in the Arctic (Goodman et al., 2015). Since energy intake was not recorded, there exists a gap in the literature examining this aspect. A study investigating ways to facilitate energy intake estimates of military concluded that factors other than food palatability and availability should be identified and considered to address underconsumption in the field (Mandic, 2018). Also, the CAF National Combat Rations Program is continuously making changes and

improvements to rations, so previously documented feedback may no longer reflect the current feeding challenges.

To sum up, the objectives of this thesis were elaborated based on the limitations of previous studies, to build on earlier results.

3.2. Main research objective

The main research objective of this study was to identify the factors influencing dietary intake of combat rations by soldiers in the CAF working in the Arctic. The research study presented in this thesis was done in two phases.

3.3. Specific objectives

The first phase of the study focused mostly on the Objective 1, at an exploratory level. Phase 1 thus informed the second phase of the research project, which addressed more directly and in depth the three objectives presented below.

Specific objectives:

1. To document CAF soldiers' perception of factors influencing intake of combat rations while working in the Arctic.
2. To assess the daily energy intake of CAF soldiers on combat rations working in an extremely cold environments compared to estimated daily energy requirements of soldiers working in the Arctic.

3. To assess the weight and body composition changes of CAF soldiers during an Arctic course.

3.4. Hypotheses

The hypotheses for each specific objective were:

Objective 1: There is a variety of factors influencing the dietary intake of soldiers working in the Arctic, such as food temperature and large amounts of time necessary to prepare meals.

Objective 2: The daily energy intake of soldiers is 500-1000 kcal lower than recommended, when compared to estimated daily energy requirements, due to not consuming the entire rations distributed.

Objective 3: Losses in body weight and modified body composition with decrease in fat mass are seen after an Arctic military training.

3.5. Significance

Concerns regarding operational suitability of the current combat rations have led to consider developing rations for cold-weather operations. The findings from this study will help elicit and understand the underlying reasons and difficulties for soldiers in the CAF to reach their energy needs during a winter training in the Arctic. This study was needed to identify the factors influencing the dietary intake of combat rations by soldiers,

and help better understand their experience with combat rations in a very cold setting: their general perception of combat rations, the operational suitability of the rations, their appreciation of meals, as well as other factors influencing their dietary intake. This study was designed to help find strategies to better meet daily energy requirements of military personnel to prevent possible physical and cognitive performance impairments. This new knowledge will be taken into consideration for the development of combat rations adapted for an extremely cold environment. Also, the study finding will help identify areas to focus on in nutrition education for military personnel. Finally, this study can be used as a springboard to continue improving food and nutrition policies.

CHAPTER 4. OVERVIEW OF THE METHODOLOGY

A mixed-method study design was used, by combining a quantitative and qualitative component. Methodologies with sequential triangulation allows the research question to be studied from various angles with complimentary data, where the quantitative results collected inform further qualitative research methodology (Morse, 1991). Methodologies used in each phase of the project are summarized below.

4.1. Phase 1 of the study

Phase 1 of the project was completed during the summer and fall of 2018. A national online survey was sent to soldiers of the CAF who participated in trainings in the Canadian Arctic in previous years (see Appendix B, C and D). This survey had 39 open- and close-ended questions. It included questions on demographics, physical markers (e.g. hunger, symptoms, perceived weight change), and factors influencing dietary intake and acceptability of combat rations in the Arctic.

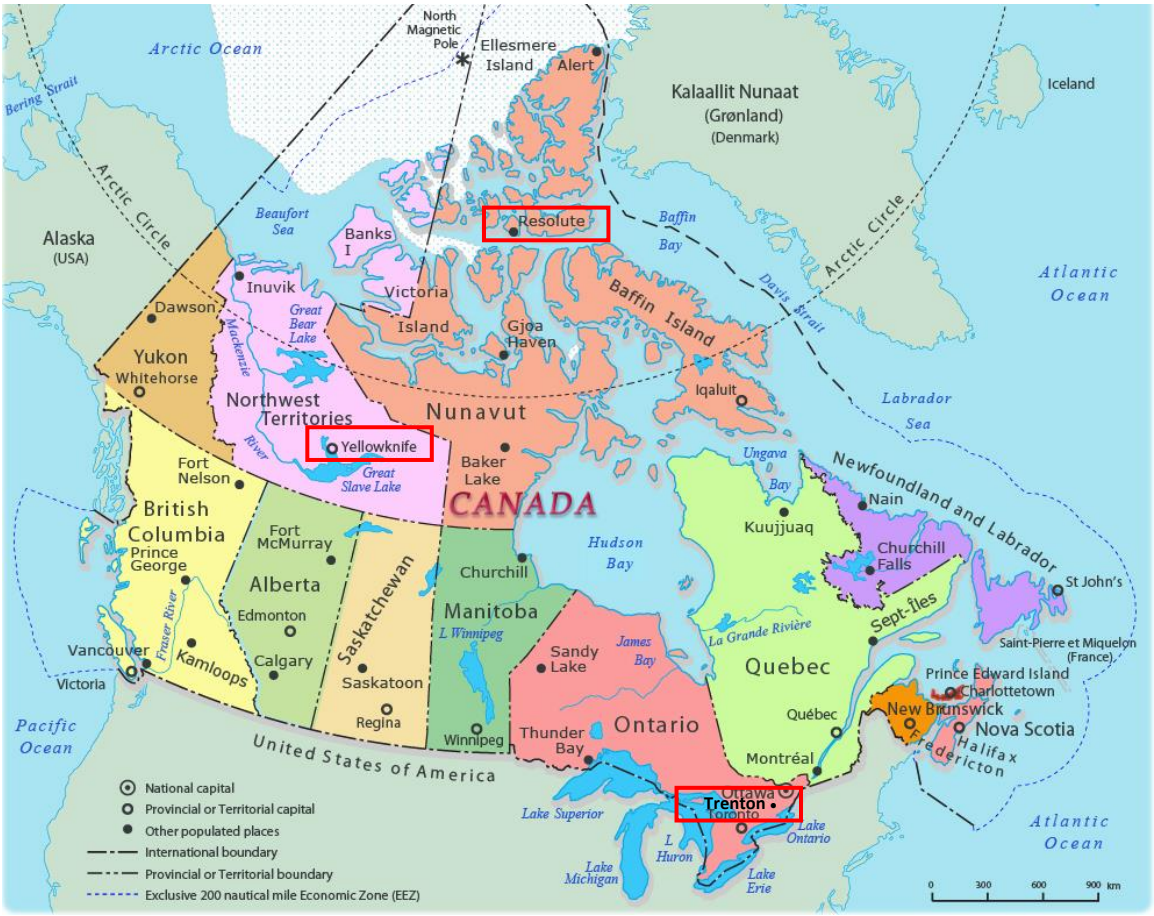
The methodology of this part of the research project is further described in the "Methods" section of the article presented in Chapter 5.

4.2. Phase 2 of the study

Every year, the Arctic Operations Advisor (AOA) course trains military personnel in planning and coordinating operations in the Canadian Arctic. This 8-week course,

divided in three stages, takes place from January to March for up to 45 participants and 10 instructors. The first stage (Sub-Arctic stage[3]) takes place in Yellowknife (Northwest Territories) for three weeks. It is followed by the second stage (High-Arctic stage) at the CAF Arctic Training Centre in Resolute (Nunavut) for the final four weeks of the course. The AOA course ends with four days in Trenton (Ontario) to debrief and conclude the training. The following map indicates the locations of the various parts of the AOA course:

Figure 4.1. Map of Canada with AOA course locations
(http://www.geographicguide.net/america/canada.htm)



[3] Although Yellowknife (62° north latitude) is located in the Arctic region (above 60° north latitude), the Yellowknife portion of the AOA course is considered the Sub-Arctic stage.

Phase 2 of the project was carried out in the winter and spring of 2019, with participants of the AOA course. Data was collected in three different Canadian cities, corresponding to the AOA course locations.

In Yellowknife, after consent from participants was obtained (see Appendix E), short surveys were distributed to collect demographic information (see Appendix F). Other collected data included height, weight, and body composition by bioelectrical impedance analysis.

In Resolute, a mid-point weight was measured as well as dietary intake; participants completed a 24-hour food diary for a typical day they consumed combat rations (see Appendix G).

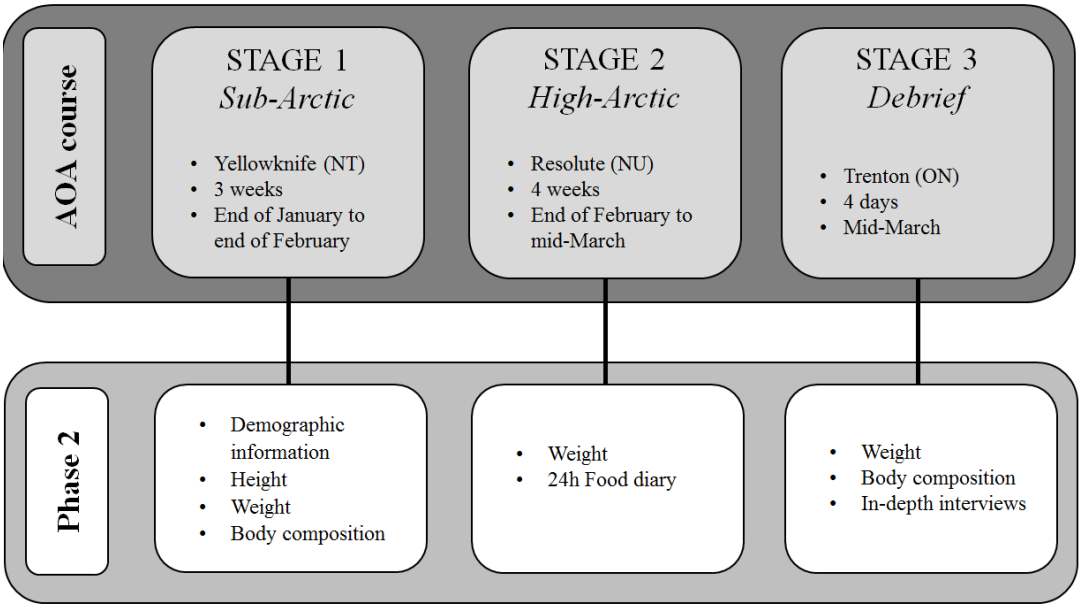
In Trenton, final weight and body composition measurements were taken. Participants also shared their experience with combat rations in the Arctic via in-depth semi-structured individual interviews conducted by two dietitians (see Appendix H).

Figure 4.2 shows a schematic representation of the methodologies used in Phase 2 of this study. The measurements and data collected at different time points are indicated alongside the AOA course program.

The methodology of the quantitative portion of the research project (i.e. food diary and body measurements) is further described in the "Material and methods" section of the article presented in Chapter 6.

The methodology of the qualitative part of the research project (i.e. individual interviews) is further described in the "Methods" section of the article presented in Chapter 7.

Figure 4.2. Schematic representation of the methodologies of Phase 2 of the research project, with data collection points showed alongside the AOA course program.



4.3. Ethics approval

All parts of this study have been approved by the University of Ottawa Research Ethics Board (see Appendix A).

CHAPTER 5. ARTICLE 1 – FACTORS INFLUENCING CANADIAN SOLDIERS' DIETARY INTAKE OF COMBAT RATIONS IN THE ARCTIC: A NATIONAL SURVEY

Authors:

Florence V. Lavergne[1-2]

Denis Prud'homme[2]

Isabelle Giroux[2-3]

[1] *Interdisciplinary School of Health Sciences, Faculty of Health Sciences, University of Ottawa (ON)*

[2] *Institut du Savoir Montfort, Ottawa (ON)*

[3] *School of Nutrition Sciences, Faculty of Health Sciences, University of Ottawa (ON)*

Acknowledgements:

We would like to thank the Canadian Armed Forces for their support and cooperation in this study, especially LCdr Lynda Hinch (RD), and Hilda-Anne Troupe (RD), of the CAF Strat J4 Foodservices. We also thank the research participants who made this study possible.

5.1. Abstract

Purpose: To determine Canadian Armed Forces (CAF) soldiers' perception of the factors influencing their dietary intake of combat rations while working in the Arctic.

Methods: An online bilingual survey was sent nationally between July and September 2018 to 172 CAF soldiers who worked in the Arctic in 2015-2018. The survey included 39 open- and close-ended questions, including some about factors influencing intake and acceptability of combat rations.

Results: Fifty-four individuals responded to the survey (31.4% response rate). Six surveys were incomplete and excluded. Trainees (n=37) and instructors (n=11) from nine provinces participated. Factors that most negatively affected dietary intake were eating on-the-move, equipment required for food preparation and consumption, and weather/environmental conditions. Participants reported that 61%, 68%, and 71% of breakfast, lunch, and supper rations were eaten. They noted significant time was needed to prepare rations since they were frozen. Sixty-five percent of soldiers reported losing weight during their work in the Arctic.

Conclusions: The combined effect of certain factors could contribute to reducing dietary intake of soldiers. More research is needed to further explore the soldiers' perspectives about barriers and facilitators to combat ration intake in the Arctic.

Keywords*: Army, Military, Arctic, Ration, Dietary Intake*

5.2. Introduction

The Canadian Armed Forces (CAF) carry out missions in extreme climates in many countries, including Canada. The CAF needs to be present in the Canadian Arctic, for surveillance and sovereignty purposes, where they also offer training to soldiers for cold-weather operations [1].

Feeding the Canadian military worldwide remains a challenge. When fresh feeding is not possible, CAF utilizes combat rations which are pre-packed and ready-to-eat foods. CAF has developed a total of 21 different ration menus: seven breakfasts, seven lunches and seven suppers. Many criteria have to be respected in terms of nutrient and energy content, variety, and shelf life [2,3]. Each meal provides 1600 kcal on average, for a total of approximately 4800 kcal/day [2]. The combat rations are designed in accordance with the Dietary Reference Intakes [2,3]. A day's worth of food (i.e. three combat rations) weighs about 2.7 kg. CAF provides the same rations to Canadian military throughout the world, regardless of the working environment. During field training and deployments, it is essential that soldiers have an adequate food intake to compensate for their higher energy expenditure, and meet their daily nutritional needs in order to prevent physical and cognitive performance impairments [3–7].

However, CAF members do not seem to consistently meet their daily energy needs with combat rations when working in extreme environments like the Arctic (≥60° north latitude), and especially the High-Arctic (above the Arctic Circle, 66.5° north latitude) where winter temperatures are below -30°C [2,8–12]. A low dietary intake over a prolonged period of time can contribute to involuntary weight loss and diminished

performance, as well as increase risk of injury in the field [8,13,14]. Very little has been researched on Canadian military nutrition, even less so in the Arctic, but many factors are thought to influence their dietary intake [2,9,13,15]. Such factors include the temperature of foods, emotional state of individuals, time restraints to prepare and consume meals, and variety of combat rations [3,9,15,16].

Factors influencing the dietary intake of combat rations by soldiers in the Arctic need to be documented in greater depth to understand the underlying reasons of reported underconsumption. This study aimed to determine CAF members' perception of the factors influencing their dietary intake while working in the Arctic. Information from this research will enhance understanding of different factors affecting intake of soldiers and help pinpoint which ones need to be further studied to then explore options to make combat rations better adapted for the Arctic.

5.3. Methods

Study Participants

With permission from the CAF, we recruited military members who were on training in the High-Arctic for a minimum of three weeks between January and April where combat rations were used for at least 14 days. Trainees and instructors who worked in the Arctic between 2015-2018 were invited to participate (see Appendix B).

Data Collection

We created a bilingual survey (see Appendix D) inspired by previous surveys made by the CAF Strat J4 Food Services to obtain feedback on combat rations and guided by literature showing a variety of factors to consider [3,9]. It was tailored to address the research question and population studied. The 20-minute survey had 39 open- and close-ended questions. It included questions on demographics (age, sex, number of years in the CAF, etc.), physical markers (e.g. perceived hunger, symptoms, weight change) as well as general and specific questions regarding factors influencing dietary intake and acceptability of combat rations in the Arctic. There were questions on food variety, acceptability of rations, amount of food eaten, time allotted for meals, and ability to heat foods. Furthermore, participants had opportunities to add comments and elaborate on their responses. Supporting quotes from the surveys are included in the presentation of results.

Four dietitians created and reviewed the survey, including two working within the CAF Strat J4 Food Services, with extensive knowledge of the military culture. The remaining two, along with another dietitian reviewed the French translation to ensure reliability of the survey [17,18].

The survey was piloted by two military members to test the survey and ensure the comprehension of questions and overall content, as well as to evaluate the length of time required to complete the survey. This enhanced the validity by ensuring the survey would accurately capture what is being studied [18,19].

Once finalized, the survey was created on *SurveyMonkey* (SurveyMonkey Inc., San Mateo, California, USA). The study context, the survey link and a consent form were

sent by the main researcher to the CAF contact via email. This person had access to mailing lists of individuals who participated in Arctic trainings in previous years and therefore sent the email to invite potential participants between July-September 2018. They could complete the survey in their language of preference (French or English). They could stop at any point and skip questions, without consequences. Completing the survey and submitting it provided implied consent to participate in the study. Participation was voluntary, and surveys were anonymous allowing participants to freely disclose information and making it impossible for researchers to trace which survey each participant completed. Given the anonymous nature of the surveys, participants could not withdraw their results once submitted. A code was assigned to each participant. No financial compensation was given to participants.

Data Analysis

Results were compiled, verified and analyzed in Microsoft Excel (Office 2010, Microsoft Inc., Redmond, Washington) to obtain descriptive statistics. Frequencies, means, standard deviations, and unpaired t-tests were done. Statistical significance was reached at $p < 0.05$.

Ethics Approval

Ethics approval was obtained from the Research Ethics Board of the University of Ottawa.

5.4. Results

The survey was sent to 172 individuals. There were 54 respondents (31.4% response rate); however six surveys were largely incomplete (<50%) and therefore excluded from the study. The final number of participants who completed the survey was 48.

Trainees (n=37) and instructors (n=11) from nine provinces participated (ages 31.8±7.1 years; 45 men and 3 women; 10 Francophones and 38 Anglophones). There were 42 Caucasians, and 6 others (e.g. native American, Chinese). Seventy-nine percent of the participants has worked in the Arctic in 2018. On average, participants had 12.1±6.8 years of experience in the CAF. Fifty-four percent of participants (n=26) reported having previous experience in the Arctic, some having lived in Northern Canada, others having been in the Arctic for military purposes, thus being exposed to combat rations in this environment. Participants ate the standard CAF combat rations, except for one participant who consumed the vegetarian/religious option.

The majority of participants indicated being hungry between meals (92%) and at night (71%) (Supplementary figure 5.1). Thirty-eight percent (n=18) of participants reported having experienced gastrointestinal symptoms following the consumption of combat rations during the Arctic training. Of these respondents, the most commonly indicated symptoms were constipation (n=11) and gas (n=10), followed by bloating (n=7), heartburn (n=7), diarrhea (n=4), nausea (n=2) and headache (n=1). Sixty-five percent of participants (n=31) self-reported losing weight during their Arctic training (from 1.8 to 11.3 kg) (Table 5.1).

Supplementary Figure 5.1. Soldiers' reported hunger outside of mealtimes (n=48)

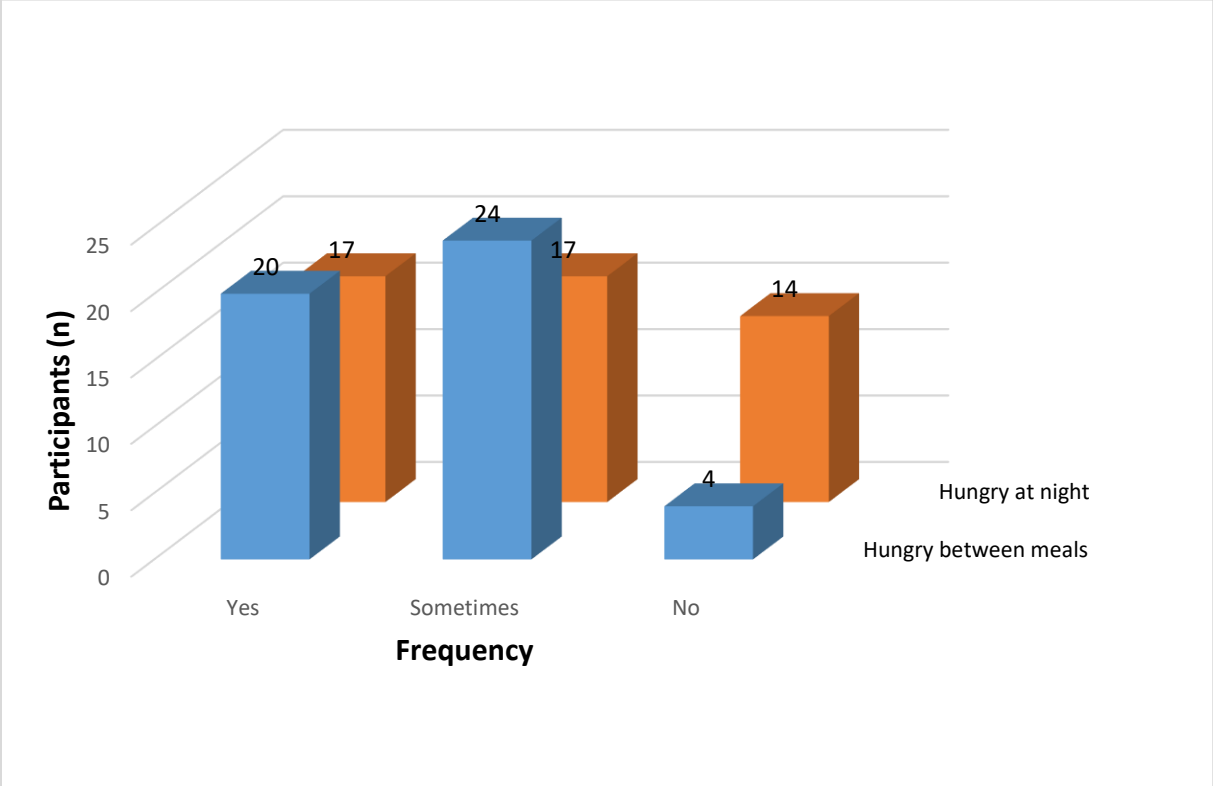


Table 5.1. Perception of weight changes during Arctic military training (n=48)

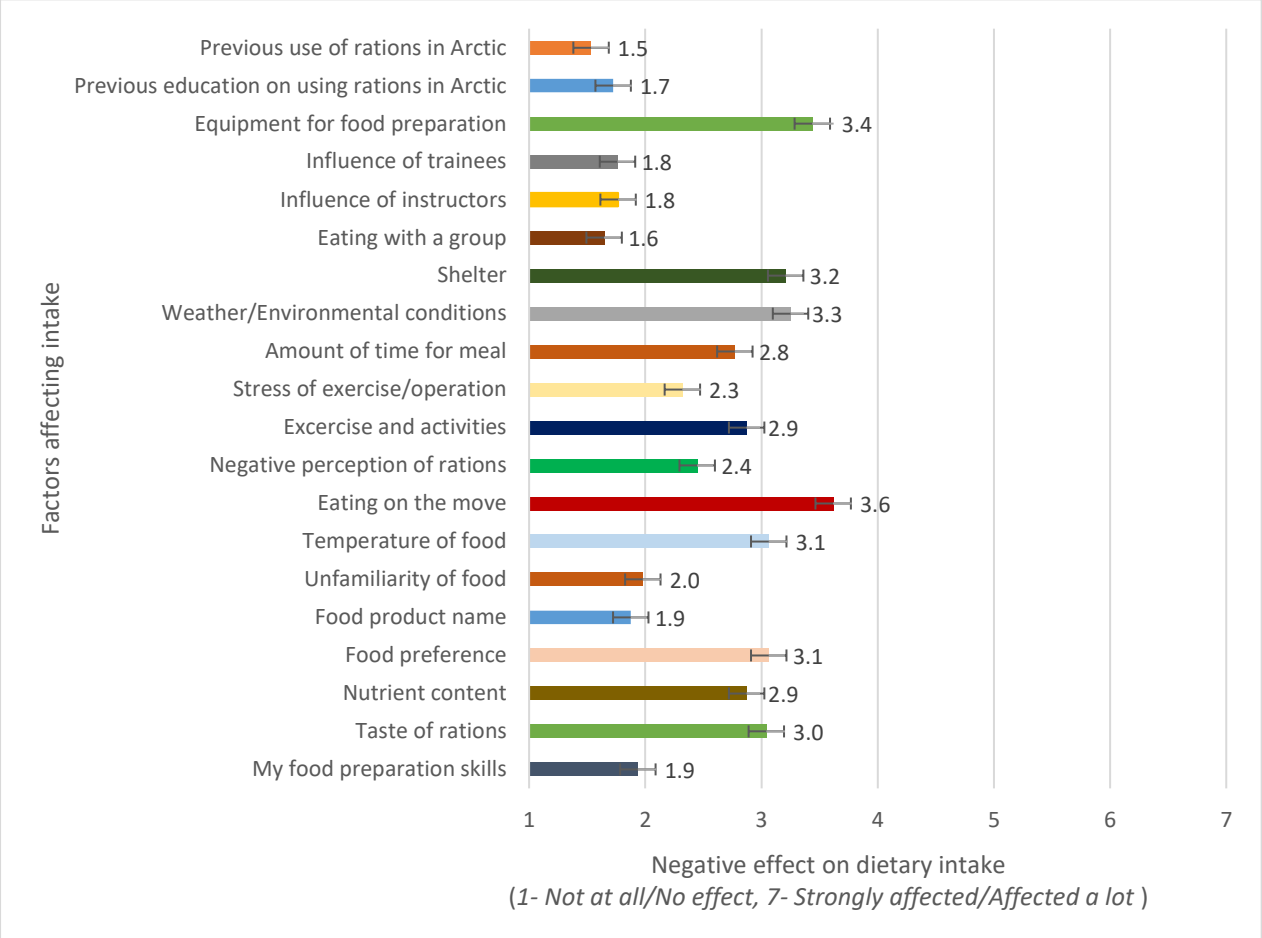
	Number of individuals (%)	**Weight change* (kg) [range]**
Weight gain	3 (6.3%)	+6.0 ± 2.6 [4.5-9.1]
Weight loss	31** (64.6%)	-5.3 ± 2.5 [1.8-11.3]
Stable weight	14 (29.2%)	0

** mean ± standard deviation*
*** 2 people reported intentionally losing weight*

In terms of factors influencing dietary intake of combat rations in the Arctic, a list of 20 factors was provided for participants to rate how much each of them affected their dietary intake of rations. Any other factor could be added and explained in a comment box. However, no other factors were added. To rate the factors, a 7-level Likert scale (from *1-Not at all/No effect* to *7-Strongly affected/Affected a lot*) was provided. Based on

group average, the three factors that most negatively affected dietary intake were eating on-the-move (3.6±2.1), equipment required for food preparation/consumption (3.4±2.1), and weather/environmental conditions (3.3±2.1). In contrast, the three factors that affected the least dietary intake were previous military use of combat rations in the Arctic (1.5±1.2), eating with a group (1.6±1.1), and previous military education on how to use the combat rations in the Arctic (1.7±1.5) (Figure 5.2).

Figure 5.2. Soldiers' perception of factors negatively affecting intake of rations* (n=48)



mean ± standard deviation
**Participants were asked "Please mark how much each factor negatively affected your intake of rations"*

In addition, participants evaluated the rations, more specifically their acceptability, based on a list of 13 factors such as ease of preparation, weight and preparation time, on a 7-level Likert scale (from *1-Very unacceptable* to *7-Very acceptable*). The three highest scores of acceptability were ease of consumption (4.9±1.6), amount of water required (4.9±1.7), and quantity of food per day (4.9±1.7). The three lowest scores of acceptability were preparation time (3.8±1.5), ease of digestion (4.0±1.7), and texture (4.0±1.5).

Time needed to prepare the combat rations was linked with the fact that they were frozen, thus requiring more time to prepare, as explained by this participant:

> "*Heating rations from frozen requires them to be heated twice: once to thaw them out, and the second time to heat them. This doubles the time to prepare rations compared to temperate Canada. This also requires twice the fuel and removes the stove from heating the tent while it heats rations."* (P44)

While in the Arctic, 60.4% (n=29) of participants were also offered one Light Meal Combat ration (LMC) – snacks that can be eaten in addition to daily meals – for an extra 1000 kcal. Based on the same 13 factors as for the combat rations, participants also had the opportunity to evaluate the snacks. The three highest scores of acceptability on the 7-level Likert scale were weight of LMC (5.8±1.2), ease of preparation (5.3±1.5), and preparation time (5.3±1.5). Fifteen participants provided comments, many of which talked specifically about the jerky and fruit bar being good snack options, but were always frozen, consequently making them difficult to consume, even more so on-the-

move. Others wanted a greater variety of snacks and stated: *"We only received 1 type of LMC with beef jerky and a fruit bar. Both needed to be warmed up or you risked breaking your teeth."* (P3) and *"The LMC is primarily employed as a snack while traversing the ground on snowmobile. Items packed should be easy to consume on-the-move. They need to have the ability to be eaten while frozen."* (P9).

As for meal patterns, the majority of participants ate their combat rations between 4-6:59am (68%), 10am-12:59pm (74%), and 4-6:59pm (79%). LMCs were eaten sporadically throughout the day, reflecting their purpose as snacks between meals and outside of regular mealtimes (26% eaten between 12-3:59am; 23% between 1-3:59pm; 30% between 7-9:59pm).

Participants reported that 61%, 68%, and 71% of breakfast, lunch, and supper rations respectively were eaten. When asked if they were able to heat their ration, 67% (n=32) reported consistently being able to do so, 27% (n=13) occasionally, and 6% (n=3) only rarely.

Participants were asked if they had enough time to eat to which 68% responded *Yes*, 30% *Sometimes*, and 2% *No*. Table 5.2 displays the distribution of responses per meal.

Table 5.2. Perception of having enough time to eat breakfast, lunch, and supper during Arctic military training* (n=47)

Frequency	Breakfast Ration (n) [%]	Lunch Ration (n) [%]	Supper Ration (n) [%]
Yes	32 [68%]	29 [62%]	35 [74%]
Sometimes	15 [32%]	16 [34%]	11 [23%]
No	0 [0%]	2 [4%]	1 [2%]

**Participants were asked "Did you have enough time to eat you rations?"*

When comparing combat ration consumption in the Arctic versus non-Arctic settings, participants reported finding it easier to feed themselves ($p<0.05$) and were more likely able to meet their energy needs in non-Arctic settings ($p<0.05$). This was summarized by a participant, *"Eating rations in a non-Arctic setting is far easier than in the Arctic as there's quicker and more options available to heat the ration. Furthermore, rations can be eaten cold if required in a non-Arctic setting."* (P20)

Fifty-eight percent of participants reported stripping their rations, where items from rations are removed and discarded upon receiving meals. Sixty-seven percent indicated this is something they normally do, regardless of the environment they are working in. Items typically discarded from rations were desserts, breads and cardboard/packaging from rations (Table 5.3). Reasons for stripping rations include reducing weight carried, personal food preferences, frozen items, time-consuming to prepare, and too much water needed to prepare.

Table 5.3. Items discarded from the rations by participants in Arctic military training* (n=48)

Rations Items	Participants (n)
Dessert	12
Bread	6
Cardboard and packaging	4
Condiments	4
Frozen food (e.g. bread, peanut butter, chocolate bar)	3
Tea and coffee	3
Juice	2
Salt and pepper	2
Sugar	2
Jam	1
Main meal	2
Rice	2
Powdered mashed potatoes	1
Cereal	1

Jerky	1
Mint chocolate	1
Everything requiring extra water	1

**48 items were reported by participants*

Seventy-two percent of participants brought food from home for their Arctic training for various reasons: to provide extra energy when needed, to increase the food variety, to ease carrying, because they could be eaten frozen or are not affected by cold temperatures, and/or are perceived as morale boosters (Table 5.4). Sixty-five percent reported normally bringing food from home when deployed or on course. Seventeen percent of participants brought supplements from home for their Arctic training, such as protein supplements (n=10), vitamins (n=5), electrolytes (n=1) and caffeine (n=1).

Table 5.4. Food brought from home in Arctic military training by participants* (n=47)

Food categories	**Participants (n)**
Bars (granola, protein, energy)	22
Trail mix/Nuts/Dried fruit	17
Candy (gum, chocolate, gummies)	13
Meat products (salami, jerky)	11
Coffee	3
Salty snacks (chips, pea crisps)	3
Instant soup	2
Other (hot sauce, energy drink, etc.)	5

**76 items were reported by participants*

Participants commented on combat rations; many suggested developing Arctic-specific rations and expressed concern about the suitability of current rations in Arctic climates. Some recommended using freeze-dried foods to decrease the weight of rations, avoid frozen items, and reduce the preparation time. Two participants explained,

"Canned/foil packets freeze solid and take a considerable amount of fuel energy to defrost and heat. Freeze-dried foods would be a better option for the Arctic" (P9) and *"I believe an Arctic specific ration is required. IMP's [rations] are for operations in moderate climates."* (P14).

5.5. Discussion

This study sought to determine the perception of CAF members about factors influencing their dietary intake in order to better understand the main barriers to combat ration preparation and consumption in extreme environments like the Canadian Arctic.

The majority of participants reported being hungry, either between meals or during the night. This could be caused by participants not consuming all items provided at each meal, and stripping combat rations. Previous studies have demonstrated this to be a common behaviour amongst military members, where rations are opened for select items to be chosen and eliminated [9,20]. Hatton (2005) estimated that up to 1367 kcal/day are discarded, representing approximately 38% of food provided by daily rations not consumed to provide the necessary energy to sustain continued activities. Other studies in cold-weather operations reported only 51-78% of rations being eaten [2,13], which is comparable to self-reported intake in this study.

A possible consequence of this behaviour is unintended weight loss [21]. Although we did not measure weight change, the majority of participants perceived losing weight, and as much as 11.3 kg. Weight changes can be attributed to a lower food intake and a higher energy expenditure during the training [4,22]. A poor nutritional

status can lead to physical and cognitive impairments such as fatigue, reduced morale, hormonal imbalance, decrease in skeletal mass, and increased risk of injury such as stress fractures with weight loses of 3-5% in <48 hours, or >10% over ≥4 weeks [4,7,9,13,23,24]. More research is needed to measure the energy expenditure of military working in extreme cold-weather environments to then better assess their energy requirements during such activities.

The factors that negatively affected dietary intake of combat rations the least were previous military use of rations, eating with a group, and previous military education on how to use rations in the Arctic. These are indicators of the simplicity of preparing rations, hence requiring little cooking skills and education about their use in the field. The complexity stems rather from the environment (i.e. the Arctic) since the rations were frozen, thus requiring more time for preparation [9,21]. In fact, participants noted the weather/environmental conditions as a factor having a great impact on dietary intake, as well as the equipment required for food preparation/consumption. Since rations are frozen, equipment like pressure cookers are essential to heat food, in comparison to temperate climates where rations could be eaten cold or room temperature. Consequently, preparing and consuming rations in the Arctic is harder than non-Arctic environments, as indicated by participants. Therefore, the environment played a role in dietary intake and eating practices. Similarly, other extreme environments such as elevated heat or high altitude come with their challenges as well, but remain uniquely different from the Arctic [2].

A common reason given to explain a low dietary intake in the military is insufficient time to prepare and eat rations [13]. Intense trainings, condensed schedules,

and operation demands can shorten mealtimes [13,25]. In the Arctic, the only way one can eat a meal while working in this environment is with dedicated time towards meal preparation and consumption since the combat rations are frozen and need to be thawed out. However, in this study, allotted time for meals did not seem to be a factor limiting dietary intake for the majority of participants. Other factors could therefore influence their dietary intake [3]. This being said, eating on-the-move was greatly affected in cold-weather activities, as participants reported [2,9].

Several participants suggested changing the combat rations to freeze-dried foods. It would be good, in future research, to explore this option and ask military members if they can foresee this as a feasible option. In fact, other countries (e.g. United States, Netherlands, and Norway) have developed combat rations specifically for cold environments, all of which include freeze-dried items [3]. Pros and cons of cold-weather rations from other countries should be taken into consideration in the design of Canadian rations. However, they may not all be transferable given that the CAF works in far more northern communities than other countries.

This study has some limitations: dietary intake and body weight were not measured. Sample size does not allow extrapolating these results to the entire CAF. Also, participants included individuals from trainings over the course of several years. Lived experiences could have varied based on the activities and schedule as well as combat rations offered, therefore overlooking inconsistencies from one training to another. However, this allows results to better capture the overall experiences of military working in the same extreme environment. As changes to the combat rations are constantly being implemented by CAF National Combat Ration Program, some feedback and comments

by participants may have already been applied. Nonetheless, this can help confirm and reinforce the changes already implemented.

It is worth noting that data including weight changes are self-reported. However, it points to the need to measure weight changes over time in future studies to verify accuracy and extent of weight changes in order to make appropriate recommendations. Additionally, it would be beneficial to further study CAF members' perception and report their experience in using rations in the Arctic.

Indeed, the combined effect of certain factors could contribute to reducing the dietary intake of soldiers. Working in the Arctic comes with unique challenges that are different from other environments and need to be addressed. Results from this study confirm that there is a variety of factors that influence the dietary intake and eating practices of military members. Knowing that, this study can guide future research and help pinpoint what specific factors need to be further studied to inform upcoming decision-making about combat rations.

5.6. Relevance to practice

Our findings highlight the plurality of factors at play in regards to feeding with combat rations in an extreme environment in the military. Also, this topic has been under-documented in the Canadian literature and is of great relevance to dietitians since they have the expertise and knowledge necessary to develop menus and food items suitable for this unique population based on the complexity of factors affecting intake.

5.7. References

1. Lajeunesse A. The Canadian Armed Forces in the Arctic: Purpose, capabilities, and requirements [Internet]. 2015 [cited 2019 Jul 11]. Available from: http://www.deslibris.ca/ID/247838

2. Mandic I, Jacobs I. Field-feeding for CF land military operations: Basis guidelines for standard and incremental allowances for food service providers. Defence Research and Development Canada; 2013. Report No.: DRDC Toronto CR 2013-104.

3. NATO Research and Technology Organisation. Nutrition science and food standards for military operations [Internet]. 2010 [cited 2019 Jul 11]. Report No.: RTO-TR-HFM-154. Available from: https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf

4. Henning PC, Park B-S, Kim J-S. Physiological decrements during sustained military operational stress. Mil Med. 2011 Sep;176(9):991–7.

5. Teo L, Crawford C, Yehuda R, Jaghab D, Bingham JJ, Gallon MD, O'Connell ML, Chittum HK, Arzola SM, Berry K. Whole dietary patterns to optimize cognitive function for military mission-readiness: a systematic review and recommendations for the field. Nutr Rev. 2017 Jun;75(suppl_2):73–88.

6. Edwards JSA, Askew WE, King N. Rations in cold Arctic environments: recent American military experiences. Wilderness Environ Med. 1995 Nov;6(4):407–22.

7. Franchini E, Brito CJ, Artioli GG. Weight loss in combat sports: physiological, psychological and performance effects. J Int Soc Sports Nutr [Internet]. 2012 Dec [cited 2019 Jul 13];9(1). Available from: https://jissn.biomedcentral.com/articles/10.1186/1550-2783-9-52

8. Castellani JW, Spitz MG, Karis AJ, Martini S, Young AJ, Margolis LM, Phillip Karl J, Murphy NE, Xu X, Montain SJ, Bohn JA, Teien HK, Stenberg PH, Gundersen Y, Pasiakos SM. Cardiovascular and thermal strain during 3–4 days of a metabolically demanding cold-weather military operation. Extreme Physiol Med [Internet]. 2017 Dec [cited 2019 Jul 10];6(1). Available from: http://extremephysiolmed.biomedcentral.com/articles/10.1186/s13728-017-0056-6

9. Goodman L, Sullivan-Kwantes W, Blais A-R. Observations and Survey Results of Army Field Feeding in the Arctic; Arctic Field Feeding Logistics and Effectiveness [Internet]. Defence Research and Development Canada; 2015 [cited 2019 Jun 30]. Report No.: DRDC-RDDC-2015-R289. Available from: https://www.researchgate.net/publication/318276583_Observations_and_Survey_Results_of_Army_Field_Feeding_in_the_Arctic_Arctic_Field_Feeding_Logistics_and_Effectiveness

10. Environment and Climate Change Canada. Daily Data Report for January 2019 [Internet]. 2019 [cited 2019 Jul 13]. Available from: http://climate.weather.gc.ca/climate_data/daily_data_e.html?StationID=53060&timeframe=2&StartYear=1840&EndYear=2019&Day=10&Year=2019&Month=1#

11. Ahmed M. Assessments of Dietary Intakes of Canadian Armed Forces Consuming Field Rations [doctoral thesis]. [Toronto, ON]: University of Toronto; 2017.

12. Jones PJ, Jacobs I, Morris A, Ducharme MB. Adequacy of food rations in soldiers during an arctic exercise measured by doubly labeled water. J Appl Physiol. 1993 Oct;75(4):1790–7.

13. Marriott BM, editor. Not eating enough: Overcoming underconsumption of military operational rations [Internet]. Committee on Military Nutrition Research, Institute of Medicine. Washington, DC: National Academy Press; 1995 [cited 2019 Jul 11]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/25121269

14. Sullivan-Kwantes W, Fung J. Health protection factors during Arctic Operations: Key findings to date. Defence Research and Development Canada; 2018. Report No.: DRDC-RDDC-2018-D127.

15. Carins J, Tennant ML. Influences on the consumption of Australian Ration Packs: Review of a contextual model and application to Australian Defence Force data. Australia: Defence Science and Technology Organisation, Australian Government; 2011 p. 71.

16. Marriott BM, Carlson SJ, editors. Nutritional needs in cold and in high-altitude environments: Applications for military personnel in field operations. Committee on Military Nutrition Research, Institute of Medicine. Washington, D.C.: National Academy Press; 1996.

17. Fortin M-F. Fondements et étapes du processus de recherche. Les Éditions de la Chenelière. Montreal; 2006. 485 p.

18. O'Leary Z. The essential guide to doing research. SAGE Publications Ltd. London; 2004. 226 p.

19. Golafshani N. Understanding Reliability and Validity in Qualitative Research. Qual Rep. 2003;8(4):597–606.

20. Hatton P. Food and beverage consumption of Canadian Forces soldiers in an operational setting: Is their nutrient intake adequate?. [Montreal]: McGill University; 2005.

21. King N, Mutter SH, Roberts DE, Sutherland MR, Askew EW. Cold weather field evaluation of the 18-Man Arctic Tray Pack Ration Module, the Meal, Ready-to-Eat, and the Long Life Ration Packet. Mil Med. 1993 Jul 1;158(7):458–65.

22. Hirsch ES, Matthew Kramer F, Meiselman HL. Effects of food attributes and feeding environment on acceptance, consumption and body weight: lessons learned in a twenty-year program of military ration research. Appetite. 2005 Feb;44(1):33–45.

23. Hodgdon J, Hesslink RL, Hackney A, Vickers R, Hilbert R. Norwegian military field exercises in the Arctic: cognitive and physical performance. Arctic Med Res. 1991;50 Suppl(6):132–6.

24. Montain SJ, Young AJ. Diet and physical performance. Appetite. 2003 Jun;40(3):255–67.

25. Jackson TK, Cable SJ, Jin WK, Robinson A, Dennis SD, Vo LT, Prosser TJ, Rawlings JA. The importance of leadership in soldier's nutritional behaviors: Results from the Soldier Fueling Initiative program evaluation. US Army Med Dep J. 2013;79–90.

CHAPTER 6. ARTICLE 2 – ENERGY INTAKE, WEIGHT, AND BODY COMPOSITION OF CANADIAN SOLDIERS PARTICIPATING IN AN ARCTIC TRAINING COURSE

Authors:

Florence V. Lavergne[1-2]

Raphaëlle Laroche-Nantel[3]

Denis Prud'homme[2]

Isabelle Giroux[2-3]

[1] *Interdisciplinary School of Health Sciences, Faculty of Health Sciences, University of Ottawa (ON)*

[2] *Institut du Savoir Montfort, Ottawa (ON)*

[3] *School of Nutrition Sciences, Faculty of Health Sciences, University of Ottawa (ON)*

Acknowledgements:

The authors wish to thank the soldiers who participated in this study, the Canadian Armed Forces Strat J4 Foodservices for their support and cooperation in this study, especially LCdr Lynda Hinch (RD), as well as research assistants, especially Karine Brousseau.

6.1. Abstract

Introduction: It has been reported that military training in an extreme environment increases the risk of weight loss, which could affect soldiers' performance. Thus, the purpose of this study is to assess the daily energy intake and requirements of Canadian Armed Forces (CAF) soldiers consuming combat rations over an 8-week military course in the Arctic and to document the impacts on weight and body composition.

Methods: Body weight was measured with a digital scale at the beginning, middle and end of the course. Energy intake was measured using a 24-hour food diary at mid-course. Body composition measurements (fat mass (FM) and fat-free mass (FFM)) were obtained at beginning and end of the course using hand-to-foot bioelectrical impedance analysis. Energy requirements were estimated using a predictive equation developed for a military population.

Results: Fourteen CAF soldiers out of 24 completed the study. A weight loss was measured from the beginning to mid-course after consumption of combat rations for a week, with 12 participants losing 3.5% body weight (p=0.001). During that period, soldiers' energy intake was 2799±835 kcal/day in comparison to estimated energy requirements of 5577±681 kcal/day, resulting in an energy deficit of 49.8±19.2%. In the remaining three weeks of the course, all participants gained weight (2.6±1.4 kg) while they ate at the dining facility. No differences were seen in body weight, FM and FFM when comparing beginning and end of the course.

Conclusions: Soldiers' body weight significantly decreased after field training in the Arctic, during which combat rations were provided. Energy intake was significantly

lower than estimated energy requirements. More research is needed to explore ways to make combat rations better adapted for this climate in order to reduce energy deficit and maintain body weight of soldiers during training in an extreme environment.

***Keywords**: Army, Military, Arctic, Ration, Dietary Intake, Body Composition*

6.2. Introduction

The Canadian Armed Forces (CAF) are responsible for protecting and defending our country as well as supporting international military and humanitarian operations. Military members are expected to maintain a good health and fitness status in order to carry out missions and meet physical demands.[1] It has been reported that a suboptimal health and fitness status can impede on soldier performance.[2–4] Keeping in mind military personnel generally have higher energy needs during training and deployments than the general population, meeting energy requirements is crucial for optimal performance.[1,5] These energy requirements are influenced by the environment in which military members work. From a physiological standpoint, extreme climates are more demanding.[6] In fact, in cold environments, the energy requirements are elevated due to heavy clothing and equipment, difficulty to move around and travel on snow-covered terrain, and additional energy spent to maintain body temperature.[1] Indeed, the CAF is present across Canada, including the Arctic. Their responsibilities in northern Canada revolve around defending sovereignty and ensuring security of the region.[7] Thus, military trainings take place every year in the Arctic to familiarize soldiers and train them adequately to conduct cold-weather operations.[7,8]

However, working in extreme environments comes with its set of challenges, and they differ from other, more temperate, regions. In the High-Arctic (above the Arctic Circle, 66.5° north latitude), where the mean winter temperature are below -30°C, travelling, communication, and the overall equipment require special attention.[9,10] Additional precautions for all activities need to be taken in these extreme conditions in order to minimize risk of incidents and injury.[11]

As for feeding in the military, combat rations (Individual Meal Pack; IMP) are provided to soldiers when fresh-feeding is not feasible. These meals are pre-packed and ready-to-use, each providing an average of 1600 kcal, for a daily total of at least 4800 kcal.[12] In situations where soldiers might not reach their energy needs with three IMPs, additional snacks are given, called Light Meal Combat rations (LMC, 1000 kcal). However, underconsumption of combat rations is very common in the military population, for various reasons such as lack of time to eat, limited variety of meals, and personal food preferences.[5,13] (Lavergne, F.V., Prud'homme, D., Giroux, I., in preparation) Consequently, soldiers may not meet their energy needs.[8,14] Over a prolonged period of time, this can lead to weight loss and an increased risk of physical and cognitive performance decrements.[15] Thus, documenting the energy intake and tracking physical changes, such as body weight and composition, of soldiers during training in the Arctic are key to formulating appropriate recommendations for this population.

The aim of this study was to assess the daily energy intake and requirements of CAF soldiers consuming combat rations over an 8-week military course in the Arctic and to document the impacts on weight and body composition.

6.3. Materials and methods

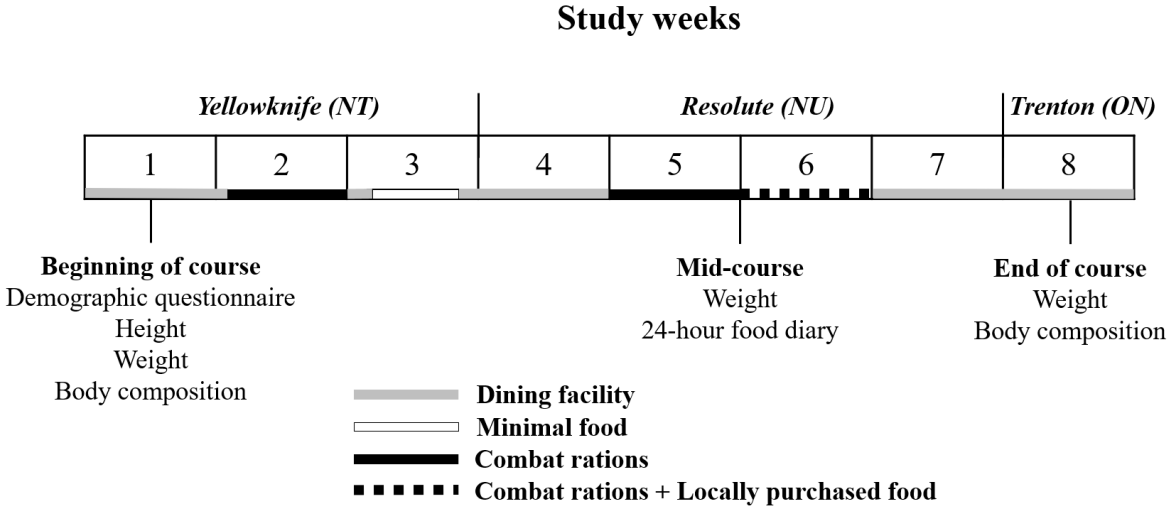
Study participants and setting

With permission from the CAF, we recruited military members participating in an 8-week Arctic Operations Advisor (AOA) course between January and March 2019. All trainees and course instructors were eligible to participate. This course aimed to equip

individuals with the necessary knowledge and training to advise their commander about organization, planning, and coordination of operations in cold-weather environments. The AOA course started in Yellowknife (NT) for three weeks of introductory activities, and preparation for the remainder of the course (Figure 1). The following four weeks were in the High-Arctic, mainly at the CAF Arctic Training Centre in Resolute (NU), as well as smaller surrounding communities (low -39°C to high -22°C, without windchill). The course provided familiarization with the Arctic conditions through training on use of communication technology, acquaintance with equipment and clothing, mobility skills, and field training including survival without a tent. The final few days of the AOA course were in Trenton (ON). This study did not alter the AOA course program.

During the course, the group of participants either consumed combat rations (three IMPs and one LMC per day) or meals at the dining facility and locally purchased food (Figure 6.1). The course started in Yellowknife, and included one week of field-training (week 2) with combat rations (6 days), then survival (week 3) with minimal food, such as a fish (3 days). Another similar week-long field-training (week 5) happened near Resolute where participants relied on combat rations as energy source.

Figure 6.1. Study design for the 8-week military Arctic course



Activities during week 5 included a 5 km walk to the training site and back, wearing Arctic-appropriate clothing and equipment (~13 kg), carrying rucksacks (~35 kg) and pulling heavy toboggans (~100 kg). On-site activities included building various snow shelters (i.e. igloos, snow caves) during 6-8 hours/day in which they slept.

Anthropometrics and body composition

After informed written consent was obtained, data were collected at three different points of the course: at the beginning, at the end of week 5 (mid-course), and at the end. Two research dietitians travelled to Yellowknife for the start of the course to recruit study participants. Participants completed a short questionnaire collecting demographic information. Height was measured in duplicates to the nearest 0.1 cm using a stadiometer (PortStad), and body weight was measured to the nearest 0.1 kg with a calibrated digital scale. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Weight was measured at the beginning, middle and end of the course. Hydration

status (i.e. total body water) and body composition (i.e. fat mass (FM) and fat-free mass (FFM)) were measured using hand-to-foot bioelectrical impedance analysis (Tanita BC-418). FM and FFM were measured at the beginning and end of the course for different body compartments (left and right arms, and left and right legs, and torso), and for the total body. The "athlete" setting on the body composition analyzer was selected for body composition measurements, corresponding to individuals who do at least 10 hours/week of intense physical activity or individuals who have been fit for years but currently exercise less than 10 hours/week.[16]

After the completion of the military course, participants who completed the study received a copy of their individual measurements and a nutrition education booklet (*Combat Rations for Top Performance Field Handbook*) developed by the CAF Strat J4 Food Services.

Energy intake

Energy intake was measured using a 24-hour food diary of a typical day, completed at the end of week 5 of the course. Bilingual food diary forms were created, adapted from others made by the CAF Strat J4 Food Services or used in a previous study.[17] Food diaries had a designated section for each IMP meal and LMC. A list of combat ration components per meal (e.g. main entrée, bread, dessert, condiments) was given in each section in order to facilitate data entry for participants by limiting risks of participants' forgetting items. Furthermore, participants were instructed to write specific items eaten next to the pre-established categories. They were also asked to add any items they consumed that were not listed (i.e. food brought from home). Next to each item,

participants wrote the percentage that represented the amount consumed. Food diaries were completed in Resolute then verified by a dietitian with participants during a post course interview. Once verified, the energy intake from the 24-hour food diaries was analyzed using the nutritional information for Canadian combat rations, provided by the CAF Strat J4 Food Services.

During week 2 (Yellowknife), there was a condensed schedule and heavy workload which resulted in little time to eat. On the other hand, more time was provided for mealtime in week 5.

Energy requirements

Total daily energy requirements were estimated using the following predictive equation recently developed by Barringer et al.[18] specifically for military personnel:

$$\text{Energy requirements (kcal/d)} = [61.99 \times \text{FFM (kg)}] + [716.49 \times \text{PAF}] - 721.30$$

FFM at baseline was used, with a physical activity factor (PAF) of 2.41 (moderate-high) after comparing the reported detailed daily activity schedule of the course to physical activity levels described in the Barringer et al. study.[18]

Statistical analysis

Paired *t* tests were used to determine differences in weight and body composition (beginning vs. end of course). Repeated measures ANOVA and Sidak post-hoc test were used to measure changes over time in weight (beginning vs middle vs end of course).

Statistical significance was reached at $p<0.05$, and data are presented as means ± standard deviation (SD) and ranges. Data were compiled, verified and analyzed in Microsoft Excel (Office 2010, Microsoft inc., Redmond, Washington) and IBM SPSS Statistics (version 25.0. IBM Corp., Armonk, NY, USA).

Ethics approval

This study was approved by the Research Ethics Board of the University of Ottawa.

6.4. Results

Study participants

Twenty-four participants initially started the study. Ten dropped out due to staying in Resolute after the course or not completing the course. Fourteen CAF military members based out of 6 provinces completed all parts of the study (males; age: 31±5.5 years). Although instructors were eligible, only course attendees participated. On average, participants had 10.5±2.8 (range: 7-16) years of experience in the CAF. Half of participants had previous experience in the Arctic, having gone one to three times. No differences were noted between both subgroups.

Anthropometrics and body composition

At the beginning of the course, the average height of participants was 175.5±6.9 cm, and the average weight was 96.4±22.4 kg (range: 70.2-130.7 kg). Their BMI was 30.8±6.8 kg/m^2. The mid-point weight measurement in Resolute was 93.2±19.6 kg (range: 68.4-122.8 kg), resulting in an average decrease of 3.2±3.3 kg, or 2.8% (range:

weight gain of 2.0 to weight loss of 7.7%) for all participants. Twelve participants lost weight: 3.9±3.0 kg (range: 0.6-9.5 kg, p=0.001), equivalent to 3.5% (range: 0.8-7.7%). Two participants gained weight (0.3 and 1.8 kg). At the end of the course in Trenton, the average weight of participants was 95.8±19.7 kg (range: 69.1-125.0 kg). This weight was significantly different from the mid-point weight, resulting in a weight gain for all participants after they returned to fresh feeding (2.6±1.4 kg; range: 0.3-4.9 kg) (Supplemental figure 6.2). Figure 6.3 shows the individual weight changes throughout the course. However, when comparing the weight at the beginning of the course with the weight at the end of the course, no change was observed (p=0.61).

Supplementary Figure 6.2. Body weight changes (Δ) of Canadian Armed Forces soldiers during the first and second part of the Arctic course (n=14)

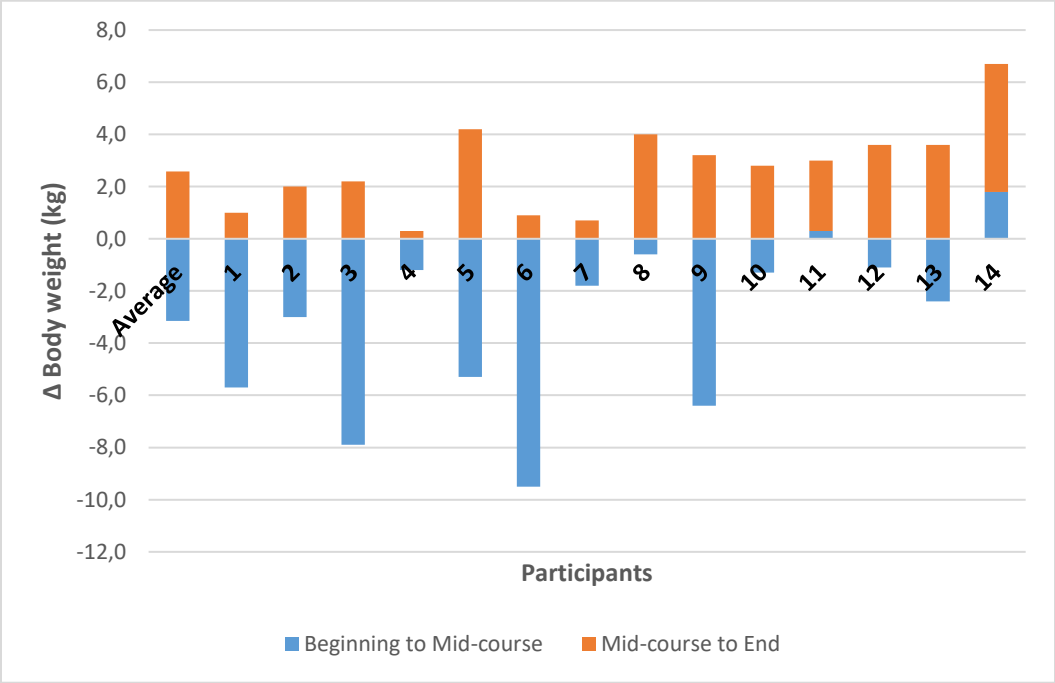
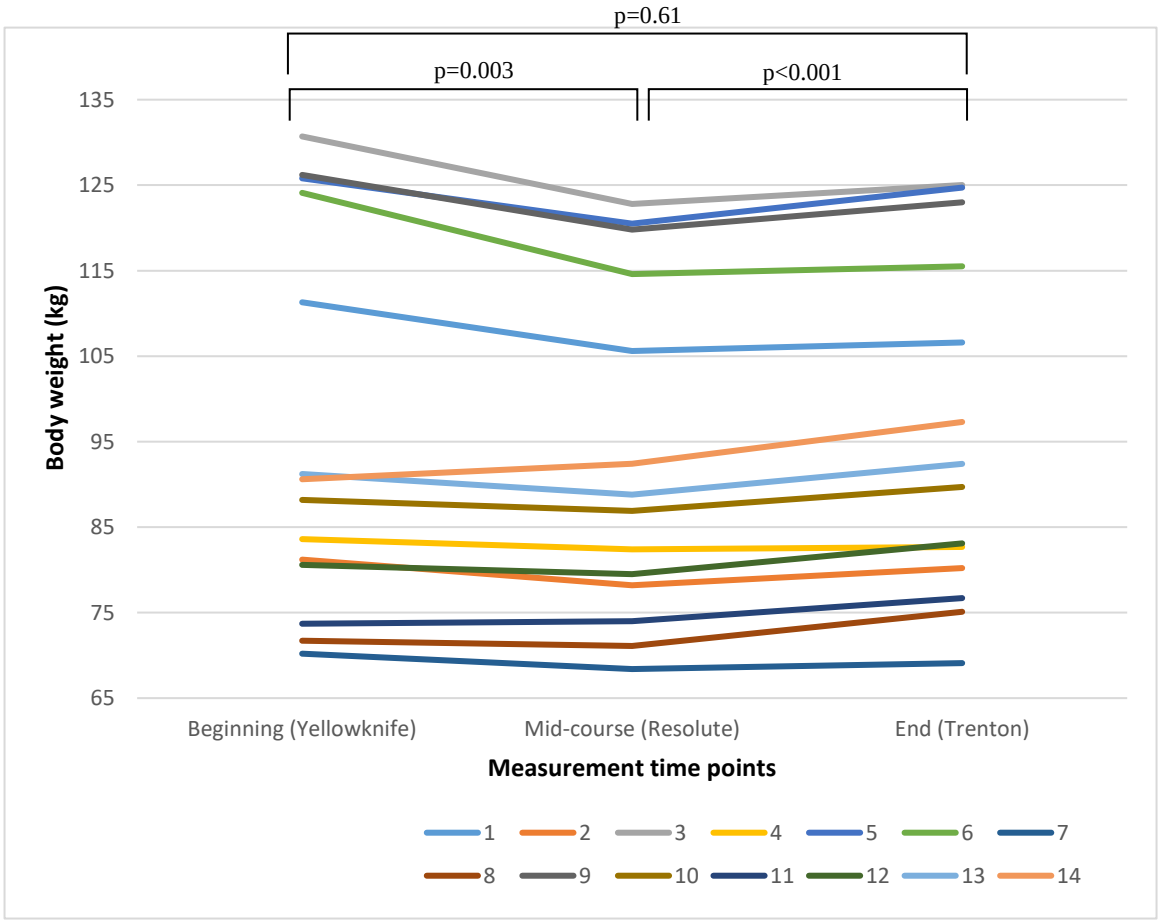


Figure 6.3. Changes in body weight of Canadian Armed Forces soldiers at different time points during the Arctic course (n=14)



Hydration status was measured at the beginning and end of the course, with an average total body water of 58% at both time points. No significant difference was found for FM and FFM between the beginning and end of the course for total body and each body compartment (Supplemental Table 6.1).

Supplemental Table 6.1. Total and compartment fat mass and fat-free mass of Canadian Armed Forces soldiers at the beginning and end of the Arctic course (n=14)

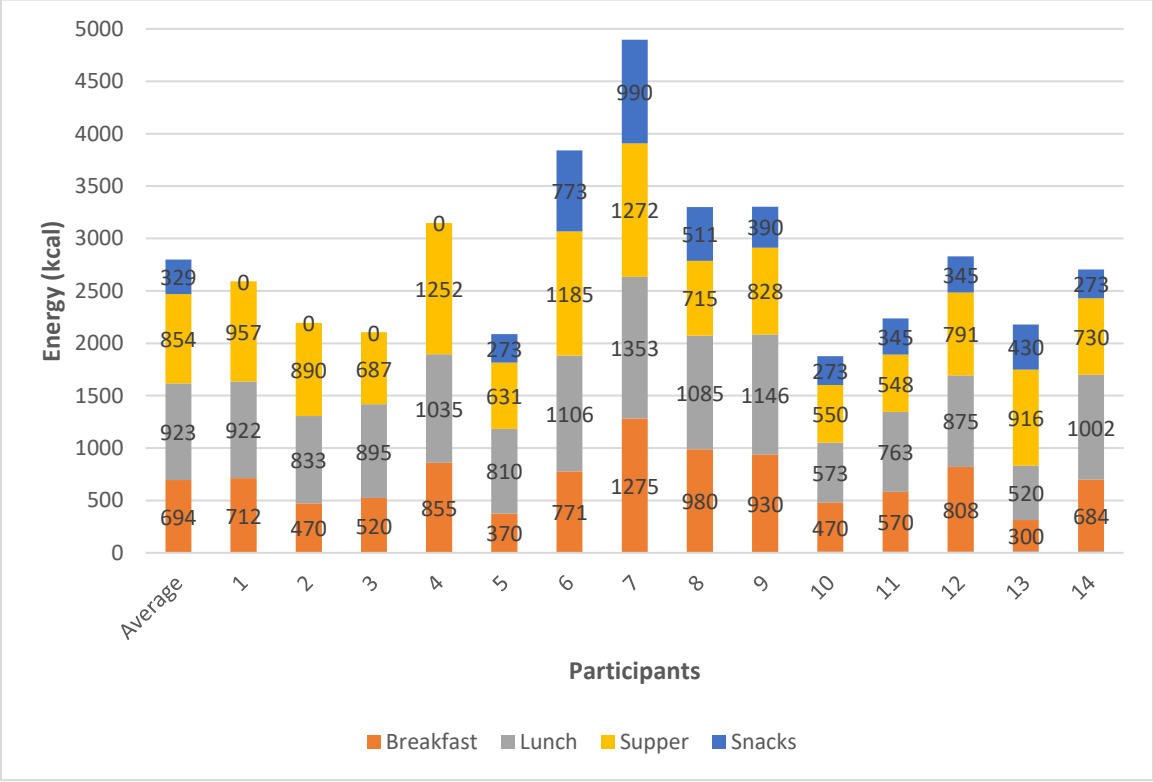
	FM (kg)		FFM (kg)	
	Beginning	End	Beginning	End
Limbs	2.2 ± 1.9	2.1 ± 1.7	9.0 ± 4.6	9.0 ± 4.5
Trunk	12.4 ± 6.7	11.8 ± 6.3	37.9 ± 4.3	38.3 ± 4.1
Total body	21.2 ± 11.7	20.3 ± 10.8	73.8 ± 11.0	74.3 ± 9.8

Data are presented as mean ± SD; FM = Fat mass; FFM = Fat-free mass
Measurements for limbs include right and left arms and legs.

Energy intake

On average, CAF members consumed 2799±835 kcal/day, ranging from 1866 to 4890 kcal/d (Figure 6.4).

Figure 6.4. Distribution of energy intake between meals and snacks of each participant for one day during an Arctic course (n=14)



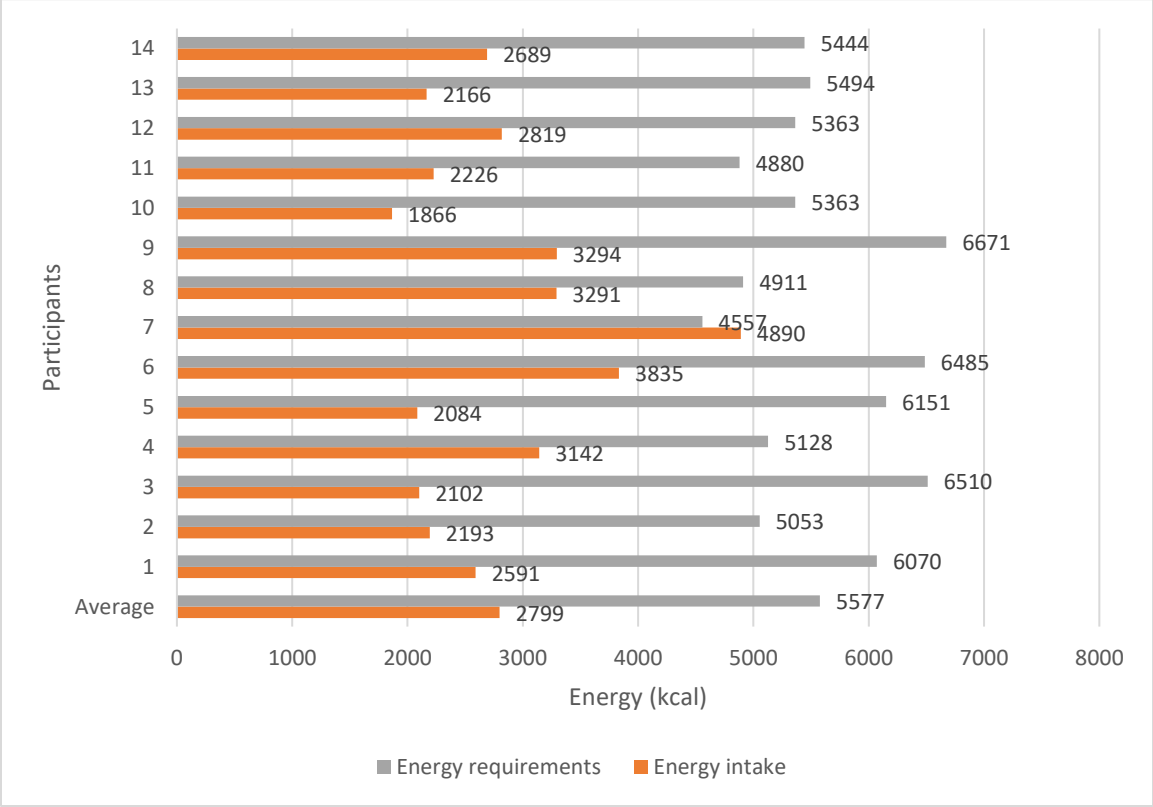
Energy intake was distributed throughout the day: 25±5% at breakfast, 33±5% at lunch, 30±6% at supper, and 12±8% with snacks. The snacks were foods eaten outside of mealtimes, thus including LMCs and other items brought from home. Most CAF members (n=10) consumed LMCs. Five participants brought food with them from home, increasing their intake by 8 to 530 kcal/day.

Results from this study show that only the main entrée was consumed by every CAF member of the group at all meals. From the other categories available, the chocolate bars were the most frequently consumed, with 93% of participants eating this item at lunch and 86% eating one at supper. The chocolate bar was not available in the breakfast menu IMPs. The next most frequently consumed item was sports drinks, with 71%, 64% and 43% of participants consuming it at breakfast, lunch and supper, respectively. As for snacks, fruit bars were the most popular item from the LMCs, with 71% of participants eating it, followed by beef jerky (43%) and coffee (36%).

Energy requirements

Total daily energy requirements were established at 5577±681 kcal/day (range: 4557-6671 kcal/day), thus resulting in an average energy deficit of 2778 kcal/day (range: energy surplus of 333 to energy deficit of 4408 kcal/day), representing 49.8±19.2%. The participant with the lowest estimated energy requirements was the only individual whose intake exceeded his requirements (Figure 6.5). There was a tendency for a positive correlation between energy deficit and weight loss (r^2=0.264, p=0.06).

Figure 6.5. Energy intake in comparison to estimated energy requirements of Canadian Armed Forces soldiers during the Arctic course for a day (n=14)



6.5. Discussion

An important finding of this longitudinal observational study is a significant weight loss of 3.5% (range: 0.8-7.7%) observed in 86% (n=12) of participants at course mid-point, after participants consumed combat rations during a week of field-training where they worked continuously for several hours per day in very cold temperatures. They also had combat rations during a previous week in Yellowknife, followed by minimal food then dining facility access (see Figure 6.1). It is worth noting that a weight loss of <3% over 7-30 days has minimal health effects, and that one >3% but <10% is

unlikely to affect performance.[12,19–21] However, some participants lost as much as 7.7% of their body weight, which is near the 10% threshold over ≥4 weeks established as leading to health and performance decrements, such as increased fatigue, confusion, risk of injury and decreased immune function, as seen in athlete and military populations.[5,15,19,22] A systematic review on body weight and composition changes of military personnel consuming combat rations stated that the most pronounced weight losses were seen during cold-weather trainings: 5.6% over 20 days, and 6.3% over 30 days.[19] Consequently, a weight decrease as seen in this study could become problematic, especially if continued over a longer period of time. In fact, there are times when soldiers are on rations for extended periods of time, particularly deployments. In future studies, it would be beneficial to evaluate performance by measuring the impact of weight loss on various military task performance indicators.

Once that part of the course that required utilization of combat ration feeding was completed, all participants gained weight in the remaining three weeks, during which they had access to the dining facility and commercial foods. Comparison of body weights at beginning and end of the course were similar, indicating participants were able to regain the weight lost during the course while on combat rations. Likewise, their FM and FFM were comparable at the beginning and end of the course.

When comparing energy intake and requirements, we estimated a substantial daily energy deficit of nearly 50% for soldiers while on combat rations during field training in the Arctic, likely contributing to the measured weight changes. A study with 21 Norwegian male soldiers participating in a 1-week winter training obtained similar results, where energy deficit was measured at 49%.[6] In that study, energy expenditure

was measured using doubly labelled water, and varied between 5480 and 6851 kcal/day during the two phases of the training respectively. Another study during a cold-weather field training with Canadian soldiers observed an energy deficit of 2889 kcal/day, also measured using doubly labelled water, in comparison to 2778 kcal/day in the current study.[25] Furthermore, if soldiers in the present study ate everything provided (three IMPs ≈ 4800 kcal, one LMC ≈ 1000 kcal), they would have reached the estimated total daily energy requirements (5577 kcal/day).

This being said, the malnutrition screening tool developed by the Canadian Malnutrition Task Force[26] would assess some participants as being at risk of malnutrition since many reached both malnutrition indicators: unintended weight loss and reduced dietary intake. Therefore, further necessary precautions should be taken to prevent soldiers from facing negative health effects from inadequate feeding during prolonged work in the Arctic.

In fact, Goodman et al.[8] reported that 74% of soldiers indicated skipping lunch during an Arctic training. On the contrary, in the present study, the meal providing the most energy was lunch (31%). This suggests that mid-day mealtime may not have been skipped, and might reflect the ability to consume food during dedicated time for lunch in this Arctic course. Also, during the AOA course, soldiers were offered LMCs, providing up to 1000 kcal. Not all trainings offer LMCs in addition to IMPs; this is done when it is suspected energy needs might not be reached with IMPs alone and/or when it is it requested. Considering energy intake was below energy requirements in all but one participant, it reinforces the need to offer LMCs since they provided 16% of daily energy intake and were consumed by the majority of participants. In another study, additional

snacks (~1000 kcal) were also provided to soldiers, and once again, their intake was below requirements but higher than the control group not provided with snacks.[14] With the LMCs, only select items were eaten, suggesting different choices could be offered in the hopes of increasing soldiers' intake with snacks that are more acceptable to them and operationally suitable. Further research could elicit this, and help understand the reasons for reported underconsumption of combat rations during Arctic training.

Although weight was measured at mid-point, we were unable to measure body composition at that time due to logistical constraints in bringing the equipment to the Resolute training site. As such, we cannot indicate which body compartment was most affected by weight loss from the beginning to mid-course, while on combat rations. Although measuring body composition via bioelectrical impedance analysis has its limits, a consistent hydration status was maintained at both measurement points, falling within acceptable range of 50-65% of body weight for men, thus increasing reliability.[16,27] Also, energy expenditure was not measured. However, the equation used to estimate total daily energy requirements was specifically developed for a military population and generated results comparable to energy expenditure measured using doubly labelled water.[18]

In addition, another limitation was various types of feeding regimen throughout the course. More frequent (i.e. weekly) measurements of body weight and composition would have helped document more clearly the effect of rations on these measurements.

By measuring energy intake with food diaries, we were able to measure the distribution of energy intake throughout the day. Using a daily food waste collection method and having the food content subsequently analyzed may provide a precise estimate of intake, but fails to show when food consumption occurs throughout the

day.[6,28] Even though food diaries were completed for one day, participants reported the food diary represented their usual intake of combat rations during the course, and was verified with a dietitian. Since combat rations are standardized meals, precise nutritional information for each item was available from the CAF Food Services, reducing the errors associated with estimating the energy from each food, thus increasing precision.

From this study, we can conclude that body weight of participants decreased after consumption of combat rations while in field training in the Arctic for two weeks, when energy intake was significantly lower than estimated energy requirements. However, participants regained weight by the end of the course when they had access to fresh feeding. As for body composition (FM and FFM), no changes were noted between the beginning and end of the course. These findings highlight the challenges in adequately feeding soldiers with combat rations in extreme climates. More research is needed to explore ways to mitigate this problem. Results from this study can be taken into consideration in the development of combat rations better suited for military training in the Arctic to reduce energy deficit and promote optimal energy intake.

6.6. References

1. Tharion WJ, Lieberman HR, Montain SJ, et al. Energy requirements of military personnel. *Appetite*. 2005;44(1):47-65. doi:10.1016/j.appet.2003.11.010

2. Marriott BM, Carlson SJ, eds. *Nutritional Needs in Cold and in High-Altitude Environments: Applications for Military Personnel in Field Operations*. Committee on Military Nutrition Research, Institute of Medicine. Washington, D.C.: National Academy Press; 1996.

3. Edwards JSA, Askew WE, King N. Rations in cold Arctic environments: recent American military experiences. *Wilderness & Environmental Medicine*. 1995;6(4):407-422. doi:10.1580/1080-6032(1995)006[0407:RICAER]2.3.CO;2

4. Montain SJ, Young AJ. Diet and physical performance. *Appetite*. 2003;40(3):255-267. doi:10.1016/S0195-6663(03)00011-4

5. Marriott BM, ed. *Not Eating Enough: Overcoming Underconsumption of Military Operational Rations*. Committee on Military Nutrition Research, Institute of Medicine. Washington, DC: National Academy Press; 1995. https://www.ncbi.nlm.nih.gov/pubmed/25121269. Accessed July 11, 2019.

6. Margolis LM, Murphy NE, Martini S, et al. Effects of winter military training on energy balance, whole-body protein balance, muscle damage, soreness, and physical performance. *Appl Physiol Nutr Metab*. 2014;39(12):1395-1401. doi:10.1139/apnm-2014-0212

7. Lajeunesse A. *The Canadian Armed Forces in the Arctic: Purpose, Capabilities, and Requirements*.; 2015. http://www.deslibris.ca/ID/247838. Accessed July 11, 2019.

8. Goodman L, Sullivan-Kwantes W, Blais A-R. *Observations and Survey Results of Army Field Feeding in the Arctic; Arctic Field Feeding Logistics and Effectiveness*. Defence Research and Development Canada; 2015. https://www.researchgate.net/publication/318276583_Observations_and_Survey_Results_of_Army_Field_Feeding_in_the_Arctic_Arctic_Field_Feeding_Logistics_and_Effectiveness. Accessed June 30, 2019.

9. Environment and Climate Change Canada. Daily Data Report for January 2019. http://climate.weather.gc.ca/climate_data/daily_data_e.html?StationID=53060&ti

meframe=2&StartYear=1840&EndYear=2019&Day=10&Year=2019&Month=1#. Published June 11, 2019. Accessed July 13, 2019.

10. Lackenbauer PW, Lajeunesse A. The Canadian Armed Forces in the Arctic: Building Appropriate Capabilities. *Journal of military and strategic studies*. 2016;16(4):60.

11. Sullivan-Kwantes W, Fung J. *Health Protection Factors during Arctic Operations: Key Findings to Date*. Toronto ON, Canada: Defence Research and Development Canada; 2018:17.

12. Mandic I, Jacobs I. *Field-Feeding for CF Land Military Operations: Basis of Guidelines for Standard and Incremental Allowances for Food Service Providers*. Toronto: Defence R&D Canada; 2013:89.

13. NATO Research and Technology Organisation. *Nutrition Science and Food Standards for Military Operations*.; 2010. https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf. Accessed July 11, 2019.

14. Margolis LM, Murphy NE, Martini S, et al. Effects of Supplemental Energy on Protein Balance during 4-d Arctic Military Training: *Medicine & Science in Sports & Exercise*. 2016;48(8):1604-1612. doi:10.1249/MSS.0000000000000944

15. Henning PC, Park B-S, Kim J-S. Physiological decrements during sustained military operational stress. *Military Medicine*. 2011;176(9):991-997. doi:10.7205/MILMED-D-11-00053

16. Tanita Corporation. Body Composition Analyzer BC-418, Instruction Manual. https://tanita.eu/media/wysiwyg/manuals/medical-approved-body-composition-monitors/mc-418-instruction-manual.pdf. Published 2018. Accessed July 9, 2019.

17. Carins, Kullen CJ. *Field Acceptability and Consumption of CR1M and Potential New Food Items during the Hot Weather Ration Trial*. Australia: Defence Science and Technology Organisation, Australian Government; 2011:29.

18. Barringer ND, Pasiakos SM, McClung HL, Crombie AP, Margolis LM. Prediction equation for estimating total daily energy requirements of special operations personnel. *Journal of the International Society of Sports Nutrition*. 2018;15(1). doi:10.1186/s12970-018-0219-x

19. Tassone EC, Baker BA. Body weight and body composition changes during military training and deployment involving the use of combat rations: a systematic literature review. *Br J Nutr*. 2017;117(6):897-910. doi:10.1017/S0007114517000630

20. Weinberg AD. Dehydration: Evaluation and Management in Older Adults. *JAMA*. 1995;274(19):1552. doi:10.1001/jama.1995.03530190066035

21. Fogelholm GM, Koskinen R, Laakso J, Rankinen T, Ruokonen I. Gradual and rapid weight loss: effects on nutrition and performance in male athletes. *Medicine & Science in Sports & Exercise*. 1993;25(3):371-377.

22. Franchini E, Brito CJ, Artioli GG. Weight loss in combat sports: physiological, psychological and performance effects. *Journal of the International Society of Sports Nutrition*. 2012;9(1). doi:10.1186/1550-2783-9-52

23. World Health Organization. Mean Body Mass Index. http://www.who.int/gho/ncd/risk_factors/bmi_text/en/. Published 2019. Accessed August 4, 2019.

24. Mullie P, Vansant G, Hulens M, Clarys P, Degrave E. Evaluation of body fat estimated from body mass index and impedance in Belgian male military candidates: Comparing two methods for estimating body composition. *Military Medicine*. 2008;173(3):266-270. doi:10.7205/MILMED.173.3.266

25. Ahmed M. Assessments of Dietary Intakes of Canadian Armed Forces Consuming Field Rations. 2017.

26. Canadian Malnutrition Task Force. Canadian Nutrition Screening Tool. 2014. http://www.nutritioncareincanada.ca/sites/default/uploads/files/CNST.pdf. Accessed July 14, 2019.

27. Aandstad A, Holtberget K, Hageberg R, Holme I, Anderssen SA. Validity and Reliability of Bioelectrical Impedance Analysis and Skinfold Thickness in Predicting Body Fat in Military Personnel. *Military Medicine*. 2014;179(2):208-217. doi:10.7205/MILMED-D-12-00545

28. Ahmed M, Mandic I, Lou W, Goodman L, Jacobs I, L'Abbe MR. Validation of a Tablet Application for Assessing Dietary Intakes Compared with the Measured Food Intake/Food Waste Method in Military Personnel Consuming Field Rations. *Nutrients*. 2017;9(3). doi:10.3390/nu9030200

CHAPTER 7. ARTICLE 3 – CANADIAN ARMED FORCES SOLDIERS' PERCEPTION OF COMBAT RATION USE DURING ARCTIC TRAINING: A QUALITATIVE STUDY

Authors:

Florence V. Lavergne[1-2]

Denis Prud'homme[2]

Isabelle Giroux[2-3]

[1] *Interdisciplinary School of Health Sciences, Faculty of Health Sciences, University of Ottawa (ON)*

[2] *Institut du Savoir Montfort, Ottawa (ON)*

[3] *School of Nutrition Sciences, Faculty of Health Sciences, University of Ottawa (ON)*

Acknowledgements:

The authors wish to thank the soldiers who participated in this study, the Canadian Armed Forces Strat J4 Foodservices for their support and cooperation in this study, especially LCdr Lynda Hinch (RD), as well as research assistants, especially Mylène Rosa (RD).

7.1. Abstract

Background: Soldiers in the Canadian Armed Forces (CAF) work in various extreme environments, including the High-Arctic, where energy requirements have been estimated to be increased by ~15% compared to temperate climates. Soldiers often do not reach their energy needs with combat rations. Soldiers also face additional challenges to feeding in the Artic.

Objective: The aim of this study was to document the perception of CAF soldiers about individual, dietary, and environmental factors influencing intake of combat rations during field training in the Arctic.

Design: This qualitative phenomenological study included in-depth semi-structured individual interviews with participants recruited by purposive sampling.

Participants and setting: Soldiers (n=16) participating in the Arctic Operations Advisor course in Yellowknife and Resolute (Canada) from January to March 2019 were recruited to participate in this study.

Main outcome measures: Interviews focused on participants' perspectives and lived-experiences regarding factors influencing their dietary intake of combat rations during an Arctic field training allowing to document barriers and facilitators to optimal eating.

Statistical analyses performed: Interviews were transcribed verbatim and coded using a directed content analysis approach. Data were analysed with NVivo qualitative data analysis software.

Results: Soldiers explained food and water was frozen, thus limiting water availability and greatly increasing meal preparation time. Food variety was deemed adequate by some, but others preferred more options. Individual food preferences, and soldier mood

and team morale could act as barriers or facilitators to intake. Overall, the complexity of combat ration intake in the Arctic stemmed from the interaction of individual, dietary, and environmental factors.

Conclusions: Reducing barriers to combat ration consumption by enhancing operational suitability of rations for the Arctic environment may promote dietary intake. Bearing in mind many interrelated factors influenced dietary intake of participating soldiers, the CAF would benefit from further assessing which challenges related to soldiers' intake in the field could be addressed.

Keywords*: Military, Arctic, Ration, Dietary Intake, Qualitative*

7.2. Introduction

Feeding soldiers of the Canadian Armed Forces (CAF) worldwide is a complex undertaking considering the logistical constraints and unique physiological demands of this population. Energy needs of military in training and deployments are generally above those of the average population.[1] Total energy expenditure of male military personnel was evaluated as being 38% greater than civilian men, and 17% higher in military women compared to civilian women.[1] Furthermore, CAF members work in various environments, such as the Arctic, which also heightens energy requirements by 8-15% to maintain core body temperature, in addition to wearing heavy clothing and traveling on snow/ice-covered terrain.[2,3]

Whenever fresh-feeding is not possible, CAF members are given combat rations: pre-packed and ready-to-eat foods designed to facilitate eating on the move during field training and missions.[4] Each combat ration provides on average 1600 kcal/meal, for a daily total of approximately 4800 kcal. These combat rations are utilized by Canadian military across the world, including in the Arctic. However, previous research reported soldiers do not consume sufficient energy to compensate for increased energy expenditure, thus resulting in a negative energy balance since only 47-78% of combat rations were actually being consumed in some instances.[5] Hence, a daily energy deficit can accumulate with time in the field which can eventually impact performance and health, causing impairments such as lower concentration in high stake situations and unintended weight loss.[6–8]

A multitude of factors can influence dietary intake of combat rations by soldiers. Meiselman[9] developed the "Three Factor Model" to present the different categories of

factors influencing intake: the food (portion size, food temperature, food variety, etc.), the individual (age, gender, dietary influences, satiety, moods/emotions, etc.), and the environment (appropriateness, time of day, weather, etc.). Although these factors are known to impact dietary intake, more research is needed to further understand soldiers' perspectives regarding which specific factors influence their intake when working in cold climates and how these factors may compound in such extreme climates as the Arctic. This phenomenological study aimed to document the perception of CAF soldiers in training in the Arctic about the individual, dietary, and environmental factors influencing intake of combat rations during field training.[10] Findings from this study can help understand the complexity of factors, the interactions between them, and how they influence the dietary intake of soldiers in the Arctic to help guide the development of specialized combat rations suitable for this environment and identify other possible areas of improvement.

7.3. Methods

Study Participants

A purposive sample of soldiers participating in the Arctic Operations Advisor course was recruited to participate in the study. This eight-week course between January and March 2019 aimed to train soldiers in planning and conducting cold-weather operations. The course started in Yellowknife (NT) to prepare for the second part of the course in the High-Arctic: in Resolute (NU) and surrounding communities. The course included classroom teaching and field training. Soldiers consumed combat rations for 14 days and ate at the dining facility at different times of the course. Participation in the

study was voluntary. Free and informed written consent was obtained from all participants prior to starting the study.

Data collection

Semi-structured individual interviews were conducted. A bilingual interview guide was created, modified from interview guides used in previous studies with the military.[11,12] Participants could choose to do the interview in their language of preference (French or English). The interview guide was piloted with two active CAF members to test interview length and content. It was then refined and finalized. Before the interviews, participants completed a short demographic questionnaire. Sixteen in-depth interviews were conducted by two dietitians during two consecutive days, within 72 hours after participants returned from the Arctic course. Interview length varied between 30-66 minutes. Each dietitian interviewed 8 participants. All interviews were audio-recorded and conducted in a private setting (boardroom or private room) with a closed door so they could not be overheard. Field notes were also taken during the interviews.[13] At the beginning of each interview, participants were reminded that interviews were recorded for data collection purposes.

The interview covered the following topics: food and nutrition knowledge, healthy eating, combat ration use, mood and morale, influence of others, physical impact and activity, and snacks and supplements. Supporting quotes from participants are included in the results and were translated from French to English as needed.

At the end of the interview, participants received a nutrition education booklet (*Combat Rations for Top Performance Field Handbook*) developed by the CAF Strat J4

Food Services. The research team's contact information was given to participants in case they had additional questions or wanted to see their written interview transcript.

Data analysis

Audio-recordings were transcribed verbatim, then verified to ensure accuracy of transcripts. The directed content analysis approach was used for coding, where initial codes and their definition originated from previous theory and research findings on military nutrition.[14] Two researchers independently coded 25% of interviews using the initial code book, while also identifying potential new codes.[15,16] After comparing and discussing analyses, the initial coding scheme was revised to include new codes. The initial interviews were re-analysed to capture the new codes, followed by content analysis of the remaining transcripts. A third-party was involved when discrepancies in coding and differences in interpretation occurred.[17] Intra-coder reliability was evaluated by re-coding four randomly selected transcripts and comparing with original coding results.[18] A 90% reliability threshold was used.[18] Content analysis was done using NVivo qualitative data analysis software.[19] Some data are also presented with mean ± standard deviation, calculated with Microsoft Excel.[20]

Ethics approval

Ethics approval was obtained from the Research Ethics Board of the University of Ottawa.

7.4. Results

Sixteen male CAF members participated (31.6±5.2 years, range: 24-43 years). Eleven interviews were done in English and the remaining five were in French. Participants based out of six provinces had been in the CAF for an average of 10.7±2.6 years.

Six main themes emerged from the interviews with regards to participants' perception of the factors influencing their dietary intake of combat rations while training in the Arctic.

Theme 1: Food and water temperature

A common theme throughout all interviews was that field training in the Arctic meant foods in combat rations would be completely frozen. Foods therefore needed to be thawed and warmed up in order to be consumed. One participant (P) noted:

"I'm going to the field, the rations are going to be frozen, and I'm not going to eat very much. So eat more now, and then starve during the field ex[ercise], and then eat again." (P6)

With everything being frozen, soldiers were required to set-up cooking tents, and place individually-packaged items in a pot with water over a heat source (i.e. portable gas stoves). However, no liquid water was readily available, since it was also frozen. Thus, soldiers brought ice blocks with them and chipped off ice to first melt in pots prior to adding food. While main entrées were cooking, soldiers would eat snacks and small items

such as trail mix that did not require thawing. Once meals were cooked and distributed, desserts were placed in the cooking pot to be thawed out.

Many soldiers tried to address this challenge by putting small items such as condiments in their parka to help thaw them out. However, it was not feasible for bigger items:

"In doctrine it says that you can put a ration inside of your coat. The thing is, would you want to put an ice block against your skin for a long time? Chances are no, right? So it's possible, but it's really stupid." (P10)

Several participants compared their experience in the Arctic with working in more temperate regions, where they would not bother warming up the rations:

"You can eat the rations cold usually. But in these temperatures, you couldn't 'cause they're blocks of ice. So it takes quite a long time to prepare them and thaw them out." (P2)

Moreover, since foods needed to be thawed out, many participants commented on the fact that everything they consumed was therefore hot. In some cases, this also deterred them from eating certain items. For example, one stated:

"The main entrée and the dessert, when they aren't frozen in temperate climates, they are eaten. But since the dessert is an ice block, eating hot peaches or pears in syrup… it's so-so. You eat them as popsicles or you don't eat them." (P13)

On the other hand, another stated:

"I would say whenever you're cold though it's nice to eat a warm meal." (P3)

Theme 2: Time needed to prepare meals

Due to the logistical challenges regarding meal preparation, time was a critical factor. The majority of participants expressed concern about the large amount of time required to prepare meals in the Arctic.

"Usually at least an hour. The very minimal, if we were really busy, would be 45 minutes." (P8)

"So there could be good stuff in the ration, but you don't have time to really prepare it all, especially when it's all frozen." (P2)

Consequently, adequate planning was essential in order to find time to eat:

"It's really a time and preparation thing. If you're not thinking ahead, it's hard to do." (P10)

Although long periods of time were needed, participants had split views in regards to the adequacy of time allotted for meals. This was directly linked to the activities scheduled. For example, many skipped meals during field training. As such, a participant stated:

"The second week, we missed breakfast and lunch for 3 days." (P7) and another:

"I know what we're supposed to eat and drink is nowhere near what we have time to eat and drink." (P4)

To help mitigate this problem, soldiers would eat snacks, like chocolate bars, jerky and fruit bars, instead of the main meals due to lack of time.

On the other hand, during another field training of the course, time constraints were significantly reduced and sufficient time was given.

"No, I don't recall actually skipping meals. Not required to, anyway. There was always enough time." (P8)

Theme 3: Water availability

A direct consequence of the conditions in the Arctic was that water availability was hindered. As previously mentioned, soldiers brought ice blocks that needed to be melted to provide drinking and cooking water. A participant shared:

"It's more labour-intensive to make the water and melt it. So as a result, you don't have a lot." (P2) and another,

"I would drink about half a litre of water with the meal, because that was the only time to resupply it. You had to boil it or, melt the ice, or keeping it hot so it wouldn't freeze in your thermos." (P16)

A common practice was to have one soldier remain in the tent to continuously melt water while others worked. Mobilizing one person for a few hours allowed enough water to be prepared.

When asked if freeze-dried rations would be a feasible option to reduce the amount of frozen foods, many soldiers were concerned about the difficulty in obtaining adequate amounts of water to rehydrate food since this is "*too logistically heavy*" (P12) in the Arctic. They were hesitant, but open to trying this option:

"I would be curious to know how much more water you need to bring if it [rations] was dehydrated, versus, you know… Our rations, water is already in it." (P9)

Some soldiers reported being dehydrated as a result of low water availability. One soldier stated:

"Then it hit everyone after lunch. All the guys had a headache. Access to water was a very very influential factor." (P12)

Theme 4: Personal preferences

Personal preferences (taste, texture, etc.) with regards to combat rations greatly affected whether or not they were consumed. Foods that were appreciated were more likely to be consumed, and the contrary occurred too:

"I would always eat the main entrées. A couple times I didn't but that was just because I just didn't like the entrée I got." (P14)

Also, some items, like the hot sauce, were well appreciated and made the meals more enjoyable since *"you can eat anything as long as it has the right condiments"*. (P10)

Moreover, some soldiers mentioned that the Canadian combat rations were amongst the best in comparison to other countries, namely because of the items offered and overall quality of the food.

"We do have really good meals provided compared to most countries… Probably the best meals out of all countries. So it [healthy eating] is a concern, but at the end of the day, we do have the best meals. We compare with other countries." (P5)

Many suggested adding soups and broth to rations, especially for the Arctic. Considering water is always warm, adding these options would be viable.

Theme 5: Food variety

Dietary intake was also influenced by the variety of foods offered. Participants had mixed opinions in regards to the variety of meals: some saying variety was adequate and understood the complexity of developing rations,

"I get it, you can only put so many things in there. So I think the variety is fine." (P14)

whereas others would prefer a wider variety of items.

"The problem we're having now is that that's the only variety we have, so people get sick of them, they don't want to eat them." (P2)

However, the quality of food was a priority over quantity:

"It would be fine if there is more variety for meals, however I would maybe prefer to have less but that are all good, than 25 varieties but 15 that are not edible." (P9)

Overall, 15 participants pointed out the food variety as being a necessary element of combat rations to accommodate different tastes since there is *"no one-size-catches-all solution"* (P10).

Theme 6: Mood and morale

Finally, another common theme in the interviews was soldier mood and team morale. According to participants, combat rations themselves could positively contribute to morale and would therefore dictate dietary intake.

"If there's a chocolate bar I'll throw it in there, 'cause that's always a morale booster." (P7);

"So definitely morale. Like I said, when you're out in the field all the time, usually the only time you get a break or something to look forward to is meal time. So it's kind of like your whole day revolves around breakfast, lunch and dinner." (P14)

and

"So you're eating the sugary stuff first. That is actually a benefit in my opinion. Morale is better than nutrition at that point." (P10)

Not only could food affect morale, but it also impacted behaviour, as stated:

"I would say it really affects your mood and your morale and your state of mind and just generally how you are feeling, which is going to give you more patience or impatience, from what you've eaten." (P1)

In contrast, combat rations could also decrease group morale; less appreciated rations had a negative impact. Also, returning to fresh-feeding after consuming combat rations was consistently welcomed by all, as stated by this soldier:

"Well all the guys I've seen and had experience with are a lot happier with fresh rations. And if we can hunt or fish or catch our food as well, that helps morale as well." (P5)

Theme interactions

Furthermore, some theme interactions were identified, namely between morale and food variety.

"Eating the same things over and over and over again is morale killing, but like I said, I get it. You can only have so much variety in a box of food." (P14)

Another soldier explained morale is closely tied to food temperature:

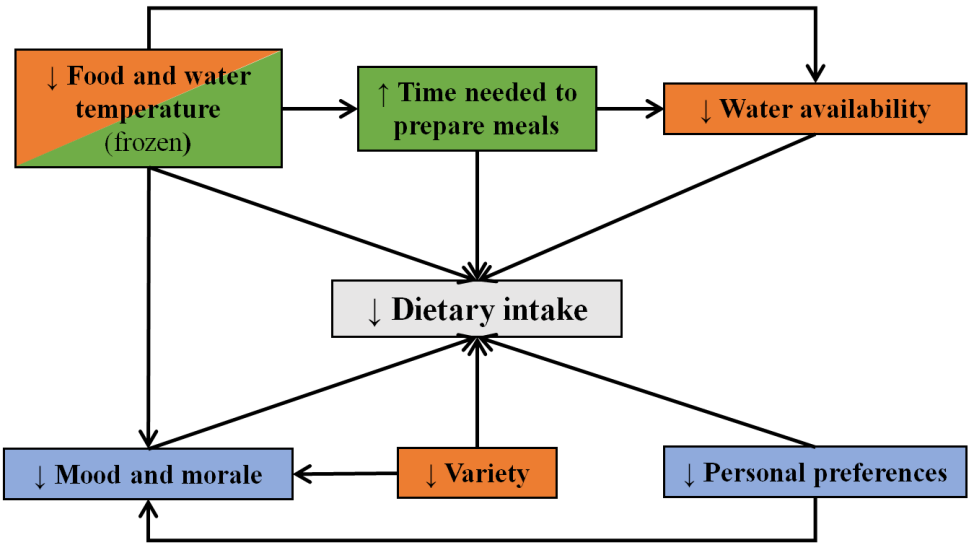
"Say like day 2-day 3, whenever you're freezing cold, you get to eat a warm ration, I think it brings up morale after that." (P3)

When asked about the main challenges in terms of preparing rations in the Arctic, one explained:

"Well, it's really time. It took time because everything was frozen." (P11)

To summarize the findings from the interviews, the main themes are presented in Figure 7.1 to show the interactions between factors that influenced intake of combat rations by participating soldiers in the Arctic.

Figure 7.1. Major themes identified by participants and how they interacted to influence dietary intake of combat rations by CAF soldiers while in training in the Arctic (n=16) (**Individual**, **dietary**, and **environmental** factors)



7.5. Discussion

The aim of this study was to document CAF soldiers' perception of the individual, dietary, and environmental factors influencing intake of combat rations while training in the Arctic. Research has shown that many factors are at play in regards to military feeding, but little is known about soldiers' lived-experiences in cold environments.

All participants brought up the temperature of foods and water as a main barrier to food consumption. The necessity to thaw out food required to have water to put in cooking pots. Ironically, water was also frozen, making meal preparation a two-step

process of first melting ice, then thawing out food. Access to water was twofold: on one hand, there was no shortage of water in the High-Arctic, bearing in mind this region is covered in ice and snow during most of the year. On the other hand, water was only available in solid form during this time of year because of the extremely low temperatures, hence reducing its actual availability. Similarly, a study by Goodman et al.[11] with military training in the Arctic also reported that frozen combat rations consisted of the main challenge in this harsh environment, contributing to 74% of participants usually skipping lunch rations. Access to drinking and cooking water was therefore directly affected by the environment itself, although not a limited resource *per se*. Another consideration about the provision of water is the amount of fuel needed to melt ice, adding to the operational complexity of food preparation.[21] To sum up, meal preparation with combat rations in the Arctic is a logistically and resource-heavy undertaking.

Inevitably, having frozen foods meant more time was required to prepare meals. Combat rations are designed in such a way that minimal preparation is needed prior to consumption. Indeed, participants unanimously agreed their personal cooking skills did not influence their ability to prepare combat rations given that they simply need to be warmed up. However, the whole preparation process suddenly became very complex and extremely time-consuming in the Arctic. Fortunately, most participants reported having enough time to prepare meals during one of the field trainings, which is not always the case in military settings.[1] In a study where seven focus groups were conducted with soldiers, all groups "talked about their leaders rushing them to eat and finish their meals in a minimum amount of time". [22(p85)]

To alleviate challenges regarding time necessary to prepare frozen combat rations, many countries have developed combat rations specifically designed for cold environments.[23] These rations contain freeze-dried foods, thus limiting their capacity to freeze.[24] Also, dehydrated rations are more favourable in terms of weight compared to the current combat rations; the latter weigh 2.7 kg/day in comparison to <1.5 kg/day for many countries with dehydrated rations.[23] Soldiers will often take out some items from the combat rations they plan on eating and throw out the rest, which reduces the load to carry and minimizes space, especially when dismounted.[4] With adequate available water, freeze-dried rations could be beneficial in this regard, especially since heavier equipment and gear often get priority.[25] Furthermore, having combat rations for cold-weather operations could allow them to be tailored to this environment; combat rations can be more energy-dense to reflect the elevated energy needs in cold climates.[1,26]

As many participants reported, soldiers often do not warm up their combat ration due to lack of time or simply do not bother taking the time to do so in temperate climates. Keeping this in mind, ready-to-eat rations remain a better option for this environment. It would therefore be unreasonable to change all combat rations to dehydrated foods. When developing combat rations, it is essential to consider what operationally works for the environment military are working in as well as time availability to prepare meals. Trials with freeze-dried rations will help determine whether or not this is a feasible option in the Arctic, and compare them to current rations. If they are more labour-intensive to prepare, this can reduce dietary intake since "increased effort is associated with less consumption".[9(pK-29)]

As for variety, enhancing it should be pursued to increase overall satisfaction and perceived combat ration quality.[27] Low food variety and repetitive meal choices can contribute to menu fatigue.[23] Additionally, it is important to be attentive to the food preferences and dislikes of the military, and strive to meet preferences of the target audience.[28] Taste-testing, preferably field testing in the conditions in which rations will be used as opposed to a laboratory setting, can be done to evaluate items and guide future decisions.[29] Yet there needs to be a balance between accommodating military and developing combat rations within the limits of available resources, knowing combat rations are temporary solutions until fresh-feeding is possible.

In this study, soldiers highlighted the importance of morale. Interestingly, morale is closely tied to personal preference: several soldiers greatly appreciated some items (e.g. chocolate bars and coffee) and referred to them as being "morale boosters", thus helping to increase their intake. This occurs regardless if soldiers are working in extreme heat or cold.[30] Moreover, low mood and morale "may adversely affect cognitive performance".[7(p47)] Optimizing soldier performance not only includes physical health, but a psychological component as well.

As demonstrated in this study, the main factors affecting dietary intake were inter-related and cannot be studied in silo. Indeed, in Figure 1, factors were categorized based on Meiselman's Three Factor Model which highlights that eating is influenced by the interaction between individual, dietary and environmental factors. As seen in our results, these factors were dependent on one another. The advantage is that an improvement in one area will positively affect other aspects. However, the opposite can also happen. All factors need to be considered when designing combat rations for optimal dietary intake in

the Arctic. For example, combat rations could be operationally suitable (e.g. easy to prepare, do not freeze), but if the majority of soldiers dislike them, they will unlikely consume them – or might, but out of pure necessity to provide energy. It is therefore in the best interest of CAF to develop combat rations better adapted to the environment in which soldiers work to reduce potential health effects of continuous underconsumption of combat rations.[31]

This study included participants from an Arctic military course. It is worth noting that there could very well be differences in factors influencing dietary intake in other training contexts where soldiers would be facing different conditions, doing different activities, etc. which would consequently affect their lived experience and perceptions about combat ration use.

Underconsumption of food and energy deficits in military have been documented.[4] However, little has been researched on a qualitative level to explore soldiers' perception and opinions with regards to combat ration use, even less so in the Arctic. This study is one of few Canadian qualitative studies focusing on military nutrition and documenting barriers and facilitators to dietary intake from combat rations.

In conclusion, results from this study contribute to document that dietary intake of combat rations during field training in the Arctic is influenced by the interaction of multiple factors including food and water temperature, time needed to prepare meals, water availability, personal preferences, food variety, as well as soldier mood and team morale. The necessary time to prepare and consume combat rations should be provided to soldiers, as reasonably possible. To promote intake and morale, foods that are well appreciated by the majority should be identified in order to remain and be frequently

included in combat rations in some specific environments like the Arctic. Also, it seems as though varying the selection of rations can be beneficial to increase appreciation, while keeping in mind food quality may be more important than variety. This stresses the need to be attentive to soldiers' perspectives and working conditions. Since the operational suitability of combat rations greatly depends on the working environment, combat rations better adapted for specific extreme environments, such as the Arctic, could be developed to promote optimal dietary intake, and in the long run, better physical and mental health of soldiers. The CAF would benefit from further research in military nutrition to evaluate favourable changes within available resources and explore which other challenges related to soldiers' intake in the field could be addressed.

7.6. References

1. Tharion WJ, Lieberman HR, Montain SJ, et al. Energy requirements of military personnel. *Appetite*. 2005;44(1):47-65. doi:10.1016/j.appet.2003.11.010

2. Sluik D, de Graaf K, de Groot LC, Cavelaars AE. *Recommendations for Nutrient Composition of Combat Rations for the NATO Response Force: Energy and Nutrient Recommendations and Consideration of Current Combat Rations*. Wageningen, Netherlands: Wageningen University and Research Centre; 2008:J1-J56. https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf. Accessed July 11, 2019.

3. Lackenbauer PW, Lajeunesse A. The Canadian Armed Forces in the Arctic: Building Appropriate Capabilities. *J Mil Strateg Stud*. 2016;16(4):60.

4. Mandic I, Jacobs I. *Field-Feeding for CF Land Military Operations: Basis of Guidelines for Standard and Incremental Allowances for Food Service Providers*. Toronto: Defence R&D Canada; 2013:89.

5. Baker-Fulco CJ. Overview of dietary intakes during military exercises. In: Marriott BM, ed. *Not Eating Enough: Overcoming Underconsumption of Military Operational Rations*. Committee on Military Nutrition Research, Institute of Medicine. Washington, DC: National Academy Press; 1995:121-150. https://www.ncbi.nlm.nih.gov/books/NBK232462/. Accessed July 11, 2019.

6. Franchini E, Brito CJ, Artioli GG. Weight loss in combat sports: physiological, psychological and performance effects. *J Int Soc Sports Nutr*. 2012;9(1). doi:10.1186/1550-2783-9-52

7. Marriott BM, ed. *Not Eating Enough: Overcoming Underconsumption of Military Operational Rations*. Committee on Military Nutrition Research, Institute of Medicine. Washington, DC: National Academy Press; 1995. https://www.ncbi.nlm.nih.gov/pubmed/25121269. Accessed July 11, 2019.

8. Jones PJ, Jacobs I, Morris A, Ducharme MB. Adequacy of food rations in soldiers during an arctic exercise measured by doubly labeled water. *J Appl Physiol*. 1993;75(4):1790-1797. doi:10.1152/jappl.1993.75.4.1790

9. Meiselman HL. *NATO Ration Characteristics Likely to Increase/Decrease Consumption*. NATO RTO; 2010:K1-KK46. https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf. Accessed July 11, 2019.

10. Rodriguez A, Smith J. Phenomenology as a healthcare research method. *Evid Based Nurs*. 2018;21(4):96-98. doi:10.1136/eb-2018-102990

11. Goodman L, Sullivan-Kwantes W, Blais A-R. *Observations and Survey Results of Army Field Feeding in the Arctic; Arctic Field Feeding Logistics and Effectiveness*. Defence Research and Development Canada; 2015. https://www.researchgate.net/publication/318276583_Observations_and_Survey_Results_of_Army_Field_Feeding_in_the_Arctic_Arctic_Field_Feeding_Logistics_and_Effectiveness. Accessed June 30, 2019.

12. Jayne JM, Bujak BK, Torres-McGehee TM, et al. Role of Drill Sergeants in Nutrition Behaviors of Soldiers in Basic Combat Training. *J Acad Nutr Diet*. 2019;119(1):69-75. doi:10.1016/j.jand.2018.05.009

13. Phillippi J, Lauderdale J. A Guide to Field Notes for Qualitative Research: Context and Conversation. *Qual Health Res*. 2018;28(3):381-388. doi:10.1177/1049732317697102

14. Hsieh H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. *Qual Health Res*. 2005;15(9):1277-1288. doi:10.1177/1049732305276687

15. L'Écuyer R. Étapes de l'analyse de contenu: Modèle général. In: *Méthodologie de l'analyse développementale de contenu: Méthode GPS et concept de soi*. Sillery, QC: Presses de l'Université du Québec; 1990:51-123.

16. Harris JE, Gleason PM, Sheean PM, Boushey C, Beto JA, Bruemmer B. An Introduction to Qualitative Research for Food and Nutrition Professionals. *J Am Diet Assoc*. 2009;109(1):80-90. doi:10.1016/j.jada.2008.10.018

17. Jacoby L, Siminoff LA, eds. *Empirical Methods for Bioethics: A Primer*. Vol 11. Amsterdam ; London: Elsevier JAI; 2008.

18. Van der Maren J-M. Le codage et le traitement des données. In: *Méthodes de recherche pour l'éducation*. Vol 22. 2nd ed. Montreal, QC: Les Presses de l'Université de Montéal; 1996:427-457. https://www.jstor.org/stable/1585818?origin=crossref. Accessed July 22, 2019.

19. *NVivo*. (for Windows) [computer program]. Version 11. Burlington, MA: QSR International Pty Ltd; 2015.

20. *Microsoft Excel*. [computer program]. Office 2010. Redmond, Washington; 2010.

21. Freund BJ, Sawka MN. Influence of cold stress on human fluid balance. In: Marriott BM, ed. *Nutritional Needs in Cold and in High-Altitude Environments: Applications for Military Personnel in Field Operations*. Committee on Military Nutrition Research, Institute of Medicine. Washington, D.C.: National Academy Press; 1996:161-180.

22. Jackson TK, Cable SJ, Jin WK, et al. The importance of leadership in soldier's nutritional behaviors: Results from the Soldier Fueling Initiative program evaluation. *US Army Med Dep J*. 2013:79-90.

23. NATO Research and Technology Organisation. *Nutrition Science and Food Standards for Military Operations*.; 2010. https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf. Accessed July 11, 2019.

24. Edwards JSA, Roberts DE, Mutter SH. Rations for use in a cold environment. *J Wilderness Med*. 1992;3(1):27-47. doi:10.1580/0953-9859-3.1.27

25. Murthy WS, Singh SN. Nutritional requirements for human adaptation in extreme environments. *Proc Indian Natl Sci Acad*. 2003;B69(4):485-506.

26. Marriott BM, Carlson SJ, eds. *Nutritional Needs in Cold and in High-Altitude Environments: Applications for Military Personnel in Field Operations*. Committee on Military Nutrition Research, Institute of Medicine. Washington, D.C.: National Academy Press; 1996.

27. Hirsch ES, Matthew Kramer F, Meiselman HL. Effects of food attributes and feeding environment on acceptance, consumption and body weight: lessons learned in a twenty-year program of military ration research. *Appetite*. 2005;44(1):33-45. doi:10.1016/j.appet.2004.04.010

28. de Graaf C, Cardello AV, Matthew Kramer F, Lesher LL, Meiselman HL, Schutz HG. A comparison between liking ratings obtained under laboratory and field conditions: the role of choice. *Appetite*. 2005;44(1):15-22. doi:10.1016/j.appet.2003.06.002

29. de Graaf C, Kramer FM, Meiselman HL, et al. Food acceptability in field studies with US army men and women: relationship with food intake and food choice

after repeated exposures. *Appetite*. 2005;44(1):23-31. doi:10.1016/j.appet.2004.08.008

30. Booth C, Coad R, Roberts W. Evaluation of an Australian combat ration pack as a sole nutrition source during 23 days of military adventurous training in the tropics. *Nutr Diet*. 2003;60(4):239-247.

31. Henning PC, Park B-S, Kim J-S. Physiological decrements during sustained military operational stress. *Mil Med*. 2011;176(9):991-997. doi:10.7205/MILMED-D-11-00053

CHAPTER 8. GENERAL DISCUSSION AND CONCLUSION

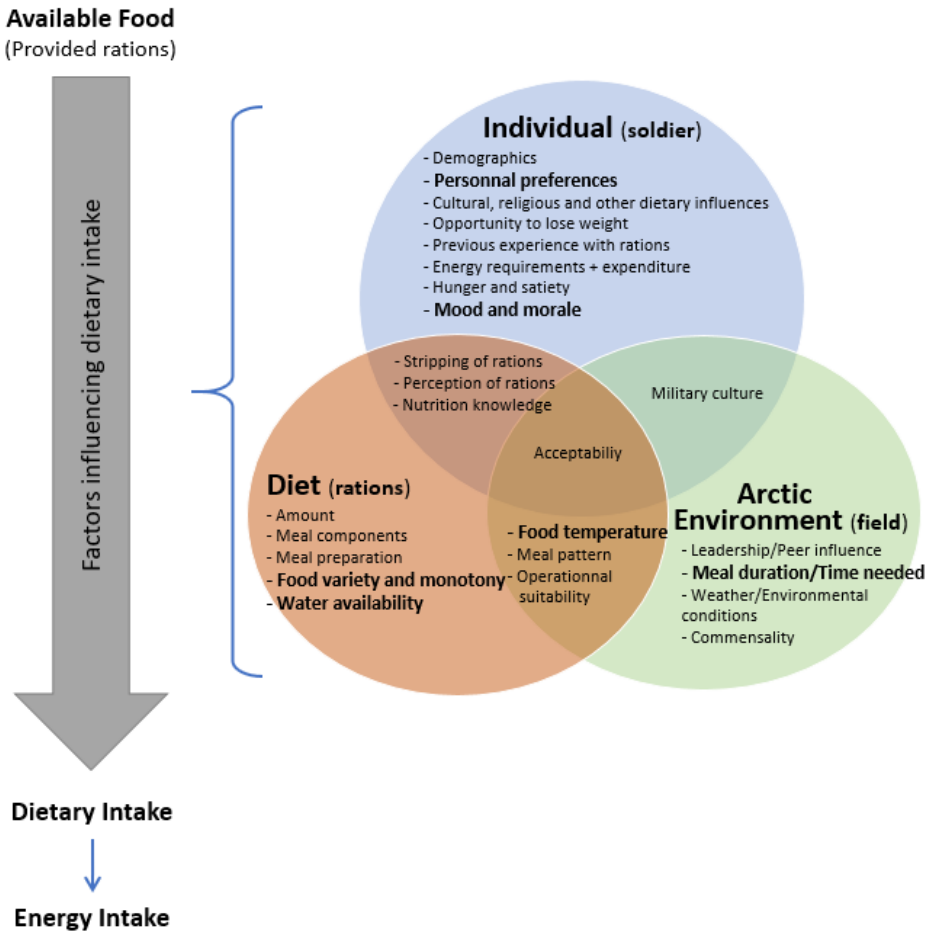
8.1. Summary and discussion of key findings

This study aimed to identify the factors influencing dietary intake of combat rations by soldiers in the CAF working in the Arctic. To accomplish this, the current study was conducted in two phases, with the results from the first one informing the second. Three specific objectives were addressed in order to answer the research question.

First, we wanted to document CAF soldier's perception of factors influencing intake of combat rations. Based on the literature review, Meiselman's Three Factor Model (2010) was modified to better correspond to the military population and the context in which soldiers use combat rations (see Figure 2.1 in Chapter 2 - Literature Review). The exploratory Phase 1 of this study highlighted some factors negatively affecting dietary intake, such as eating on-the-move, the equipment required for food preparation and consumption, as well as weather/environmental conditions. In fact, significant time was needed to prepare combat rations since they were frozen in the Arctic. From these results, Phase 2 sought to study in greater depth the factors affecting dietary intake by focusing on soldiers' perception and experiences during a training in the Arctic. Individual interviews were done and content analysis was completed. Interrelationships between factors influencing intake were identified and presented in Figure 7.1 (Chapter 7 - Article 3). The latter provides a new conceptualisation of the main factors affecting intake of combat rations, and can perhaps be adapted and used in other environments with similar challenges. This figure shows these factors pertain to the

individual, the diet and the environment, as originally presented in the Modified Three Factor Model. As much as Figure 7.1 can help explain a low intake compared to estimated energy requirements, the dependency of factors on one another can also be an asset to enable a higher dietary intake amongst military personnel. For example, increasing variety and food options matching personal preferences can improve team morale and increase intake of combat rations. Below is Figure 8.1, the Modified Three Factor Model with emphasis on the six main factors affecting intake identified by soldiers during in-depth interviews (Chapter 7 – Article 3). More research should be done on the other factors, such as nutrition knowledge, hunger/satiety, peer influence, and allotted time for meals, to evaluate to what extent they influence energy intake of soldiers during field training in the Arctic, since they could play a greater role than captured with participants in this study. Nonetheless, we verified the hypothesis that many factors influence intake, including food temperature and meal preparation time.

Figure 8.1. Modified Three Factor Model, based on Meiselman's model (2010), with emphasis (in bold) on the six main factors affecting dietary intake of soldiers consuming combat rations in the Arctic.



The second objective of the current study was to measure daily energy intake of combat rations in comparison to estimated daily energy requirements. Energy needs of the military are generally higher than the civilian population, and are even more elevated in field trainings in extremely cold climates (Marriott & Carlson, 1996; Tharion et al., 2005). It therefore followed that assessing the daily energy intake of CAF soldiers working in this environment was crucial to understand if this also occurred with this population, and if so, to what extent. Results from Phase 2 of this study show that CAF

soldiers consumed 2799±835 kcal/d, in comparison to energy needs of 5577±681 kcal/d estimated with a predictive equation (Barringer et al., 2018). Although this represents a significant energy deficit (2778 kcal/d or 49.8±19.2%), it is not surprising based on previous studies demonstrating similar results. For example, Margolis et al. (2014) measured an energy deficit of 49% during a week-long winter training. Energy expenditure varied between at 5480 to 6851 kcal/d using doubly-labelled water during different parts of the training (Margolis et al., 2014). Also, energy deficits of 2889 kcal/day were measured in another study (Ahmed, 2017) compared to 2778 kcal/day in the present study. These energy deficits, including those we estimated, were superior to the average deficit of 1500 kcal/d observed in 10 other studies of cold-weather trainings for which results were compiled by Baker-Fulco (1995).

As for measuring energy needs, other methods such as doubly labelled water could have generated more precise results rather than using estimations using a predictive equation, since it is a valid method for military in field conditions (DeLany et al., 1989). Using accelerometers would have been another option – also more practical than doubly labelled water – although they have not consistently produced reliable results in military populations (Horner et al., 2013). Also, these methods would have required a researcher to be on-site with participants to collect data, which was not possible in the current study. Using predictive equations is also very cost-effective, thus enhancing feasibility.

The predictive equation used in the current study was chosen amongst many equations developed over the years. Although the Estimated Energy Requirements equations from the Institute of Medicine are used for healthy adults (Institute of Medicine, 2005), the highest physical activity factors – i.e. used for elite athletes and

military personnel – were excluded to develop these equations, consequently making them unsuitable for this population as it would underestimate energy requirements (Mandic & Jacobs, 2013). For an active population, the Sports Nutrition Care Manual from the Academy of Nutrition and Dietetics recommends using the Cunningham equation multiplied by an activity factor (Academy of Nutrition and Dietetics, 2019; Cunningham, 1991). However, in the current study, an equation recently developed by Barringer et al. (2018) was used, since it was developed specifically for a military population. This equation was based on data collected during 12 trainings involving a total of 133 participants from the Special Operations Forces, where energy expenditure was measured by doubly labelled water technique. In fact, energy requirements obtained from Barringer et al.'s (2018) predictive equation were similar to those measured, with no significant difference in results.

To sum up the second objective, results obtained in this study corroborate the hypothesis that the average daily energy intake of soldiers training in the Arctic is lower than recommended. Furthermore, the results pointed to an average deficit of 2778 kcal/d for participating Canadian soldiers, which is much larger than the predicted 500-1000 kcal/d deficit based on previous studies (Baker-Fulco, 1995; Marriott, 1995). The current study identified that this was mainly due to not consuming the entire combat rations distributed because of many factors. Indeed, participants of the national survey distributed during Phase 1 of this project reported consuming on average 66% of foods in combat rations. Furthermore, as demonstrated in Phase 2, if soldiers ate everything provided (three IMPs ≈ 4800 kcal, one LMC ≈ 1000 kcal), they would have reached the estimated total daily energy requirements (5577 kcal/day).

For the third objective, we assessed the weight and body composition changes of CAF soldiers during an Arctic course during which combat rations were provided. Low energy intakes confirmed that measuring anthropometric changes (i.e. weight and body composition) was the next step to assess effects of low intake. In fact, the survey results (see Chapter 5 - Article 1) showed that the majority of participants perceived losing weight (5.3±2.5 kg), ranging from 1.8 to 11.3 kg. Since these results were self-reported and seemed fairly high, and disparities between perceived and actual weight changes often occur (Martin Ginis et al., 2012), we measured weight at three time-points during an Arctic military course, in Phase 2 of the study. Indeed, 12 participants (86%) lost weight (3.9±3.0 kg, range: 0.6-9.5 kg) after consuming combat rations over 14 days, as hypothesized. Perceived amounts of weight lost (in Phase 1) were thus comparable to those measured (in Phase 2). It is worth noting that weight lost was observed over a relatively shot period of time, and there are times when soldiers can be on rations for extended periods of time, particularly on deployments, where higher weight changes possibly occur (H.-A. Troupe, personal communication, September 2019). Twelve soldiers then regained weight by the end of the course. A factor that could have contributed to weight changes is the participants' hydration status. However, participants had an identical hydration status (average of 58% for all 14 participants) at the beginning and end of the course, falling within the normal range of 50-65% of body weight (Tanita Corporation, 2018). Nonetheless, one of the themes that emerged from interviews with soldiers (in Phase 2) was the low availability of water during field training since ice needed to be melted – a time-consuming process. As a result, many reported in individual interviews being dehydrated during training. It is therefore possible that mid-course

weight reflected in part a dehydrated state and depicted weight seemingly lower than if soldiers were well hydrated.

As for body composition of soldiers on rations in the Arctic, we reject the hypothesis that it would change as well, based on measurements obtained with bioelectrical impedance analysis at the beginning and end of the course. However, if measurements were taken at mid-point, they would have perhaps captured some changes in body composition, since body weight changes were observed at mid-point. Also, measurements taken periodically over a longer period of time might also show changes in body composition, as documented in Tassone and Baker's systematic review (2017) where fat mass and fat-free mass were reduced to varying degrees during military training and deployment.

Ultimately, weight changes are repercussions of high physical activity and low dietary intake compared to energy requirements. In the current study, the reasons for the latter were explored first through the survey (Phase 1), which directed the subsequent part of the study (Phase 2), with interview questions formulated to further investigate soldiers' experiences. Undoubtedly, in the survey and interviews, weather/environmental conditions and time needed to prepare meals were amongst the main factors reported to negatively affect dietary intake. These factors may seem apparent but needed to be confirmed and clearly identified using a rigorous scientific approach, instead of suggesting changes to combat rations based on assumptions. Moreover, interviews revealed morale to be an important element to soldiers in terms of influencing their intake of combat rations in the Arctic, which was not captured in the survey. This highlights that food fulfills a role that goes beyond simply providing fuel for physical work.

8.2. Strengths

A strength of this study was the use of a mixed-method approach, combining quantitative and qualitative aspects, which allowed to collect complementary information about a phenomenon (Forman et al., 2008). Measuring energy intake as well as weight and body composition in addition to obtaining soldiers' perceptions provided a more comprehensive representation of the challenges they were facing with combat rations during cold-weather operations. In fact, triangulating data with surveys, body measurements and interviews allowed studying the research question through different lenses (Farmer et al., 2006; Golafshani, 2003).

Also, the methodologies used in this study did not alter the military course, thus using a naturalistic approach to inquiry, which allowed to study research subjects in their natural setting (McInnes et al., 2017). This also increased feasibility of the research study, while still including participants from across the country. Furthermore, the combat rations consumed by participants are standardized meals which increased the precision in measuring energy intake.

Although focus groups would have been more time-efficient in Phase 2, individual interviews allowed participants to share their own perspective without peers' influence, especially since there were contradicting views between some participants. For example, some participants found the rations' food variety adequate whereas others would prefer a wider variety.

This study was done with an interdisciplinary research team and with the close collaboration of members of the CAF Strat J4 Food Services. Having members of the

research team from the University of Ottawa allowed to bring a fresh look at the military nutritional practices within the CAF regarding combat rations, while addressing research objectives tailored to the Food Services' needs.

8.3. Limitations

Although the national survey used in Phase 1 was not validated, it was developed based on previous CAF questionnaires and with input from CAF members, and it was informed by current literature. Another limit of this study is that results from the national survey as well as the 24-hour food diary are based on self-reported data, where we trusted participants to provide honest answers. As for energy intake, it was measured based on data collected using a food diary for one day. Although food diaries of a typical day with combat rations were reviewed by a dietitian with each participant, this may not reflect accurately the usual intake of combat rations by the participant. A few days' worth of data may have been more accurate. During the Arctic course, participants consumed minimal food for three days and had access to a dining facility at other times, therefore not consuming combat rations for the entire duration of the study. While varying feeding regimens throughout trainings and deployments is common, the lack of consistency is a limitation for the purposes of the study. Also, biochemical data was not collected to assess nutritional status or measure appetite regulating hormones (Mandic et al., 2019). Body composition was only measured at the beginning and end of the course. Therefore, possible changes at mid-point were not captured. The sample of soldiers participating in this study was fairly small and may not represent the larger body of CAF military

personnel. Interpretation of results is thus specific to the study participants' experience. Finally, this study was a over short duration and does not provide information on the long-term effects of combat ration use on soldiers' performance in extremely cold environments.

8.4. Implications for policy

The study findings can help identify areas of improvement for the current Canadian combat rations provided to soldiers when used in the Arctic. The CAF can use this new knowledge to guide changes to bring about when developing environment-specific combat rations, and identify areas to focus on in nutrition education for military personnel. Additionally, current methods used to test ration acceptability can be reviewed to ensure they accurately capture soldiers' feedback. Ultimately, nutritional guidelines should aim to improve daily military feeding and optimize nutritional status, especially during military operations.

8.5. Future research directions

Following this study, many areas could benefit from further research. Indeed, long-term impact of combat ration feeding in comparison to fresh feeding, and its effects on performance (physical and cognitive) and health could be investigated, given the challenges to adequately feed military members, not to mention the added difficulties in extreme environments. Also, various physical measurements (weight, body composition,

hydration status, etc.) should be tracked in future studies to complement energy intake measurements. Further research is needed to measure energy requirements in the Arctic while doing different types of activities. Dietary intake over multiple days should be measured, both in garrison compared to combat rations during field training. Since the CAF does various Arctic trainings annually, differences and similarities between each (i.e. length of training time, physical activity and tasks, feeding regimen, environmental conditions), should be considered to interpret nuances and generalizability of results from one study to another. Furthermore, other elements need to be evaluated, such as nutrition knowledge gaps, perceived importance of adequate nutrition, and appropriateness of food ordered to meet requirements (i.e. the need to order LMCs in addition to three IMPs per day).

If changes are brought to the combat rations, they will need to be monitored and compared with previous versions to evaluate success of these changes, and ensure continuous improvements. Moreover, the CAF could benefit from further investigating into the combat rations used by other countries to identify ration adaptations for a Canadian context.

8.6. General conclusion

This study aimed to identify the factors influencing the dietary intake of combat rations by soldiers in the CAF training in the Arctic, and estimate their energy intake as well as measure their weight and body composition changes. The present thesis highlights that operational suitability of combat rations could depend on the environment

in which CAF soldiers are working, especially extreme environments. In the Arctic, many interrelated factors influenced dietary intake of study participants, such as food and water temperature, necessary time to prepare meals, water availability, variety of food, personal preferences, and soldier mood and team morale. It also provides a new conceptual model to help understand how these factors interact to influence dietary intake of rations by Canadian soldiers in the Arctic. Furthermore, the study reported that energy intake was below estimated daily energy requirements, and weight losses were measured for most participants during the field training in the Arctic when combat rations were provided. Combat rations adapted for the soldiers' work in extreme environments could help optimize consumption. In addition, further assessment of ration suitability and exploration of other factors related to soldiers' intake in the field could be evaluated in order to enhance dietary intake.

REFERENCES

Academy of Nutrition and Dietetics. (2019). *Estimations of energy requirements*. Sports Nutrition Care Manual.

Ahmed, M. (2017). *Assessments of Dietary Intakes of Canadian Armed Forces Consuming Field Rations* [Doctoral thesis]. University of Toronto.

Askew, E. W. (1995). Environmental and physical stress and nutrient requirements. *The American Journal of Clinical Nutrition*, *61*(3), 631S-637S. https://doi.org/10.1093/ajcn/61.3.631S

Baker-Fulco, C. J. (1995). Overview of dietary intakes during military exercises. In B. M. Marriott (Ed.), *Not eating enough: Overcoming underconsumption of military operational rations* (Committee on Military Nutrition Research, Institute of Medicine, pp. 121–150). National Academy Press. https://www.ncbi.nlm.nih.gov/books/NBK232462/

Baker-Fulco, C. J., Bathalon, G. P., Bovill, M. E., & Lieberman, H. R. (2001). *Military Dietary Reference Intakes: Rationale for tabled values* (Technical Note TN-00/10; p. 46). U.S. Army Research Institute of Environmental Medicine.

Barringer, N. D., Pasiakos, S. M., McClung, H. L., Crombie, A. P., & Margolis, L. M. (2018). Prediction equation for estimating total daily energy requirements of special operations personnel. *Journal of the International Society of Sports Nutrition*, *15*(1). https://doi.org/10.1186/s12970-018-0219-x

Canadian Malnutrition Task Force. (2014). *Canadian Nutrition Screening Tool*. http://www.nutritioncareincanada.ca/sites/default/uploads/files/CNST.pdf

Carins, & Kullen, C. J. (2011). *Field acceptability and consumption of CR1M and potential new food items during the hot weather ration trial* (Technical Note DSTO-TN-1041; p. 29). Defence Science and Technology Organisation, Australian Government.

Castellani, J. W., Spitz, M. G., Karis, A. J., Martini, S., Young, A. J., Margolis, L. M., Phillip Karl, J., Murphy, N. E., Xu, X., Montain, S. J., Bohn, J. A., Teien, H. K., Stenberg, P. H., Gundersen, Y., & Pasiakos, S. M. (2017). Cardiovascular and thermal strain during 3–4 days of a metabolically demanding cold-weather military operation. *Extreme Physiology & Medicine*, *6*(1). https://doi.org/10.1186/s13728-017-0056-6

Cunningham, J. J. (1991). Body composition as a determinant of energy expenditure: A synthetic review and a proposed general prediction equation. *The American Journal of Clinical Nutrition*, *54*(6), 963–969. https://doi.org/10.1093/ajcn/54.6.963

DeLany, J. P., Schoeller, D. A., Hoyt, R. W., Askew, E. W., & Sharp, M. A. (1989). Field use of D2 18O to measure energy expenditure of soldiers at different energy intakes. *Journal of Applied Physiology*, *67*(5), 1922–1929. https://doi.org/10.1152/jappl.1989.67.5.1922

Edwards, J. S. A., Askew, W. E., & King, N. (1995). Rations in cold Arctic environments: Recent American military experiences. *Wilderness & Environmental Medicine*, *6*(4), 407–422. https://doi.org/10.1580/1080-6032(1995)006[0407:RICAER]2.3.CO;2

Environment and Climate Change Canada. (2019, June 11). *Daily Data Report for January 2019*. http://climate.weather.gc.ca/climate_data/daily_data_e.html?StationID=53060&timeframe=2&StartYear=1840&EndYear=2019&Day=10&Year=2019&Month=1#

Farmer, T., Robinson, K., Elliott, S. J., & Eyles, J. (2006). Developing and Implementing a Triangulation Protocol for Qualitative Health Research. *Qualitative Health Research*, *16*(3), 377–394. https://doi.org/10.1177/1049732305285708

Fogelholm, G. M., Koskinen, R., Laakso, J., Rankinen, T., & Ruokonen, I. (1993). Gradual and rapid weight loss: Effects on nutrition and performance in male athletes. *Medicine & Science in Sports & Exercise*, *25*(3), 371–377.

Forman, J., Creswell, J. W., Damschroder, L., Kowalski, C. P., & Krein, S. L. (2008). Qualitative research methods: Key features and insights gained from use in infection prevention research. *American Journal of Infection Control*, *36*(10), 764–771. https://doi.org/10.1016/j.ajic.2008.03.010

Franchini, E., Brito, C. J., & Artioli, G. G. (2012). Weight loss in combat sports: Physiological, psychological and performance effects. *Journal of the International Society of Sports Nutrition*, *9*(1). https://doi.org/10.1186/1550-2783-9-52

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, *8*(4), 597–606.

Goodman, L., Sullivan-Kwantes, W., & Blais, A.-R. (2015). *Observations and Survey Results of Army Field Feeding in the Arctic; Arctic Field Feeding Logistics and Effectiveness* (Scientific Report DRDC-RDDC-2015-R289). Defence Research

and Development Canada. https://www.researchgate.net/publication/318276583_Observations_and_Survey_Results_of_Army_Field_Feeding_in_the_Arctic_Arctic_Field_Feeding_Logistics_and_Effectiveness

Hall, C. J., & Lane, A. M. (2001). Effects of rapid weight loss on mood and performance among amateur boxers. *British Journal of Sports Medicine, 35*(6), 390–395. https://doi.org/10.1136/bjsm.35.6.390

Hatton, P. (2005). *Food and beverage consumption of Canadian Forces soldiers in an operational setting: Is their nutrient intake adequate?.* McGill University.

Henning, P. C., Park, B.-S., & Kim, J.-S. (2011). Physiological decrements during sustained military operational stress. *Military Medicine, 176*(9), 991–997. https://doi.org/10.7205/MILMED-D-11-00053

Hermans, R. C. J., Larsen, J. K., Lochbuehler, K., Nederkoorn, C., Herman, C. P., & Engels, R. C. M. E. (2013). The power of social influence over food intake: Examining the effects of attentional bias and impulsivity. *British Journal of Nutrition, 109*(3), 572–580. https://doi.org/10.1017/S0007114512001390

Hirsch, E. S. (1995). The effects of ration modification on energy intake, body weight change, and food acceptance. In B. M. Marriott (Ed.), *Not eating enough: Overcoming underconsumption of military operational rations* (Committee on Military Nutrition Research, Institute of Medicine, pp. 151–174). National Academy Press. http://site.ebrary.com/id/10062769

Hodgdon, J., Hesslink, R. L., Hackney, A., Vickers, R., & Hilbert, R. (1991). Norwegian military field exercises in the Arctic: Cognitive and physical performance. *Arctic Medical Research, 50 Suppl*(6), 132–136.

Horner, F., Bilzon, J. L., Rayson, M., Blacker, S., Richmond, V., Carter, J., Wright, A., & Nevill, A. (2013). Development of an accelerometer-based multivariate model to predict free-living energy expenditure in a large military cohort. *Journal of Sports Sciences*, *31*(4), 354–360. https://doi.org/10.1080/02640414.2012.734632

Hoyt, R. W., Jones, T. E., Stein, T. P., McAninch, G. W., Lieberman, H. R., Askew, E. W., & Cymerman, A. (1991). Doubly labeled water measurement of human energy expenditure during strenuous exercise. *Journal of Applied Physiology*, *71*(1), 16–22. https://doi.org/10.1152/jappl.1991.71.1.16

Institute of Medicine (Ed.). (2005). *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids*. National Academies Press.

Jackson, T. K., Cable, S. J., Jin, W. K., Robinson, A., Dennis, S. D., Vo, L. T., Prosser, T. J., & Rawlings, J. A. (2013). The importance of leadership in soldier's nutritional behaviors: Results from the Soldier Fueling Initiative program evaluation. *U.S. Army Medical Department Journal,* 79–90.

Jayne, J. M., Bujak, B. K., Torres-McGehee, T. M., Frongillo, E. A., Cable, S. J., Glover, S. H., Emerson, D. M., & Blake, C. E. (2019). Role of Drill Sergeants in Nutrition Behaviors of Soldiers in Basic Combat Training. *Journal of the Academy of Nutrition and Dietetics*, *119*(1), 69–75. https://doi.org/10.1016/j.jand.2018.05.009

Jones, P. J., Jacobs, I., Morris, A., & Ducharme, M. B. (1993). Adequacy of food rations in soldiers during an arctic exercise measured by doubly labeled water. *Journal of Applied Physiology*, *75*(4), 1790–1797. https://doi.org/10.1152/jappl.1993.75.4.1790

King, N., Mutter, S. H., Roberts, D. E., Sutherland, M. R., & Askew, E. W. (1993). Cold weather field evaluation of the 18-Man Arctic Tray Pack Ration Module, the Meal, Ready-to-Eat, and the Long Life Ration Packet. *Military Medicine*, *158*(7), 458–465. https://doi.org/10.1093/milmed/158.7.458

Lackenbauer, P. W., & Lajeunesse, A. (2016). The Canadian Armed Forces in the Arctic: Building Appropriate Capabilities. *Journal of Military and Strategic Studies*, *16*(4), 60.

Lackenbauer, P. W., & Nicol, H. (2017). *Whole of Government through an Arctic Lens* (Mulroney Institute of Government).

Lajeunesse, A., & Canadian Defence and Foreign Affairs Institute. (2015). *The Canadian Armed Forces in the Arctic: Purpose, capabilities, and requirements* [Policy Paper]. http://www.deslibris.ca/ID/247838

Mandic, I. (2018). *The effects of environmental and physical stress on energy expenditure, energy intake, and appetite*. University of Toronto.

Mandic, I., Ahmed, M., Rhind, S., Goodman, L., L'Abbe, M., & Jacobs, I. (2019). The effects of exercise and ambient temperature on dietary intake, appetite sensation, and appetite regulating hormone concentrations. *Nutrition & Metabolism*, *16*(1), 29. https://doi.org/10.1186/s12986-019-0348-5

Mandic, I., & Jacobs, I. (2013). *Field-feeding for CF land military operations: Basis guidelines for standard and incremental allowances for food service providers* (Contract Report DRDC Toronto CR 2013-104). Defence Research and Development Canada.

Margolis, L. M., Murphy, N. E., Martini, S., Gundersen, Y., Castellani, J. W., Karl, J. P., Carrigan, C. T., Teien, H.-K., Madslien, E.-H., Montain, S. J., & Pasiakos, S. M. (2016). Effects of Supplemental Energy on Protein Balance during 4-d Arctic Military Training: *Medicine & Science in Sports & Exercise*, *48*(8), 1604–1612. https://doi.org/10.1249/MSS.0000000000000944

Margolis, L. M., Murphy, N. E., Martini, S., Spitz, M. G., Thrane, I., McGraw, S. M., Blatny, J.-M., Castellani, J. W., Rood, J. C., Young, A. J., Montain, S. J., Gundersen, Y., & Pasiakos, S. M. (2014). Effects of winter military training on energy balance, whole-body protein balance, muscle damage, soreness, and physical performance. *Applied Physiology, Nutrition, and Metabolism*, *39*(12), 1395–1401. https://doi.org/10.1139/apnm-2014-0212

Marriott, B. M. (Ed.). (1995). *Not eating enough: Overcoming underconsumption of military operational rations* (Committee on Military Nutrition Research, Institute of Medicine). National Academy Press. https://www.ncbi.nlm.nih.gov/pubmed/25121269

Marriott, B. M., & Carlson, S. J. (Eds.). (1996). *Nutritional needs in cold and in high-altitude environments: Applications for military personnel in field operations* (Committee on Military Nutrition Research, Institute of Medicine). National Academy Press.

Martin Ginis, K. A., McEwan, D., Josse, A. R., & Phillips, S. M. (2012). Body image change in obese and overweight women enrolled in a weight-loss intervention: The importance of perceived versus actual physical changes. *Body Image*, *9*(3), 311–317. https://doi.org/10.1016/j.bodyim.2012.04.002

McInnes, S., Peters, K., Bonney, A., & Halcomb, E. (2017). An exemplar of naturalistic inquiry in general practice research. *Nurse Researcher*, *24*(3), 36–41. https://doi.org/10.7748/nr.2017.e1509

Medical Services. (2001). *Nutrition standards and education* (AR-40-25). Department of the Army, Navy, and Air Force. https://dmna.ny.gov/foodservice/docs/references/AR_40-25_Nutrition_Standards.pdf

Meiselman, H. L. (2010). *NATO ration characteristics likely to increase/decrease consumption* (Technical Report TR-HFM-154; pp. K1-KK46). NATO RTO. https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf

Montain, S. J., & Young, A. J. (2003). Diet and physical performance. *Appetite*, *40*(3), 255–267. https://doi.org/10.1016/S0195-6663(03)00011-4

Morse, J. M. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research*, *40*, 120–123.

Murthy, W. S., & Singh, S. N. (2003). Nutritional requirements for human adaptation in extreme environments. *Proceedings of the Indian National Science Academy*, *B69*(4), 485–506.

NATO Research and Technology Organisation. (2010). *Nutrition science and food standards for military operations* (Technical Report RTO-TR-HFM-154). https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf

Osilla, E. V., & Sharma, S. (2019). Physiology, Temperature Regulation. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK507838/

Ramsey, C. B., Hostetler, C., & Andrews, A. (2013). Evaluating the Nutrition Intake of U.S. Military Service Members in Garrison. *Military Medicine, 178*(12), 1285–1290. https://doi.org/10.7205/MILMED-D-13-00178

Roberts, D. E., McGuire, B., Engell, D., Salter, C., & Rose, M. (1989). *The role of water consumption on consumption of the ration, cold weather* (Technical Report No. T13-89; p. 152). U.S. Army Research Institute of Environmental Medicine.

Schalt, A., Johannsen, M. M., Kim, J., Chen, R., Murphy, C. J., Coker, M. S., Gunga, H.-C., Coker, R. H., & Steinach, M. (2018). Negative Energy Balance Does Not Alter Fat-Free Mass During the Yukon Arctic Ultra—The Longest and the Coldest Ultramarathon. *Frontiers in Physiology*, *9*. https://doi.org/10.3389/fphys.2018.01761

Sluik, D., de Graaf, K., de Groot, L. C., & Cavelaars, A. E. (2008). *Recommendations for nutrient composition of combat rations for the NATO Response Force: Energy and nutrient recommendations and consideration of current combat rations* (pp. J1–J56). Wageningen University and Research Centre. https://apps.dtic.mil/dtic/tr/fulltext/u2/a526318.pdf

Sullivan-Kwantes, W., & Fung, J. (2018). *Health protection factors during Arctic Operations: Key findings to date* (DRDC-RDDC-2018-D127). Defence Research and Development Canada.

Tanita Corporation. (2018). *Body Composition Analyzer BC-418, Instruction Manual*. https://tanita.eu/media/wysiwyg/manuals/medical-approved-body-composition-monitors/mc-418-instruction-manual.pdf

Tassone, E. C., & Baker, B. A. (2017). Body weight and body composition changes during military training and deployment involving the use of combat rations: A systematic literature review. *British Journal of Nutrition*, *117*(6), 897–910. https://doi.org/10.1017/S0007114517000630

Tharion, W. J., Lieberman, H. R., Montain, S. J., Young, A. J., Baker-Fulco, C. J., DeLany, J. P., & Hoyt, R. W. (2005). Energy requirements of military personnel. *Appetite*, *44*(1), 47–65. https://doi.org/10.1016/j.appet.2003.11.010

Weinberg, A. D. (1995). Dehydration: Evaluation and Management in Older Adults. *JAMA*, *274*(19), 1552. https://doi.org/10.1001/jama.1995.03530190066035

APPENDIX A. CERTIFICATE OF ETHICS APPROVAL

13/06/2019

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

CERTIFICAT D'APPROBATION ÉTHIQUE | CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-04-18-379
Titre du projet / Project Title	Assessment of factors pertaining to the individual, the diet and the environment influencing the dietary intake of rations by soldiers in the Canadian Armed Forces (CAF) working in the Arctic.
Type de projet / Project Type	Thèse de maîtrise / Master's thesis
Statut du projet / Project Status	Renouvelé / Renewed
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	13/06/2019
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	04/06/2020

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Florence LAVERGNE	École interdisciplinaire des sciences de la santé / Interdisciplinary School of Health Sciences	Chercheur Principal / Principal Investigator
Isabelle GIROUX	École des sciences de la nutrition / School of Nutrition Sciences	Superviseur / Supervisor
Denis PRUD'HOMME		Co-superviseur / Co-supervisor
Lynda HINCH	DND	Assistant de recherche / Research Assistant
Raphaëlle LAROCHE-NANTEL	École des sciences de la nutrition / School of Nutrition Sciences	Étudiant-chercheur / Student-researcher
Inès AUCLAIR MANGLIAR	École des sciences de la nutrition / School of Nutrition Sciences	Étudiant-chercheur / Student-researcher
Alena MCBAIN	École des sciences de la nutrition / School of Nutrition Sciences	Étudiant-chercheur / Student-researcher
Mylene ROSA	Faculté d'éducation / Faculty of Education	Étudiant-chercheur / Student-researcher
Karine BROUSSEAU	École des sciences de la nutrition / School of Nutrition Sciences	Étudiant-chercheur / Student-researcher

Conditions spéciales ou commentaires / Special conditions or comments

550, rue Cumberland, pièce 154
Ottawa (Ontario) K1N 6N5 Canada

550 Cumberland Street, Room 154
Ottawa, Ontario K1N 6N5 Canada

613-562-5387 • 613-562-5338 • ethique@uOttawa.ca / ethics@uOttawa.ca
www.recherche.uottawa.ca/deontologie | www.recherche.uottawa.ca/ethics

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Le Comité d'éthique de la recherche (CÉR) de l'Université d'Ottawa, opérant conformément à l'*Énoncé de politique des Trois conseils* (2014) et toutes autres lois et tous règlements applicables, a examiné et approuvé la demande d'éthique du projet de recherche ci-nommé.

L'approbation est valide pour la durée indiquée plus haut et est sujette aux conditions énumérées dans la section intitulée "Conditions Spéciales ou Commentaires". Le formulaire « Renouvellement ou Fermeture de Projet » doit être complété quatre semaines avant la date d'échéance indiquée ci-haut afin de demander un renouvellement de cette approbation éthique ou afin de fermer le dossier.

Toutes modifications apportées au projet doivent être approuvées par le CÉR avant leur mise en place, sauf si le participant doit être retiré en raison d'un danger immédiat ou s'il s'agit d'un changement ayant trait à des éléments administratifs ou logistiques du projet. Les chercheurs doivent aviser le CÉR dans les plus brefs délais de tout changement pouvant augmenter le niveau de risque aux participants ou pouvant affecter considérablement le déroulement du projet, rapporter tout évènement imprévu ou indésirable et soumettre toute nouvelle information pouvant nuire à la conduite du projet ou à la sécurité des participants.

The University of Ottawa Research Ethics Board, which operates in accordance with the *Tri-Council Policy Statement* (2014) and other applicable laws and regulations, has examined and approved the ethics application for the above-named research project.

Ethics approval is valid for the period indicated above and is subject to the conditions listed in the section entitled "Special Conditions or Comments". The "Renewal/Project Closure" form must be completedfour weeks before the above-referenced expiry date to request a renewal of this ethics approval or closure of the file.

Any changes made to the project must be approved by the REB before being implemented, except when necessary to remove participants from immediate endangerment or when the modification(s) only pertain to administrative or logistical components of the project. Investigators must also promptly alert the REB of any changes that increase the risk to participant(s), any changes that considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project or the safety of the participant(s).

Marc Alain BONENFANT
Coordonnateur de l'éthique / Ethics Coordinator
Pour/For **Daniel LAGAREC** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences sociales et humanités / Social Sciences and Humanities Research Ethics Board**

APPENDIX B. PHASE 1 - INVITATION TO PARTICIPATE IN THE STUDY

You are invited to participate in a research project on the consumption of combat rations in the Arctic

Who? Individuals that have participated in an exercise or operation in the Arctic during winter 2018. Trainees and instructors are eligible to participate in this study.

What? We ask that you fill out an online survey on your experience with combat rations during the Arctic exercise or operation you completed during winter 2018. The survey will take approximately 15-30 minutes to complete. Your participation is voluntary. The data collected will remain confidential, and a summary of the results will be shared with the Canadian Armed Forces (CAF) Food Services.

Why? Your feedback will allow us to better understand the soldiers' overall experience with combat rations, and help identify factors influencing the dietary intake of soldiers working in the Arctic.

How? The survey is to be completed online via *SurveyMonkey*. In order to explore cultural differences between Francophones and Anglophones, we ask that you please complete the survey in your language of preference.

Please read the consent form attached prior to completing the survey.

If you complete and submit this survey, we consider you consent to participate in this study.

To fill out the online survey, click this link (or copy-paste the link into your browser):
https://www.surveymonkey.ca/r/combat-rations-ENG

Please complete the survey by **June 29, 2018**.

Please read the consent form attached prior to completing the survey. If you have any question, please contact:

Student researcher
Florence Lavergne

Office: Thompson 050, School of Nutrition Sciences, University of Ottawa
K1N 6N5

Supervisor
Isabelle Giroux

Office: Thompson 116, School of Nutrition Sciences, University of Ottawa
K1N 6N5

Co-supervisor
Dr. Denis Prud'homme

Montfort Knowledge Institute, Montfort Hospital

CAF contact
Hilda-Anne Troupe

Strat J4 Food Services, Strategic Joint Staff, 5-2, CAF

Thank you for your participation!

APPENDIX C. PHASE 1 - CONSENT FORM

uOttawa

Université d'Ottawa
Faculté des sciences de la santé
École des sciences de la nutrition

University of Ottawa
Faculty of Health Sciences
School of Nutrition Sciences

☎ 613-562-5800 (1596)
613-562-5632

25 University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

Consent Form

Title: Assessment of factors pertaining to the individual, the diet and the environment influencing the dietary intake of rations by soldiers in the Canadian Armed Forces (CAF) working in the Arctic.

Invitation to participate: I am invited to participate in the research study titled 'Assessment of factors pertaining to the individual, the diet and the environment influencing the dietary intake of rations by soldiers in the Canadian Armed Forces (CAF) working in the Arctic' conducted by Florence Lavergne for her Master's thesis in Interdisciplinary Health Sciences at the University of Ottawa.

Purpose of the study: The purpose of the study is to better understand the soldiers' overall experience with combat rations, and help identify factors influencing the dietary intake of soldiers working in the Arctic.

Participation: My participation will consist in completing a survey (on-line of hard copy) lasting about 15-30 minutes.

Benefits: My participation in this study will enhance the understanding of combat ration consumption in cold environments. This research project will give me an opportunity to talk about any possible barriers and facilitators to my dietary intake of rations in the Arctic.

Confidentiality and anonymity: I have been assured by the researchers that the information I will share will remain strictly confidential. If the survey is submitted on-line (via Survey Monkey), I understand that confidentiality of the data cannot be guaranteed. The Canadian version of Survey Monkey has been used (where the survey questions and results are stored in Canada). Although the data is encrypted, there is a risk, as with any information shared on the Internet, that it may be intercepted by a third party. To minimize this risk, the researchers recommend using standard security measures, such as closing the Internet browser and locking your screen once completed.

As for the hard-copy survey, I will place my completed survey in the given envelope and seal it. All surveys will be collected by the CAF Food Service representative, who will then send them directly to the University of Ottawa.

The data will be analyzed by researchers at the University of Ottawa. A summary of the results will be shared with the CAF Food Services. The summary will include a compilation of results and statistical findings from the surveys. No individual data will be shared.

Conservation of data: I am aware that the data collected (via online surveys or hard-copy surveys) will be kept in a secure manner. The research data will be stored on a USB. The computers used for data analysis have secure passwords and codes will be used to encrypt the information. Only the student researcher, the supervisors, and a research assistant will have access to the data. The data will be conserved for ten years after the completed surveys have been collected. Subsequently, the data will be destroyed and shredded.

Voluntary participation: I am under no obligation to participate and if I choose to participate, I may refuse to answer any questions. Once my survey is submitted, I can no longer withdraw my results given the anonymous nature of the study.

Acceptance: By filling out the survey, I am providing implied consent and therefore agree to participate in the above research study conducted by Florence Lavergne doing a Master's in Interdisciplinary Health Sciences at the University of Ottawa, under the supervision of Pre. Isabelle Giroux and Dr. Denis Prud'homme.

If I have any questions about the study, I may contact the student and/or the supervisors at the numbers mentioned above.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, K1N 6N8, Ottawa, ON (613) 562-5387 or ethics@uottawa.ca.

Name of student researcher: Florence Lavergne
Coordinates:
Affiliation: School of Nutrition Sciences, University of Ottawa, K1N 6N5

Name of supervisor: Professor Isabelle Giroux
Coordinates:
Affiliation: School of Nutrition Sciences, University of Ottawa, K1N 6N5

Name of co-supervisor: Dr. Denis Prud'homme
Coordinates:
Affiliation: Montfort Knowledge Institute, Montfort Hospital

Name of FAC contact: Hilda-Anne Troupe
Coordinates:
Affiliation: Strat J4 Food Services, Strategic Joint Staff, 5-2, Canadian Armed Forces

APPENDIX D. PHASE 1 – SURVEY ON COMBAT RATION CONSUMPTION DURING THE ARCTIC EXERCISE/OPERATION COMPLETED BETWEEN 2015-2018

Survey on Combat Ration Consumption During the Arctic Exercise or Operation Completed Between 2015-2018

Who? Individuals that have participated in an exercise or operation in the Arctic between 2015-2018. Trainees and instructors are eligible to participate in this study.

What? We ask that you fill out this survey on your experience with combat rations during the Arctic exercise or operation you completed between 2015-2018. The survey will take approximately 15-30 minutes to complete.

Why? Your feedback will allow us to better understand your overall experience with combat rations, and help identify factors influencing the dietary intake of soldiers working in the Arctic.

Please note there is no right or wrong answer. We ask that you refrain from writing your name in order to maintain confidentiality. Your participation is voluntary.

Important note: This survey is about combat rations (with pre-packaged items), such as the Individual Meal Packs (IMPs) and the Light Meal Combat rations (LMCs). This survey is NOT about fresh rations.

A – Demographic information

1. Location of Arctic exercise/operation: _____
2. Year of Arctic exercise/operation: □ 2015 □ 2016 □ 2017 □ 2018
3. Usual place of duty/Location of your military base: _____
4. Age: _____
5. Sex: _____
6. Ethnicity: _____
7. Mother tongue: □ French □ English □ Other: _____
8. Official language of preference: □ French □ English
9. Number of years in the Canadian Armed Forces: _____
10. Role during the Arctic exercise/operation: □ Trainee □ Instructor

11. Before the Arctic exercise/operation, did you have any previous experience working in the Arctic for military or personal purposes?
    - □ No
    - □ Yes. (Please specify the number of times you have been in the Arctic): _____

12. Did you have hands-on experience preparing combat rations prior to the Arctic exercise/operation?
    - □ Yes
    - □ No

13. Did you have hands-on experience preparing combat rations **in the Arctic** prior to the Arctic exercise/operation?
    - □ Yes
    - □ No

B – Evaluation of rations' overall operational suitability/acceptability

14. During the Arctic exercise/operation, I consumed:
    - ☐ Regular rations
    - ☐ Vegetarian/Religious rations

15. Please rate the **Individual Meal Packs** (IMPs) you consumed in the Arctic using the following rating scale:
    1- Very Unacceptable, 2- Moderately Unacceptable, 3- Slightly Unacceptable, 4- Neutral, 5- Slightly Acceptable, 6- Moderately Acceptable, 7- Very Acceptable

Characteristic	1	2	3	4	5	6	7	**Characteristic**	1	2	3	4	5	6	7
Ease of preparation								Ease of digestion							
Ease of consumption								Taste							
Amount of water required to prepare								Quantity of food per day							
Amount of fuel required to heat								Food temperature achieved							
Weight of daily ration								Texture							
Preparation time								Food variety							
Overall acceptability															

Comments:

_____

_____

16. Were you offered **Light Meal Combat** rations (LMCs, or "snack packs") during the Arctic exercise/operation? ☐ Yes ☐ No

17. If you answered YES to the previous question, please rate the **Light Meal Combat** rations (LMCs) you consumed in the Arctic using the following rating scale:
    1- Very Unacceptable, 2- Moderately Unacceptable, 3- Slightly Unacceptable, 4- Neutral, 5- Slightly Acceptable, 6-Moderately Acceptable, 7- Very Acceptable

Characteristic	1	2	3	4	5	6	7	**Characteristic**	1	2	3	4	5	6	7
Ease of preparation								Ease of digestion							
Ease of consumption								Taste							
Amount of water required to prepare								Quantity of food per day							
Weight of daily ration								Texture							
Preparation time								Food variety							
Overall acceptability															

Comments:

_____

_____

C – Diet history during the Arctic exercise/operation

18. At home, I am usually on a diet.
    - ☐ No
    - ☐ Yes. (Please specify): _____

19. When did you usually eat rations and other foods in the Arctic? Please check (✓) all the boxes that apply.
    Note: IMP = Individual Meal Pack, LMC = Light Meal Combat ration ("snack pack")

	midnight-3:59am	4-6:59am	7-9:59am	10am-12:59pm	1-3:59pm	4-6:59pm	7-9:59pm	10-11:59pm	N/A
IMP									
Snack (LMC and/or ration component)									
Personal food/supplements									

Comments:
_____
_____

20. On average, what amount of each ration did you consume? Please check (✓).

	< ¼	¼ -½	½ – ¾	> ¾	N/A
Breakfast IMP					
Lunch IMP					
Supper IMP					
LMC					

Comments:
_____
_____

21. During the mealtime, were you able to heat your rations?
    - ☐ Yes, I was consistently able to heat my rations.
    - ☐ Yes, I was occasionally able to heat my rations.
    - ☐ No, I was rarely able to heat my rations.
    - ☐ No, I was never able to heat my rations.

    Comments:
    _____
    _____
    _____

22. Did you have enough time to eat your ration? Please check (✓).

	Yes	No	Sometimes	N/A
Breakfast IMP				
Lunch IMP				

Supper IMP				
LMC				

Comments:

_____

_____

23. Please mark how much each factor **negatively** affected your intake of rations (IMPs and LMCs) during the Arctic exercise/operation on a scale of 1 (*Not at all*) to 7 (*A lot*).

Factors	1	2	3	4	5	6	7	N/A
a. My food preparation skills								
b. Taste of rations								
c. Nutrient content								
d. Food preference								
e. Food product name								
f. Unfamiliarity of food								
g. Temperature of food								
h. Eating on the move								
i. Negative perception of rations								
j. Exercises and activities								
k. Stress of exercise/operation								
l. Amount of time for meal								
m. Weather/Environmental conditions								
n. Shelter								
o. Eating with a group								
p. Influence of instructors								
q. Influence of trainees								
r. Equipment required for food preparation and consumption								
s. Previous military education on how to use the rations in the Artic								
t. Previous military use of rations in the Arctic								

Comments on factors listed above OR any other factor that negatively affected your intake:

_____

_____

_____

24. Indicate whether you agree or disagree with the following statements.
1- Strongly disagree, 2- Disagree, 3- Neither agree nor disagree, 4- Agree, 5- Strongly agree

Statements	1	2	3	4	5
a. At home, I am usually able to meet my energy needs with the food I consume.					

b. I am worried about not meeting my energy needs with rations.					
c. On rations in the Arctic, I am generally able to meet my energy needs.					
d. On rations in a non-Arctic setting, I am generally able to meet my energy needs.					
e. Feeding myself with rations in the Arctic is easy.					
f. Feeding myself with rations in a non-Arctic setting is easy.					

Comments:

_____

_____

25. Did you strip/discard items from the rations during the Arctic exercise/operation?
    - ☐ No
    - ☐ Yes
        - What did you strip/discard? _____
        - Why? _____

26. If yes, do you usually discard these items (in non-Arctic settings)? ☐ Yes ☐ No
    Please explain: _____

27. Did you bring food (i.e. snacks, granola bars) from home to the Arctic exercise/ operation?
    - ☐ No
    - ☐ Yes
        - What did you bring? _____
        - Why? _____

28. Do you usually bring food from home (in non-Arctic settings)?
    - ☐ No
    - ☐ Yes
        - What do you bring? _____
        - Why? _____

29. Did you bring supplements (i.e. protein powders, vitamins/minerals) from home to the Arctic exercise/operation?
    - ☐ No
    - ☐ Yes
        - What did you bring? _____
        - Why? _____

30. If yes, do you usually consume these supplements at home? ☐ Yes ☐ No

D – Physical impact of rations

31. Were you hungry between meals? □ Yes □ No □ Sometimes

32. Were you hungry at night? □ Yes □ No □ Sometimes

33. Did you experience any gastrointestinal symptoms more than usual, following the consumption of rations during the Arctic exercise/operation?
    - ☐ No
    - ☐ Yes

34. If yes, please check (✓) all symptoms that apply:
    - ☐ Gas
    - ☐ Bloating
    - ☐ Heartburn
    - ☐ Nausea
    - ☐ Constipation
    - ☐ Diarrhea
    - ☐ Other: _____

35. Did you lose weight during the Arctic exercise/operation?
    - ☐ No
    - ☐ Yes. Approximately how much? _____ lbs

36. If yes, was it intentional? □ Yes □ No

37. Did you gain weight during the Arctic exercise/operation?
    - ☐ No
    - ☐ Yes. Approximately how much? _____ lbs

38. If yes, was it intentional? □ Yes □ No

E – Additional comments

39. Please provide any other information or comments you did not include previously:

_____
_____
_____
_____

Thank you for your participation and feedback!

APPENDIX E. PHASE 2 - CONSENT FORM

uOttawa

Université d'Ottawa
Faculté des sciences de la santé
École des sciences
de la nutrition

University of Ottawa
Faculty of Health Sciences
School of Nutrition Sciences

Consent Form

Title: Assessment of factors pertaining to the individual, the diet and the environment influencing the dietary intake of rations by soldiers in the Canadian Armed Forces (CAF) working in the Arctic.

Invitation to participate: I am invited to participate in the research study entitled "Assessment of factors pertaining to the individual, the diet and the environment influencing the dietary intake of rations by soldiers in the Canadian Armed Forces (CAF) working in the Arctic" conducted by Florence Lavergne for her Master's thesis in Interdisciplinary Health Sciences at the University of Ottawa.

Purpose of the study: The purpose of the study is to better understand the soldiers' overall experience with combat rations, and help identify factors influencing the dietary intake of soldiers working in the Arctic.

Participation: My participation will consist in completing a survey (5 mins), and completing a 24-hour food diary using the provided form (15 mins). Height, weight, and body composition will be measured at the beginning, middle, and end of the training (15 mins). An individual interview (45 mins) will be completed after the Arctic training, at the military base, to learn in greater depth my overall experience with combat rations and dietary habits while on training.

Benefits: My participation in this study will enhance the understanding of combat ration consumption in cold environments. This research project will give me an opportunity to share about any possible barriers and facilitators to my dietary intake of rations in the Arctic.

Confidentiality and anonymity: I have been assured by the researchers that the information I will share will remain confidential. To maximize the security of the information, I will be provided an envelope in which I can place my documents and seal them, then return the designated person.

To protect the confidentiality of the data, participants' names will be coded with an identification code on all paper and electronic documents. The list linking names to identification codes will be stored and locked in the office of the principal investigator separately from the paper and electronic data. My name will not appear on any publications related to this research project.

The data will be analyzed by researchers at the University of Ottawa. A summary of the results will be shared with the CAF Food Services. The summary will include a compilation of results and statistical findings. No individual data will be shared.

☎ 613-562-5800 (1596)
613-562-5632

25 University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

Audio recording: I understand that the interview will be audio-recorded and transcribed in order to help the data collection. No names will be mentioned during the recorded interview.

Conservation of data: I am aware that the data collected (recording, transcript, body measurements, food diary, survey) will be kept in a secure manner. The research data will be stored on a USB, and hard-copy documents will be locked in a cabinet. The computers used for data analysis have secure passwords and codes will be used to encrypt the information. Only the student researcher, the supervisors, and a research assistant will have access to the data. The data will be conserved for ten years after the completed surveys have been collected. Subsequently, the list linking names to the identification codes will be destroyed and data will become anonymous.

Voluntary participation: I am under no obligation to participate and if I choose to participate, I may refuse to answer any questions. I am free to withdraw from this research at any time without negative consequences. If I withdraw from the study, the data collected thus far will be kept or destroyed as I wish.

Acceptance: By signing this form, I consent to participate in the above research study conducted by Florence Lavergne doing a Master's in Interdisciplinary Health Sciences at the University of Ottawa, under the supervision of Pre. Isabelle Giroux and Dr. Denis Prud'homme.

If I have any questions about the study, I may contact the student and/or the supervisors at the numbers mentioned below.

If I have any ethical concerns regarding my participation in this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, K1N 6N8, Ottawa, ON (613) 562-5387 or ethics@uottawa.ca.

There are two copies of this form, one of which is mine to keep. I am invited to keep it in my files.

Participant's name (printed): _____
Participant's signature: _____ **Date:** _____

Researcher's name (printed): _____
Researcher's signature: _____ **Date:** _____

Name of student researcher: Florence Lavergne
Coordinates:
Affiliation: School of Nutrition Sciences, University of Ottawa, K1N 6N5

Name of supervisor: Professor Isabelle Giroux
Coordinates:
Affiliation: School of Nutrition Sciences, University of Ottawa, K1N 6N5

Name of co-supervisor: Dr. Denis Prud'homme
Coordinates:
Affiliation: Montfort Knowledge Institute, Montfort Hospital

Name of CAF contact: LCdr Lynda Hinch
Coordinates:
Affiliation: Strat J4 Food Services, Strategic Joint Staff, 5-2, Canadian Armed Forces

APPENDIX F. PHASE 2 - DEMOGRAPHIC SURVEY

Study on Combat Rations Consumed in the Arctic

A – Demographic information

1. Name : _____
2. Usual place of duty/Location of your military base: _____
3. Age: _____
4. Sex: _____
5. Ethnicity: _____
6. Mother tongue: □ French □ English □ Other: _____
7. Official language of preference: □ French □ English
8. Number of years in the Canadian Armed Forces: _____
9. Role during the Arctic Operations Advisor course: □ Trainee □ Instructor
10. Before the AOA course, did you have any previous experience working in the Arctic for military or personal purposes?
    □ No
    □ Yes. Please specify the number of times you have been in the Arctic: _____
11. Do you have hands-on experience preparing combat rations?
    □ Yes □ No
12. Do you have hands-on experience preparing combat rations in the Arctic?
    □ Yes □ No

B – Diet history

13. At home, I am usually on a diet.
    □ No □ Yes. Please specify: _____
14. Did you bring food (i.e. snacks, granola bars) from home to this course?
    □ No □ Yes
15. If YES, what did you bring? _____
    Why? _____
16. Do you usually bring food from home (in non-Arctic settings)?
    □ No □ Yes
17. If YES, what did you bring? _____
    Why? _____
18. Did you bring supplements (i.e. protein powders, vitamins/minerals) from home to the Arctic exercise/operation?
    □ No □ Yes
19. If YES, what did you bring? _____
    Why? _____
20. If YES, do you usually consume these supplements at home? □ Yes □ No

C – Additional comments

21. Please provide any other information or comments you did not include previously:
    _____
    _____
    _____

Thank you for your participation and feedback!

APPENDIX G. PHASE 2 – 24-HOUR FOOD DIARY

24-hour Food Diary

Name: _____ Date: _____
Weight (kg): _____

1. **Please indicate how much (%) of each item from the Individual Meal Packs (IMPs) you consumed.**

2. **Please write the main entrée from your meal (e.g. Pulled pork) on the line below. For the other items of the IMP, include as many details as possible (e.g. Fruit → Apple sauce; Desert → Date squares).**

3. **If you remember the number of the IMPs you consumed, please write it on the line below, and circle the year (e.g. IMP 17 Menu #5 = #5, 2017).**

4. **Rate your appreciation using the following scale:**
   1- Very Unacceptable, 2- Moderately Unacceptable, 3- Slightly Unacceptable, 4- Neutral, 5- Slightly Acceptable, 6-Moderately Acceptable, 7- Very Acceptable

5. **Please include all other foods you consumed (apart from the ones provided in the IMPs). Include as many details as possible (e.g. ½ cup trail mix with pretzels + peanuts + almonds + dried raisins + chocolate chips; 1 peanut butter Clif Bar).**

Breakfast **Menu # :** _____ **IMP year :** **2016** **2017** **2018**

Items	Consumption (%)	Acceptability						
		1	2	3	4	5	6	7
Entrée: _____								
Fruit								
Cereals								
Sports Drink								
Coffee								
Bread (hamburger bun/tortilla/corn bread)								
Peanut butter								
Jam								
Condiments :								
Miscellaneous (energy bar/ nut mix/ beef jerky)								
Protein drink/ Drink mix/ Meal replacement								
Candy (Tic Tac mints)								

24-hour Food Diary

Food from home / other food :								

Lunch **Menu #: _____** **IMP year: 2016 2017 2018**

Items	Consumption (%)	Acceptability						
		1	2	3	4	5	6	7
Entrée: _____								
Mashed potatoes								
Fruit/desert								
Chocolate bar								
Sports Drink								
Coffee								
Bread (hamburger bun/tortilla/corn bread)								
Peanut Butter								
Condiments :								
Miscellaneous (energy bar/ nut mix/ beef jerky)								
Protein drink/ Drink mix/ Meal replacement								
Candy (Tic Tac mints)								
Food from home / other food :								

24-hour Food Diary

Supper **Menu # : _____** **IMP year: 2016 2017 2018**

Items	Consumption (%)	Acceptability						
		1	2	3	4	5	6	7
Entrée: _____								
Mashed potatoes								
Fruit/desert								
Chocolate bar								
Sports Drink								
Coffee								
Bread (hamburger bun/tortilla/corn bread)								
Peanut butter								
Condiments :								
Miscellaneous (energy bar/ nut mix/ beef jerky)								
Protein drink/ Drink mix/ Meal replacement								
Candy (Tic Tac mints)								
Food from home / other food :								

24-hour Food Diary

If you also ate a Light Meal Combat ration (LMC, or "snack pack"), please complete the section below.

Menu name: **BBQ Jerky** **Beef Jerky** **Teriyaki Jerky**

Items	Consumption (%)	Acceptability						
		1	2	3	4	5	6	7
Jerky								
Dried fruit								
Fruit bar								
Energy bar								
Nut mix								
Meal replacement								
Sports drink								
Coffee								
Chocolate bar								

Once completed, please put this form in the provided envelope, seal it, and return it to the designated person.

Thank you for your participation!

APPENDIX H. PHASE 2 - INTERVIEW GUIDE

INTERVIEW GUIDE

Themes and Main Questions	Probes (follow-up questions)
(Food and nutrition knowledge) 1. How would you describe your knowledge related to foods and nutrition?	a. What do you use as source of nutrition information? b. How would you describe your food preparation skills (in general/at home)? c. Does this influence your ability to prepare rations? How? d. To what extent were discussions or teachings about food and nutrition incorporated into your training in the Army? e. Would you have benefited from more information on food and nutrition in your training? f. Could you describe any diet requirements that are not met by the IMPs (e.g. food allergies, vegetarian, religious, vegan, etc.)?
(Healthy eating) 2. Is eating a healthy balanced diet a concern for you? 2.1 In general? 2.2 What about during the AOA course?	a. What do you think would have been ideal for you to eat/drink on the course? b. What do you consider to be good nutrition for soldiers' performance? i. What types of food and beverages should be eaten? ii. How much should a soldier eat/drink? iii. What makes a soldier's diet unhealthy? c. Do you think what you ate/drank affected your performance during the course? Explain.
(IMPs) 3. In regards to the Individual Meal Packs (IMPs), what do you think of: 3.1 Variety of the food available in the rations? 3.2 Taste of the rations? 3.3 Nutritional value? 3.4 Texture? 3.5 Ease of preparation? 3.6 Weight? 3.7 Amount of food? 3.8 Etc.	a. Do you think the IMP's could be improved? If yes, what would you improve and why? i. Taste? Type of food? Wastage? Variety offered? … b. How much time did you have for meals (preparation + eating) in Resolute? ii. Was this sufficient time? c. While in Resolute, did you have to skip meals? i. Tell me more about that. ii. If yes, how did you maintain your energy level? d. Can you please describe any challenges you had in preparing the IMPs during the daily routine? e. Please tell me about your fluid intake and what you drank while on IMPs. i. Were you thirsty? ii. Were enough fluids available to quench your thirst? f. If thawing the food is an issue in the Arctic, what would you suggest to better thaw the IMPs?

1

	g. Do you normally (in operations/deployments) eat all of your IMP? i. If not, why? What are the main reasons for this? ii. What about in Resolute: Did you eat everything in the IMP? Explain. j. Do you sometimes strip/discard items from your IMP? If so, why? ii. What portion of you IMPs did you consume in Resolute? k. Can you describe any other changes you would like to see in the current IMPs and/or suggestions to improve feeding in the Arctic? Why those changes? l. How often did you have access to fresh rations? How did you like them? i. How many days in a row were you on IMPs? ii. How often did you have local food? m. How would you feel about eating dehydrated rations?
(Mood and morale) 4. Do you think that eating IMPs on Arctic Ops impacted your mood? Team morale?	a. How did you feel if you did not have enough food during the day? b. Did you have days when you didn't have enough to eat? i. How did this affect you? ii. How did this affect your performance?
(Influence of others) 5. Based on your experience in Resolute, was your food intake (the amount of food you ate) influenced by others (instructors and/or peers) participating in course? How so?	i. What was the effect on your food intake? ii. What was the effect on your mood/psychologically/the way you felt?
(Physical impact/activity) 6.	a. Describe your digestion of IMPs. Are the rations easily digestible? i. Is this usually the case? b. After eating an IMP, do you feel full and satisfied (ie. enough food)? c. Have you experienced a weight gain, weight loss or no weight change eating the IMPs during the AOA course? i. What may have caused this? Please explain. ii. Does this reflect what you thought? Are you surprised? Did you expect this? d. How would you describe your usual exercise level? i. What about during the AOA course?

	e. Were there times you didn't eat all of your IMP and saved it for the next day? f. Was your appetite affected by the cold of other factors?
(Snacks and supplements) 7. Are you satisfied with the food/snacks available to you in the field (in Resolute) between the main meals (i.e. LMCs)?	a. Were the snacks between meals in the field giving you sufficient energy? i. What types of snacks did you normally have? ii. How often did you eat them? iii. What do you prefer to eat as a snack on the go? b. On this course, did you eat what you brought from home? i. Was it necessary to bring? c. Would you say that supplements (i.e. Vitamins, minerals, protein powders, energy boosts, etc.) are taken by many people/are promoted in the military? i. In your military training, were supplements ever addressed or encouraged?
(Conclusion) 8. Are there any final comments/concerns you would like to talk about regarding IMPs that we have not already discussed/that you think we should know about?	

APPENDIX I. ABSTRACT POSTER PRESENTED AT THE 2019 DIETITIANS OF CANADA NATIONAL CONFERENCE (JUNE 6-7, 2019)

Factors influencing the dietary intake of military members in the Canadian Armed Forces working in the Arctic

F. Lavergne[1], I. Giroux[2]
[1] Interdisciplinary School of Health Sciences, University of Ottawa
[2] School of Nutrition Sciences, University of Ottawa

uOttawa

Introduction: Military members in the Canadian Armed Forces (CAF) do not consistently meet their daily energy needs with combat rations when working in harsh environments, like the Arctic (1, 2). Low dietary intakes over a prolonged period can contribute to involuntary weight losses and diminished performance, and increase the risk of injury (3). Many factors are thought to influence soldiers' dietary intake (2, 3).

Objectives: This study aimed to determine CAF members' perception of individual, dietary, and environmental factors influencing food intake while working in the Arctic.

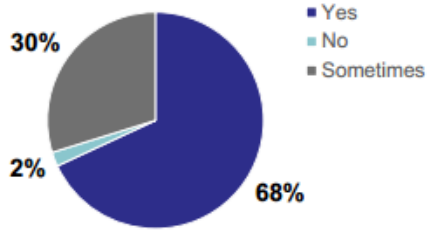
Methods: A survey was sent nationally with *SurveyMonkey* July-September 2018 to military members who worked in the Arctic 2015-2018. The survey included questions on demographics, physical markers, acceptability of rations, eating habits, and diet history during Arctic work. The 20-minute survey had 39 open and closed-ended questions, including some on food variety, amount of food eaten, time for meals, ability to heat rations, hunger, and weight changes. Excel was used to compile descriptive statistics.

Results: The survey response rate was 27.5%. Soldiers (n=37) and instructors (n=11) participated (ages 31.7±7.2 years; 45 men, 3 women). They reported that 61%, 68%, and 71% of breakfast, lunch, and supper rations were eaten. Two participants reported not having enough time to eat [Figure 1]. Eating on the move, weather/environmental conditions, and equipment required for food preparation and consumption were factors that negatively affected the most dietary intake of military members during Arctic exercises. Sixty-five percent (n=31) self-reported losing weight during their exercise (1.8−11.3 kg).

Conclusion: Preliminary results showed that many factors influenced the dietary intake of CAF members working in the Arctic. Lack of time did not seem to limit intake. More research is needed to accurately measure weight change during these exercises, and explore options to make rations better adapted for the Arctic.

Significance to the field of dietetics: These results may help dietitians develop rations better suited for this population.

Figure 1. **"Did you have enough time to eat your ration?" (n=47)**



1. Goodman, L., Sullivan-Kwantes, W., & Blais, A. R. (2015). *Observations and survey results of army field feeding in the Arctic: Arctic field feeding logistics and effectiveness* (scientific report n° R289). Defense Research and Development Canada – Toronto Research Centre.
2. Mandic, I., & Jacobs, I. (2013). *Field-feeding for CF land military operations: Basic guidelines for standard and incremental allowances for food service providers* (rapport de contrat n°104). Defense Research and Development Canada – Toronto Research Centre.
3. Committee on Military Nutrition Research. (1995). *Not Eating Enough: Overcoming Underconsumption of Military Operational Rations*. Marriott, B. M. (éd.). Institute of Medicine. National Academies Press. Washington, USA.

I would like to thank Pre Isabelle Giroux for her consistent help throughout this project, as well as the Canadian Armed Forces for their support and cooperation in this study, especially Lynda Hinch.

APPENDIX J. ABSTRACT PRESENTED AT THE CANADIAN FOUNDATION FOR DIETETIC RESEARCH SHOWCASE (JUNE 6-7, 2019)

Abstract Title
Factors influencing the dietary intake of military members in the Canadian Armed Forces working in the Arctic

F. Lavergne[1], I. Giroux[2]

[1]Interdisciplinary School of Health Sciences, University of Ottawa, ON, [2]School of Nutrition Sciences, University of Ottawa, ON

Abstract

Introduction: Military members in the Canadian Armed Forces (CAF) do not consistently meet their daily energy needs with combat rations when working in harsh environments, like the Arctic. Low dietary intakes over a prolonged period can contribute to involuntary weight losses and diminished performance and increase the risk of injury. Many factors are thought to influence soldiers' dietary intake.

Objectives: This study aimed to determine CAF members perception of individual, dietary, and environmental factors influencing food intake while working in the Arctic.

Methods: A survey was sent nationally with SurveyMonkey July-September 2018 to military members who worked in the Arctic 2015-2018. The survey included questions on demographics, physical markers, acceptability of rations, eating habits, and diet history during Arctic work. The 20-minute survey had 39 open and closed-ended questions, including some on food variety, amount of food eaten, time for meals, ability to heat rations, hunger, and weight changes. Excel was used to compile descriptive statistics.

Results: The survey response rate was 27.5%. Soldiers (n=37) and instructors (n=11) participated (ages 31.7±7.2years; 45 men, 3 women). They reported that 61%, 68%, and 71% of breakfast, lunch, and supper rations were eaten. Two participants reported not having enough time to eat. Eating on the move, weather/environmental conditions, and equipment required for food preparation and consumption were factors that negatively affected the most dietary intake of military members during Arctic exercises. Sixty-five percent (n=31) self-reported losing weight during their exercise (1.8−11.3kg).

Conclusion: Preliminary results showed that many factors influenced the dietary intake of CAF members working in the Arctic. Lack of time did not seem to limit intake. More research is needed to accurately measure weight change during these exercises and explore options to make rations better adapted for the Arctic.

Significance to the Field of Dietetics: These results may help dietitians develop rations better suited for this population.

Funding: Canadian Armed Forces

APPENDIX K. RESEARCH POSTER PRESENTED AT THE NEW FRONTIERS IN HEALTH POLICY CONFERENCE (MCMASTER UNIVERSITY, NOVEMBER 14, 2019)

Factors affecting the dietary intake of combat rations by soldiers working in the Arctic

uOttawa

F. Lavergne[1], I. Giroux[2]

[1] Interdisciplinary School of Health Sciences, [2]School of Nutrition Sciences, Faculty of Health Sciences

Introduction

- Military members in the Canadian Armed Forces (CAF) do not consistently meet their daily energy needs with combat rations when working in harsh environments, like the Arctic (1, 2).
- A low dietary intake over a prolonged period of time can contribute to a involuntary weight loss and diminished performance, as well as can increased risk of injury in the field (3).
- Many factors are thought to influence their dietary intake (2, 3).

Objectives

To determine CAF military members' perception of the individual, dietary, and environmental factors influencing their food intake while working in the Arctic.

Methods

- We created a bilingual survey with *SurveyMonkey*.
- It was sent nationally between July and September 2018 to military members who worked in the Arctic between 2015 and 2018.
- The survey included questions on :
  - Demographic information
  - Overall acceptability of rations
  - Eating habits and diet history
  - Effects of rations on physical markers
- Results were compiled and analyzed in Excel.

Results

Table 1. **Demographic information (n=48)**

Age*	31.7 ± 7.2 years
Sex	45 men, 3 women
Role	37 soldiers, 11 instructors
Language of preference	10 French, 38 English
Number of years in the CAF*	12.1 ± 6.8 years

** mean ± standard deviation*

Figure 1. **Proportion of combat ration eaten at each meal (n=48, mean ± standard deviation)**

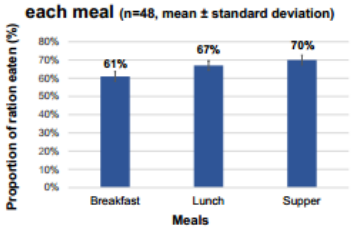


Figure 2. **"Did you have enough time to eat your ration?" (n=47)**

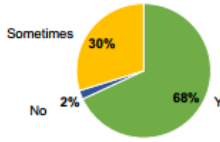
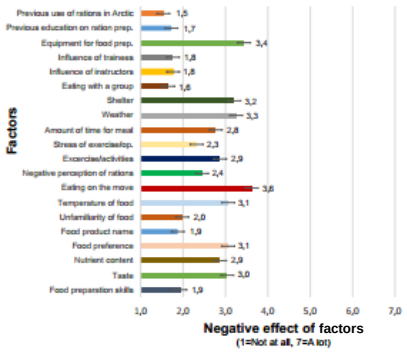


Figure 3. **Perception of weight changes during an exercise in the Arctic (n=48)**

	Number of individuals (%)	Average weight change* (kg)
Weight gain	3 (6,3%)	6,0 ± 2,6 kg
Weight loss	31** (64,6%)	5,3 ± 2,5 kg
Stable weight	14 (29,2%)	0

** mean ± standard deviation*
*** 2 people reported intentionally losing weight*

Figure 4. **"Please mark how much each factor negatively affected your intake of rations" (n=48, mean ± standard deviation)**



Conclusion

- These preliminary results show that many factors influenced the dietary intake of CAF members.
- Lack of time did not seem to limit intake. However, eating on the move, the extremely cold environment, and the equipment necessary to prepare meals seemed to have been the biggest obstacles to dietary intake.
- More research is needed to accurately measure weight change during these exercises, and to explore different options to make the rations better adapted for the Arctic.

Acknowledgements

I would like to thank Pre Isabelle Giroux for her consistent help throughout this project, as well as the Canadian Armed Forces for their support and cooperation in this study, especially Lynda Hinch.

References

1. Goodman, L., Sullivan-Kwantes, W., & Blais, A. R. (2015). *Observations and survey results of army field feeding in the Arctic: Arctic field feeding logistics and effectiveness* (rapport scientifique n° R289). Defense Research and Development Canada – Toronto Research Centre.
2. Mandic, I., & Jacobs, I. (2013). *Field-feeding for CF land military operations: Basic guidelines for standard and incremental allowances for food service providers* (rapport de contrat n°104). Defense Research and Development Canada – Toronto Research Centre.
3. Committee on Military Nutrition Research. (1995). *Not Eating Enough: Overcoming Underconsumption of Military Operational Rations*. Marriott, B. M. (ed.). Institute of Medicine. National Academies Press. Washington, USA.